2ND EDITION

Understanding ICT Standardization

PRINCIPLES AND PRACTICE

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UNDERSTANDING ICT STANDARDIZATION: PRINCIPLES AND PRACTICE

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PREFACE

ETSI has run this project to produce a 2nd edition of the textbook "Understanding ICT Standardization: Principles and Practice" along with materials to facilitate education on ICT and to raise the knowledge level of ICT standardization-related topics among lecturers and students. ETSI recruited a group of experts from those who produced the 1st edition and a further expert in IPR. All of the experts have been actively involved in current standardization production and/or research within the area of ICT.

To advance education about ICT standardization, the attractiveness of the topic among lecturers and students needs to be improved further. Comprehensive and up-to-date teaching materials constitute a major way to convey the value and raise awareness of standardization. To provide high value for teachers and students, our main objective has been to create a 2nd edition of the textbook and accompanying teaching/learning materials for standardization education that are tailored to the requirements and challenges of the ICT sector.

The experts who co-authored this 2nd edition took feedback received while updating the book which was published initially in 2018. This led to the significant changes made to the textbook and the accompanying learning material, including the slides, visualizations, quizzes and case studies.

Readers of this textbook are not required to have any previous knowledge about standardization. They are introduced firstly to the key concepts of standards and standardization, different elements of the ecosystem and how they interact, as well as the procedures required for the production of standardization documents. Then readers are taken to the next level by addressing aspects related to standardization such as innovation, strategy, IPR, business, and economics.

The contents of the book can be read in different ways. It can be read from cover to cover in a linear way, or readers may only focus on the specific chapters they are interested in. This is supported by the modular structure of the textbook, making the single chapters self-contained units that can be studied independently of other chapters. Each chapter begins with a list of learning objectives and key messages about what they will be learning in that particular chapter. For lecturers, this could be regarded as "meta-contents" to help decide which chapter of the book suits better the module or topic they are teaching.

The teaching resources comprise this textbook, which conveys the main theoretical knowledge. The text is enriched with examples from real standardization practice to illustrate the key theoretical concepts. Furthermore, the book includes case studies, where the "case" can be a standardization document, an event or action, or a company that implemented a particular practice that is related to standardization. Each case study is intended to make readers reflect on a subset of the book's learning objectives and messages, and it could potentially be used by lecturers as a building block for further learning activities more tailored to their particular teaching needs. Case studies also enable student to better see the application of the concepts learned and allow a classroom environment that promotes group discussion and interaction among students. Each chapter also includes a quiz to be used as a self-assessment learning activity.

Furthermore, each chapter includes a glossary and list of abbreviations, which are useful in any learning context and indispensable in order to better understand and recall standardization knowledge. Finally, the chapters also have their corresponding summary and references.

Alongside the textbook, a set of slides have been produced that are intended to serve as complementary teaching materials in face-to-face teaching sessions.

In addition to its use in undergraduate and Masters courses, the textbook consists of advanced topics that can serve as a starting point for graduates and PhD students interested in standardization research. The textbook also serves as a guide or checklist for experts already active in standardization activities by providing them with arguments for the justification and improvements of standards activities from a management point of view.

This textbook has been intended to reach all potentially interested readers, including those with disabilities. Hence, ETSI and the authors have committed themselves to ensure the accessibility of the book and its contents. For all interested parties there is also an electronic version of the textbook as well as the accompanying slides that can be downloaded for free form the ETSI website (www.etsi.org).

With the hope that all readers enjoy the learning process by using this 2nd edition of the textbook and the teaching materials, ETSI and the group of authors would welcome any comments and feedback that aims at improving the current materials. The authors would also like to thank all contributors to this work.

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FOREWORD

Step into any ETSI committee meeting, and you will encounter individuals with a wealth of professional experience, both in their technical areas, and in standardization processes. They acquired their technical knowledge through education, training and life-long learning. But where did they get their standardization skills? It is unlikely they received much formal education or training in standardization, beyond attending short courses run by standardization bodies, such as our ETSI Seminar.

However, standardization is not merely a technical subject. Standardization has become a key business process in the ICT industry. In our industry we talk of networked innovation and platform technologies. Software is modular and increasingly open source, while common components are found in many disparate products. Furthermore, companies make extensive use of patent protection for their innovations. In this environment, the path to commercial success for ICT products and services is often through standardization. Standardization enables common components, provides the platform technologies, unlocks a global market with all the attendant economies of scale. Standards essential patents may also release the value in protected innovations. The business-oriented view of the importance of standardization is not widely recognized, and hence it is often missing from our business and legal education.

To try to remedy this situation and prepare a new generation of standards professionals, ETSI has commissioned the development of this second edition of teaching materials for a comprehensive education course on ICT standardization. This material could be used in a standards-focussed module in engineering and scientific education. Parts of it could also be integrated into in-company training courses. The material, a textbook and a comprehensive set of slides, will be available from the ETSI website free of charge, and is designed to be adapted by lecturers and teachers according to their specific needs.

The teaching material has been developed by a team composed of researchers, lecturers and standards professionals. Indeed some team members fulfil all three roles. This work expresses their independent professional opinion and does not form an official ETSI teaching on the subject of standardization. This material is being trialled in universities and we expect its usage to grow. Please provide us with feedback for future possible updates. But mostly, I encourage you to use it, learn from it and share your knowledge of this important aspect of our ICT industry.

Luis Jorge Romero
Director General
ETSI

1 INTRODUCTION

Standards support our everyday life much more than we may think. We owe much of the progress in our modern life to standardization. Without standards, our life would not be as organized as it is today. We would have difficulties in accomplishing basic things that we now take for granted.

Imagine if time measurement or the track width of trains were not standardized, or imagine if we were not able to use our mobile devices once we are out of the reach of our operators' networks, for instance abroad.

Thousands of years ago, society recognized the importance of standardized measurements. Weight and distance, or length, cannot be measured without a common reference system agreed upon by people and institutions, in other words a system that is standardized. With technological progress, the need for standardization grows. The rapid progress in information and communication technology (ICT) could not be achieved without the advances in standardization. Standardization and standards boost progress and create a common basis, upon which technology can evolve.

Though important, ICT standardization and its methods remain a topic that is not easily accessible. In fact, standardisation principles are the same, independent of the fields of application, be it mechanical engineering, ICT, nanotechnology, on any other area of interest. ICT, however, exhibits some discipline-specific features. The present textbook deals with these specifics and explains them in a way that is as simple as possible without compromising rigour and depth. Due to the rapid technological advances in ICT, ICT standardization seems to become increasingly restrained to the expert, while remaining mysterious to the non-expert. So far, there is a fair body of research published in the area, but there is no textbook that makes the topic easy to digest by the interested student and the practitioner that requires a reference that contains the most important concepts in ICT standardization. We believe that standardization, in particular in ICT, deserves more attention, especially in relationship with education. The principles of ICT standardization should be taught in class to convey essential knowledge to students about such an important field. A good understanding of the concepts provided in this book will enable students and practicing professionals to get a good overview of the field, so that they are able to put this knowledge in practice or advance it through their own research.

Thus, this textbook is an attempt to remove the accessibility barriers related to the understanding of ICT standardization. Our aim is to cover the essentials of the field of standardization by large and the ICT-specific aspects, while additionally conveying our passion to the topic. The book is organized in chapters that are related to each other. Therefore, readers are encouraged to read the book from cover to cover.

After the current introduction, we provide, in the second chapter, a high-level overview of the scope and process of standardization, while introducing the main subjects that are covered in detail in subsequent chapters. It is a synthesis of the basic concepts mainly expressed in a simple and example-based way.

In Chapter 3, readers are introduced to the key concepts that will guide them through the tricky landscape of standardization. Thus, the chapter will provide readers with essential concepts to help them find their way along the standards ecosystem. In particular, readers will learn about Standards Development Organizations (SDOs), and the mechanisms that support cooperation and coordination between different SDOs, especially the coordination of activities between European and national SDOs as well as the coordination between European and International SDOs. Readers will also learn about the role of recognised and non-recognised SDOs, industrial consortia, and their interplay. Furthermore, the characteristics and processes of formal and de facto standardization will be described. Then, the chapter will address the main categories of ICT standards, and the naming conventions of standardization. Readers will also be introduced in the mechanisms and concepts through which standards support regulation, legislation and policy making. This chapter ends with a detailed case study that deals with the revision of a national standard about Telecare from an ICT accessibility perspective.

Chapter 4 addresses several topics related to the development of high-quality formal standards. The process of producing standards is described in detail and illustrated with several examples. As standards are written by standardization experts with deep knowledge in their technological fields, the chapter describes their roles in the standardization process as well as the technical and personal skills that enable them to carry out their daily tasks. Chapter 4 also describes the main activities and responsibilities of standardization professionals and experts and how they interact with their peers, inside the standardization group and within their own organizations. Whereas the standardization professionals consist of all contributors to the standardization process, including those that standardization bodies involve in the management and organization of the whole standardization process, standardization experts are those individuals that contribute with their specific knowledge to the written standard.

To be successful in a competitive marketplace, companies need to be innovative. They must constantly look for new opportunities for innovation. Chapter 5 deals with the interdependencies between innovation and standardization. Whereas innovation is understood as the result of a creative process, standards rather represent stability and identification of common grounds. Those aspects are—at least at a first glance— not necessarily conducive to innovation. However, standards are the result of many years of knowledge gathering and structuring. As such, standards represent an important source of codified knowledge. Although they are crucial to the company's success, many companies do not see the relationships between standards/standardization and innovation. Chapter 5 will, in particular, explain the so-called innovation potentials in standardization, in other words the aspects that make standardization conducive to innovation.

Chapter 6 deals with how companies can leverage standardization from a strategic viewpoint with the objective of being successful in the market. It also discusses different strategies that organizations may pursue when they participate in standardization. For example, what are the criteria to consider when companies should select an SDO to engage with in the development of a standard? Chapter 6 concludes with guidance on how to select standards for a given application, while elaborating criteria for the selection of the most suitable standards.

Beside standards, patents represent an important instrument for the codification and diffusion of knowledge. Chapter 7 focuses on standards-essential patents (SEPs), which are patents that are cited in standards and therefore necessary for the implementation of these standards. SEPs lead to a particular situation where standards cannot be implemented in practice without leveraging the knowledge protected by Intellectual Property Right (IP) laws, for which licensing fees are to be paid to patent owners. Opportunistic behaviour can drive patent owners to intentionally include their patent protected knowledge into standards, with the objective of claiming high fees from standard implementers. Therefore, the chapter addresses the IPR policies that SDOs have put in place to cope with this problem. In practice, there are many standards for which SEP ownership is fragmented across many owners. When implementers then need to have separate (bilateral) licensing negotiations with all patent owners, this can trigger excessive implementation difficulties by requiring a lot of resources for coordination, obviously leading to a counter-productive situation. Therefore, the chapter deals with the important role of patent pools as a one-stop shopping approach for patent owners and standards' implementers.

Chapter 8 provides an in-depth analysis of the economic contribution of standards, in particular to Gross Domestic Product (GDP). Standards are an important instrument in the diffusion of new technologies and technological know-how and contribute significantly to economic growth. Although our world is strongly reliant on standards, their effects on the economy are not well known. Standards are carriers of codified intelligence and can provide companies with state-of-the-art knowledge, saving the companies the burden of developing state-of-the-art-knowledge anew. This chapter also analyses the role of standards in public procurement. Governments use standards in the context of public procurement to improve transparency and guarantee public services of high quality. Companies that are willing to apply for public tenders need to comply with the required standards. Thus, the government can indirectly encourage the adoption of standards by companies, and therefore support the innovative strength and technological progress of a nation.

It is hoped that having provided readers with some of the background as to why we have written this book, as well as a foretaste of the main contents, that they will learn from each of the different chapters of the book. We wish all our readers a good journey and a lot of fun during their learning experience.

2 INTRODUCTION TO STANDARDS

LEARNING OBJECTIVES

- Students should be able to identify what the purpose of standards is and how standards impact people's everyday life.
- Students should know what a standardization process is. Furthermore, they should know what formal standardization and Standard Development Organisations (SDO) are.
- Students should be able to distinguish between a SDO standard and a de facto standard.
- Students should understand what benefits standards bring and what potential undesired drawbacks they may imply.
- Students should acquire a basic knowledge of the international, regional, and national standardization landscape, where multiple organizations operate and collaborate to create standards.
- Students should get a glimpse of major SDOs active in the ICT sector.
- Students should understand the basic concepts of the SDOs' processes and the characteristics of the main deliverables.

2.1 BASICS OF STANDARDIZATION

2.1.1 INTRODUCTION

The online Cambridge dictionary provides the following definitions for the term "standard": "a pattern or model that is generally accepted" (example, "This program is an industry standard for computers") and "a level of quality" (e.g., "This piece of work is below standard/is not up to standard."). As we will see in the next part of this chapter, both definitions may apply to the specific purpose of our work. For the time being, we will primarily stick to the first definition, which, in an even more general and informal way, can be expressed as such.

DEFINITION

A "standard" is "a widely agreed way of doing something". Depending on the specific area of application, "doing something" may be replaced by, for example, "designing a product", "building a process", "implementing a procedure", or "delivering a service".

Practically speaking, a standard is a document that describes a widely agreed way of doing something; in other words, it may be seen as a codification of shared knowledge. Clearly, "standard", i.e., " widely agreed and common" ways of doing things provide many benefits; our technological world simply would not work, or, at least, it would be harder and more uncomfortable to make it work without "standards". In fact, let us think about how we, computer users, would be in difficulty if each computer maker used a different way of arranging keys on a keyboard, or if each producer of computer peripherals used its own specific connectors or, even, its own protocol[1] (Figure 2.1). On the one hand, we, as users, would be confined to choosing from a limited selection of compatible devices and, on the other hand, computer and peripheral makers would be forced to pre-select, by design, the counterparts they want to interoperate with.

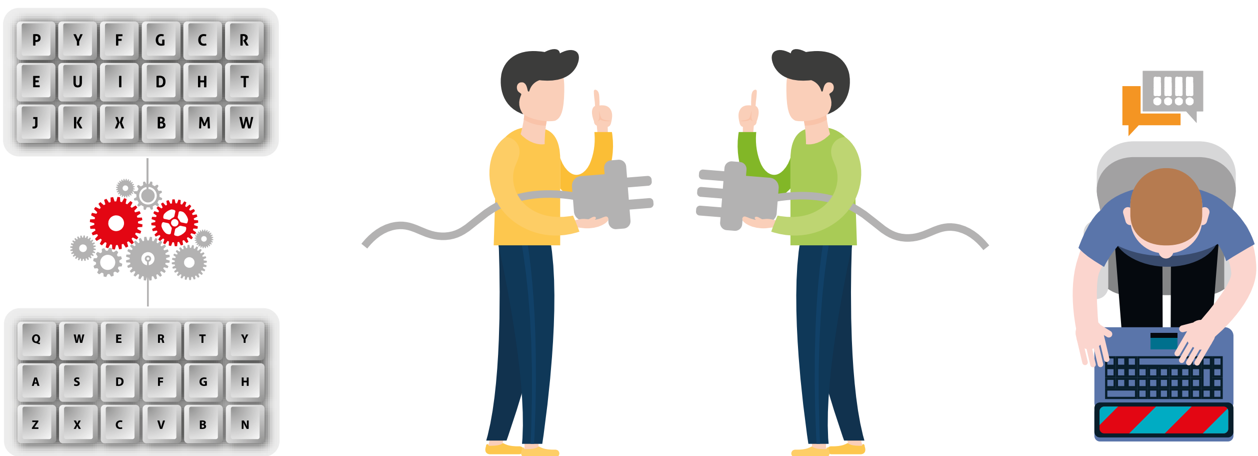

Figure 2.1: Technologies would not work without standards

Looking at the examples above (we will go back to them in more detail in the next section) they could be extended to a wide variety of other fields. It is evident how a common and agreed "way of doing things" is largely beneficial to all players in a business sector.

Such convergence towards common and agreed-upon solutions can take place in different ways, which can be called “standardization processes” (or simply “standardization”). Some organisations have well established standardization processes, and we call them Standards Development Organisations (SDOs). These processes can be a first criterion for distinguishing different types of "standards". For example, we may initially distinguish between "de facto standards" and "standard developed by devoted Standards Development Organization (SDO) standards" or “SDO standards” (sometimes also referred to as “de jure standards”, see paragraph 3.2.1. for details).

A "de facto standard", also known as "standard in actuality", arises when a winning solution is widely and independently adopted by different industries within a market segment and products developed on such a basis are widely accepted by customers.

1 Here, "protocol" means the set of messages that two devices (in this case, a PC, and a connected peripheral) need to exchange to interoperate. The protocol defines the messages to be exchanged to perform a certain action (for instance, to send a document from a PC to a printer), their logical content and format, as well as their sequence.

EXAMPLE

Some examples of "de facto standards" are:

- The most widely used keyboard layout (QWERTY) dates back to 1864, when it was patented by Christopher Sholes. The later Dvorak version (1936, by August Dvorak) was intended to increase typing speed, but owing to the already consolidated position of QWERTY, was not as successful (though natively supported by most modern operating systems).
- HD DVD (High Definition Digital Versatile Disc) and Blu-ray Disc are two digital optical formats for new-generation DVDs suitable for high-definition content.

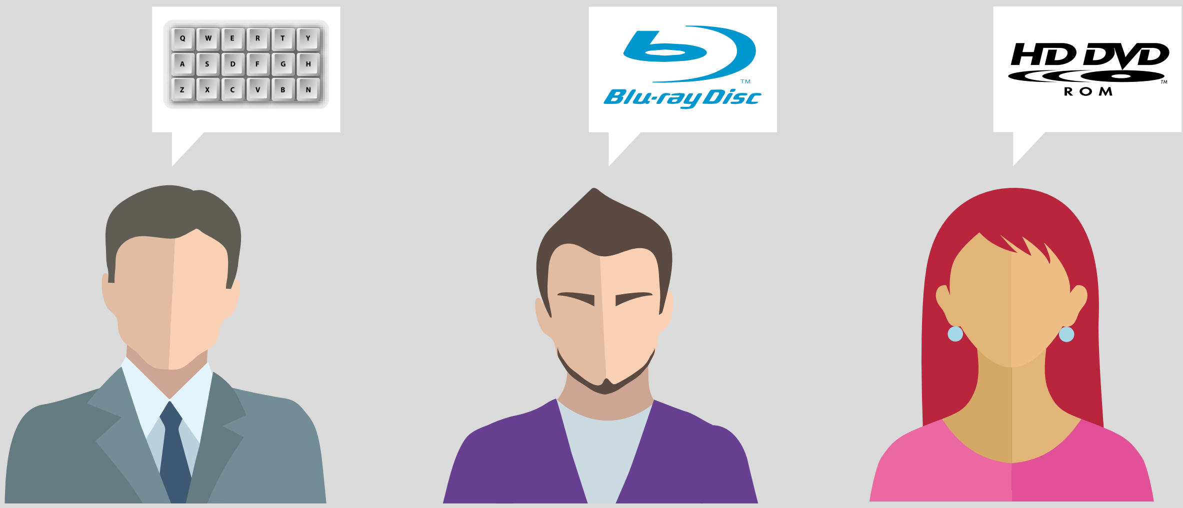

Figure 2.2: De facto standard

Differing from "de facto standards", "SDO standards" are produced by devoted organizations, called Standards Development Organizations (SDOs).

SDOs are organizations whose statutory purpose is to develop standards and that put in place formal, well-defined procedures to guarantee a fair development process. Figure 2.3 shows just a few examples of SDOs, which include, for instance, ISO (International Organization for Standardization), IEC (International Electrotechnical Commission), ETSI (European Telecommunications Standards Institute), ITU (International Telecommunication Union), and IEEE-SA (Standards Association of the Institute of Electrical and Electronics Engineers). More examples of SDOs and a description of their objectives and operations are provided in Section 2.1.3 and later sections.

Figure 2.3: Examples of SDOs

De facto standards can become SDO standards if and when an SDO publishes them. An example of this transition is the PDF (Portable Document Format), created by Adobe Systems in 1993 and later formally standardized by ISO (ISO 32000, ISO 19005-1:2005).

As you may have guessed, there are also other ways of creating standards that follow processes that ideally lie between the two types just seen (i.e., the ones adopted for creating de facto and SDO standards). The most significant case is the one related to the industrial fora or consortia (see Section 2.3 for more details about this), which do not necessarily strictly adopt rules determined by formal standardization but often define standards of substantial relevance.

2.1.2 STANDARDS IN EVERYDAY LIFE

Standards affect our everyday life, as many technologies, products, and services are based on established standards. Later in this section, we provide a few remarkable examples highlighting the strong link between our everyday life and standards. We also quote some of the most prominent SDOs and other entities that define standards (e. g., industrial fora, and consortia). Note, however, that more detailed information about these organizations' scope and history can be found in Section 2.3 and Chapter 3.

EXAMPLES

Example 1 – Smartphone browsing.

One of the actions that we do most frequently today is surfing the Internet, especially by making use of mobile devices such as smartphones. Figure 2.4 highlights some of the technological components that enable a smartphone user to browse the Web in the same way as through a wired desktop computer. If we look at the number of different devices (such as smartphones, mobile and wireless network equipment, and servers) and software modules (communication protocols, browsers, and web server applications) involved that must interoperate to support this familiar scenario, despite being produced by different vendors, the importance of a shared and interoperable technical approach is clear. In fact, as shown in Figure 2.4, there are many standards that provide the basic reference design rules for the implementation of the main components that populate this scenario. Some of these standards are related to the user equipment regarding its hardware characteristics, also considering safety issues. Other standards cover connectivity among user devices and mobile and wireless networks as well as the overall functionality of the same networks. Lastly, a number of other standards are related to the functionality of the Internet and the protocols to support web browsing.

Smartphone producers can generally refer to ISO/IEC standards for radio and telecommunication terminal equipment, which set essential requirements for safety and health, electromagnetic compatibility, and the efficient use of the radio spectrum.

As far as mobile network interfaces and functionality are concerned, smartphone makers and mobile network equipment makers and operators will likely refer to the 3rd Generation Partnership Project (3GPP), which constitutes the leading organization for the development of globally accepted solutions. 3GPP is a partnership project with seven ICT SDOs (see Section 3.2.2 for details) as partners, that defined the widely popular "third generation" UMTS, "fourth generation" LTE, and “fifth generation” 5G protocols to support data exchange over a mobile network. Similarly, to support data connectivity through wireless area networks, smartphone makers and equipment makers can refer to the widely used Wi-Fi and Bluetooth technologies, which are standardized by the IEEE and the Bluetooth Special Interest Group (SIG), respectively.

Compatibility and interworking issues are particularly challenging in the Internet environment, where a complex infrastructure needs to support information exchange among a wide range of heterogeneous devices and software applications. For this reason, despite the continuously evolving nature of Internet technologies, there is a need to establish common rules that ensure interoperability[2].

The main contributor to the definition of solutions for the operation of the Internet is the Internet Engineering Task Force (IETF), whose standards cover the basic functionalities of the Internet, such as, for instance, addressing, traffic routing and network security.

As a complement to IETF standards, the World Wide Web Consortium (W3C), in this contest, defines protocols for web functionality, such as widely used languages to build web pages (examples are HTML - HyperText Markup Language - and XML - eXtensible Markup Language) which foster the interoperability of different platforms on the Internet.

Lastly, always with the aim of ensuring interoperability, standard activities also apply to tools for developing web content and applications. One notable example is ECMA and ISO collaboration to develop a standard scripting language that is the base for the popular JavaScript technology, used to build interactive web pages and provide online software applications.

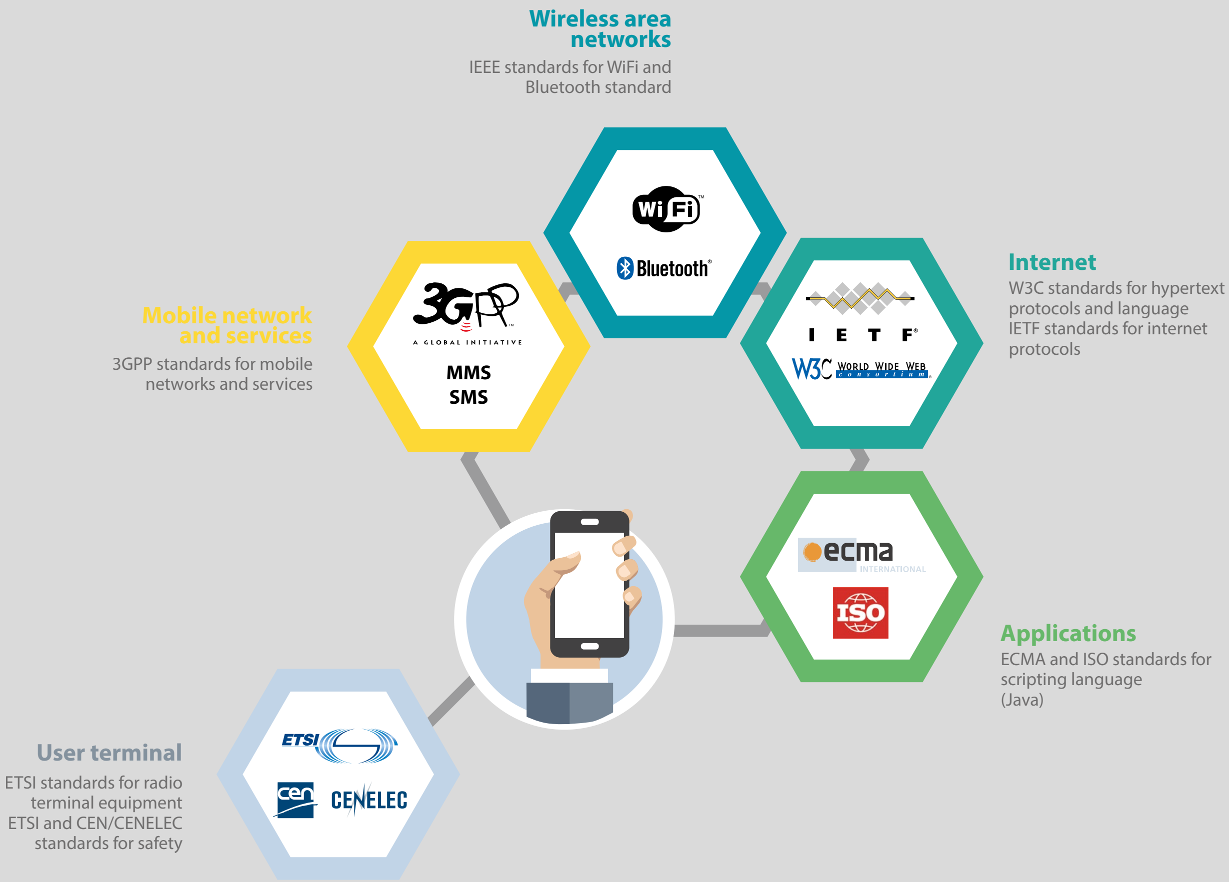

Figure 2.4: Standardization enabling smartphone web browsing

2 *For our purposes, we can define "interoperability" as the ability of different devices or software applications to exchange data and use the information that has been exchanged. This implies that interoperable devices or software applications share common protocols (as defined in Section 2.1.1).*

Example 2 – Using a Personal Computer.

Unlike the example described above, a stand-alone PC appears to be a relatively "simple" and self- contained object that each manufacturer could build using its own proprietary technology. Yet, in this case as well, a design approach based on common standards has many benefits. It allows basic components from different providers to be used interchangeably, to simplify connectivity with external peripherals and networks, and to guarantee its users a safe and environmentally compatible product. As a matter of fact, a 2010 paper (Biddle & al., 2010) identifies 251 technical interoperability standards implemented in a laptop computer and estimates an actual total number (including aspects of quality, safety, performance, measurement, environment, accessibility, design process, manufacturing process and electromagnetic compatibility) that might well be over 500. Out of the 251 identified standards, "202 (80%) were developed by SDOs and 49 (20%) by individual companies" (Biddle & al., 2010). Figure 2.5 shows only a few of the standards that may be involved. They include JEDEC for building hardware components; INCITS and VESA's standards for memory, storage, and display components; and PCI to interconnect heterogeneous cards; mechanical, physical, and software interfaces to plug and connect peripherals and networks, such as IEEE's Wi-Fi and Ethernet; the IETF's protocol stack; HDMI for audio/video peripherals and USB for a wide range of devices; and basic software tools such as compilers for ISO C/C++ programming languages. This gives an idea of the complexity of the standardization environment in a product that has become part of everyday life. Most likely, however, with the advancement of technology in recent years, the figures presented may have significantly increased.

Figure 2.5: PC-related standards

Example 3 – Switching on a lamp.

A simple action like switching on a light bulb actually involves a complex system to produce and dispatch electrical energy. Such a system is segmented into areas such as generation, high-voltage and long- distance transport/transmission of energy, and medium- and low-voltage distribution to end users, which belong to different administrative domains. For instance, the owners of the generators are usually different from the transmission line operators and distributors. All the listed players must interoperate to guarantee the balance of the whole system, in other words to balance energy demand and production, and must guarantee the availability of their own infrastructure, as whatever failure in the generation-transmission-distribution chain would cause a disruption of the service provided to clients. Furthermore, the clients themselves, who may also be small energy producers when they inject self-generated renewable energy into the network, may contribute to the stability of the whole system, by both limiting their energy intake from the network or injecting excess production into the network, according to the infrastructure actual needs.

Another critical aspect of energy infrastructures lies, of course, in safety and environmental issues. It is essential to ensure that the deployment and operation of both the generation-transmission-distribution infrastructure and the equipment on customer premises are not harmful to individuals and the environment.

The need to manage all the above-listed issues has made the electric ecosystem one of the most subject to standardization; standards cover many aspects, from the definition of architectures and protocols for system and service monitoring and management to the safety rules for installation of electrical supply and appliances in buildings (see Figure 2.6). The main SDOs involved are IEC and CEN-CENELEC; with the latter specifically focusing on Europe.

Work to standardize the electricity system is nowadays even more fervent, as it needs to cope with the envisaged evolution towards the so-called Smart Electricity Grid. The Smart Grid consists, basically, of the widespread usage of Information and Communication Technology (ICT) for the implementation of new real-time automated control mechanisms to improve the reliability, efficiency, and environmental sustainability of the electricity system. Such evolution, which requires a deep reconsideration of the design and operation of current and more traditional energy systems, has triggered various joint initiatives among SDOs traditionally involved in the electricity and ICT sectors; one of the most valuable examples, at European level, is constituted by the joint ETSI and CEN-CENELEC Smart Grid Coordination Group (CEN-CENELEC, 2018).

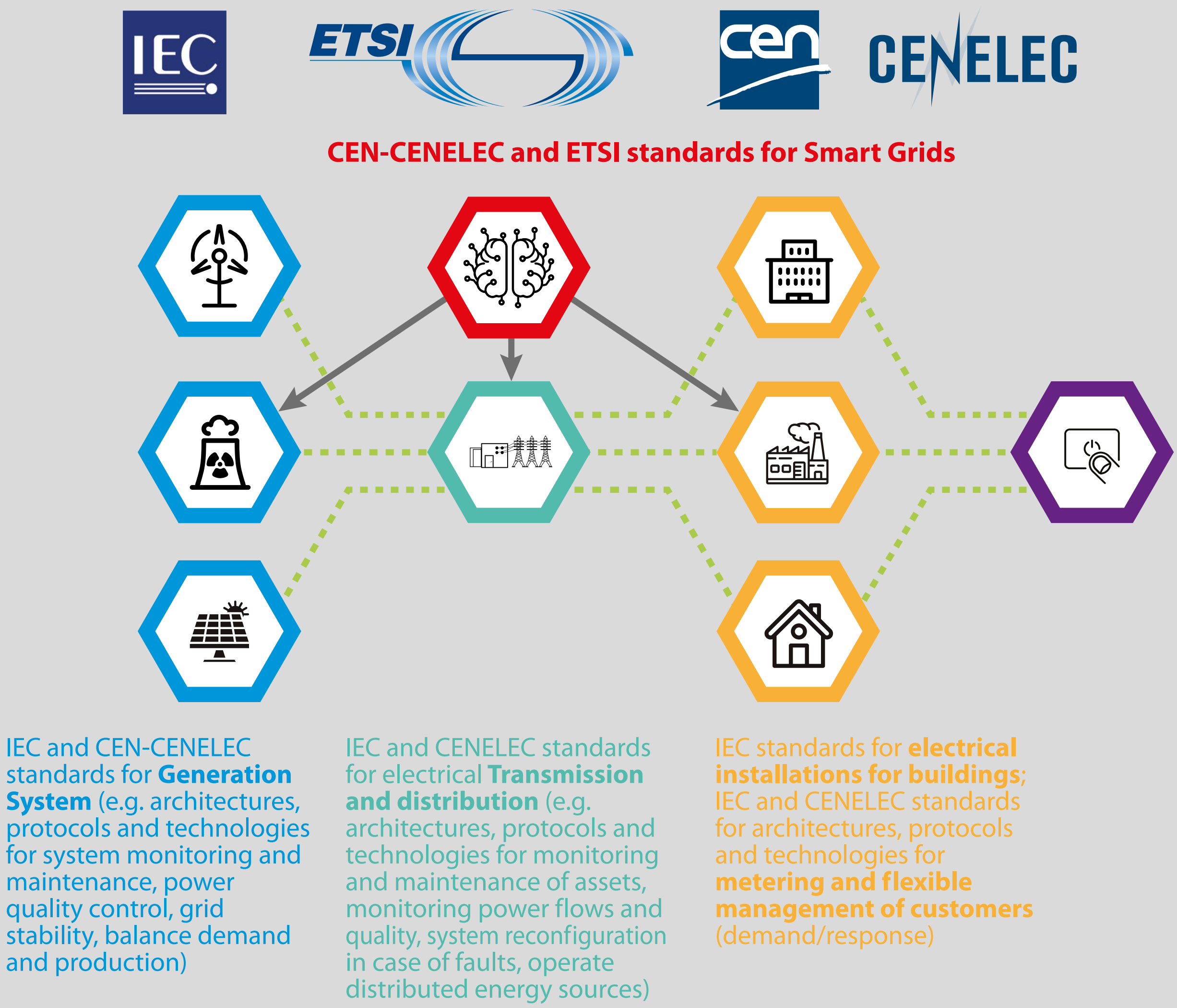

Figure 2.6: Power generation, transmission, distribution and utilization components

2.1.3 FORMAL STANDARDIZATION, SDO STANDARDS, AND REGULATION

The focus of the next parts of this chapter is on the reference process adopted for creating standards, i.e. the formal standardization, starting with its definition.

DEFINITION

Formal standardization is a well-defined process, open to any individual or organization, and its results are produced in consensus with all interested parties. Formal standardization is inspired by international directives on standardization, the most important being the principles produced by the Technical Barriers to Trade (TBT) Committee of the Word Trade Organization (WTO). The TBT committee proposed six principles for the development of international standards (see Chapter 4 for details): transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and development dimension. Some authors may refer to formal standardization as committee standardization.

Formal standardization is the process adopted by SDOs to produce standards. Hence, we refer to these standards as SDO standards. SDOs organize and manage the work of involved stakeholders (such as manufacturers, providers, consumers, and regulators, with possible contributions from academics and professionals) on the item to be standardized. In doing so, SDOs put in place all the procedures related to the formal standardization to guarantee a fair development process, which aims to build consensus among the stakeholders involved (Figure 2.7) and ensure the quality of the final deliverables.

Creating a standard, therefore, requires specific technical work by expert groups that must collaborate in defining and describing shared and interoperable solutions. There are two main concepts in this definition of standard building process that are worth noting to highlight the main characteristics of a "standard": "consensus building" and "fair development process".

By "consensus building" we mean that standards are the products of negotiation among all involved (and relevant) stakeholders, aimed at establishing a general agreement and the absence of sustained opposition to substantial issues[3] .

By "fair development process" we mean that the consensus building is regulated by procedures that aim to ensure that all involved parties can express their views and to reconcile any conflicting arguments. The process includes, for instance, provisions to publicize SDO internal body activities to stakeholders and to set up formal reviews and approvals for all deliverables.

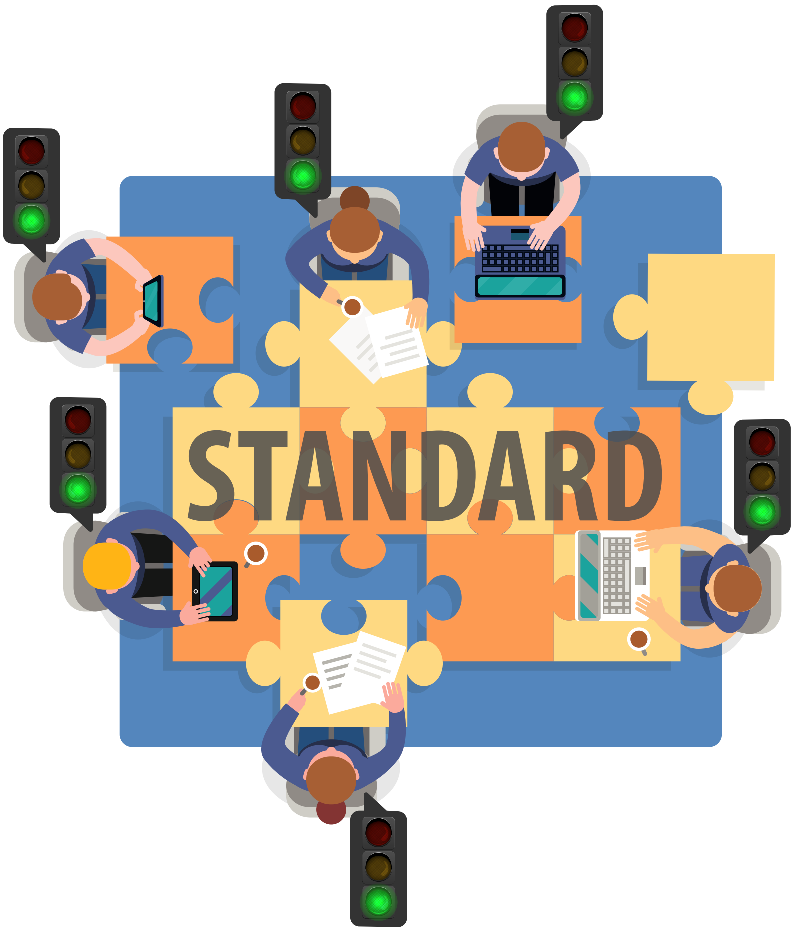

Figure 2.7: Consensus reaching

3 *ISO defines consensus as a general agreement where there is no sustained opposition to substantial issues by any important part of the concerned interests, in a process that seeks to consider the views of all parties concerned (see subclause 2.5.6 in the ISO/IEC Directives, Part 1).*

A main characteristic of "standards" is the fact that their adoption is on a "voluntary basis". This feature makes "standards" different from "regulations" (Figure 2.8). In fact, whereas conformity with standards is voluntary, regulations are compulsory. Regulations are defined by appointed authorities, which rule determined territories/markets. An item (product, service, process, etc.) that does not meet the requirements of regulations is not allowed to be sold or used on the territory/market where those regulations apply. On the contrary, non-compliance with standards, in general, does not restrict the distribution of an item "by law".

Although there is a distinction between "standards" and "regulations", they may sometimes be linked. In fact, regulatory authorities may reference established standards in regulations, as this simplifies and accelerates regulatory work, leveraging the directions of established and widely agreed best practices defined in standards.

Another main characteristic of standards is their "limited scope". As a matter of fact, standards are aimed at defining a minimum set of requirements for an item (product, service, process, etc.) in order to make it meet certain well-defined objectives, for instance to guarantee a certain degree of interoperability or to define a minimum level of performance. Standards are not intended to be a set of thorough design rules that are aimed at constraining the development of an item (Figure 2.8); many "standard-compliant" implementations of the item are possible. In this respect, standards do not substitute the designer and should not limit (at least in principle) the designer's potential to create innovative contributions in the development of new products or services. They rather give a guide and some rules useful for assuring a minimum level of interoperability and quality to the final result.

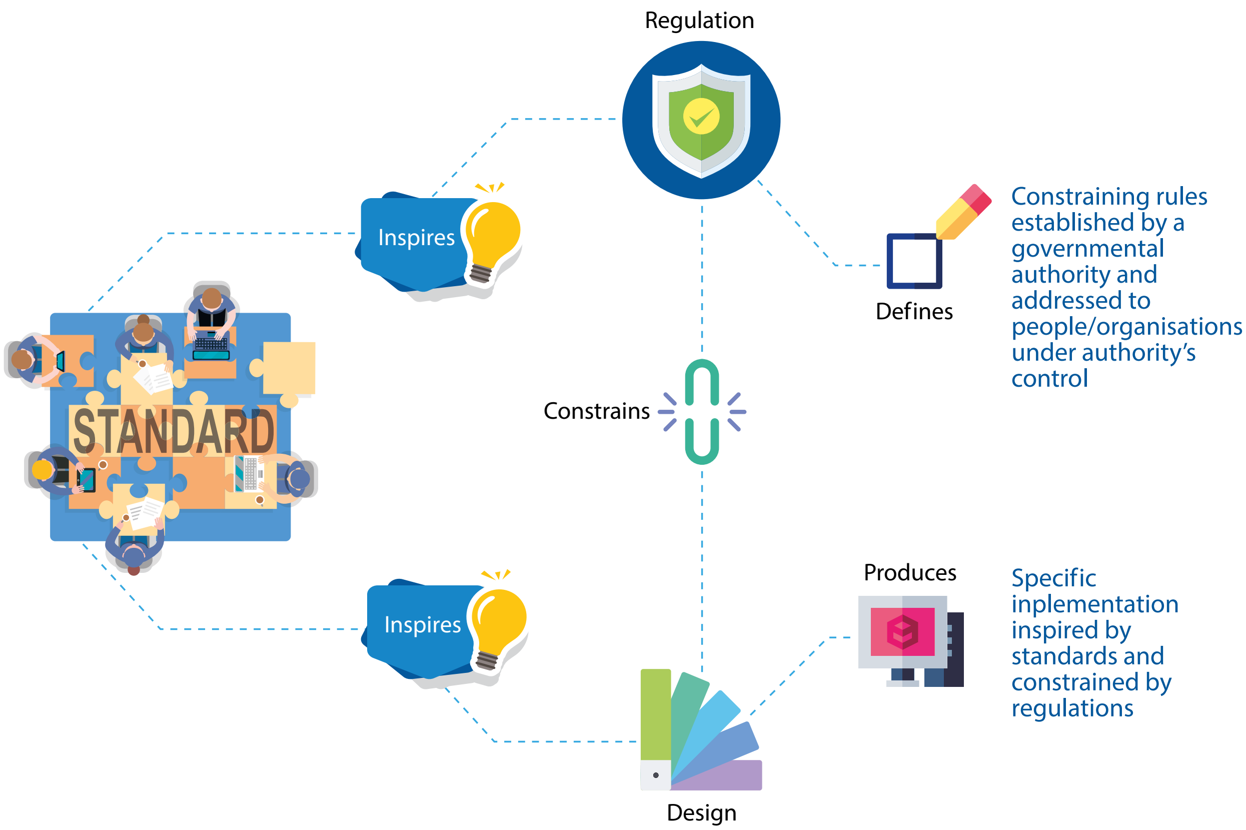

Figure 2.8: Standards and regulations

2.2 BENEFITS AND RISKS OF STANDARDIZATION

2.2.1 BENEFITS

As a consensus-built set of rules/definitions for doing something, standards benefit sustainable innovation and the economy as a whole. Standards can be used in a large number of cases to meet a diverse range of needs. They can provide a common language for defining product, service, and process requirements. They can help identify reference performance indicators concerning the safety, environmental and technical characteristics of products, giving the opportunity to set (at least) a minimum reference level of acceptability. They can ensure the correct interworking of different parts of complex systems. They can define common test and measurement procedures, allowing a fair comparison of quality and performance among different products from different producers.

We can identify three broad areas that can greatly benefit from standards: economy, environment/ safety, and innovation.

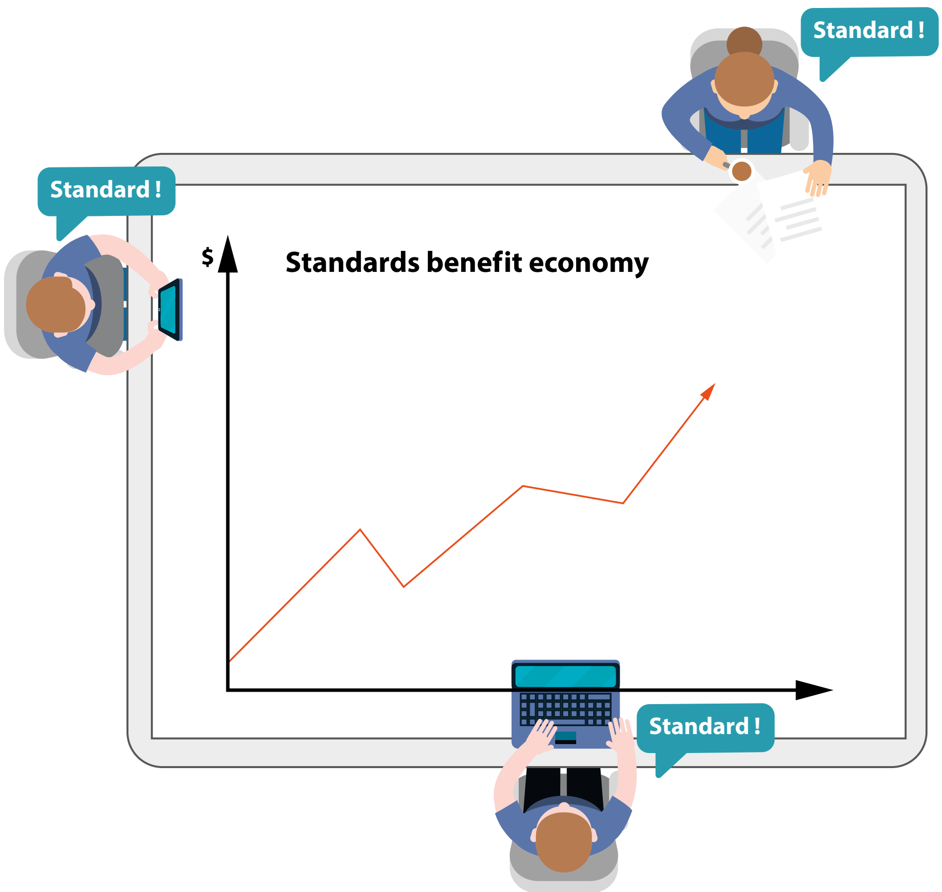

Figure 2.9: Standards benefit the economy

Standards benefit the economy by incentivizing investments, as standards ensure the stability of the technology over a reasonable period of time, and enable economies of scale by fostering interoperability. Furthermore, standards facilitate trade, thanks to common approaches among countries, encouraging broader and fairer competition.

In most relevant technological contexts, the presence of a standard actively contributes to the consolidation of new technologies and identifying evolution paths that are able to preserve past investments, which is a critical aspect, especially in rapidly evolving sectors, such as ICT.

These kinds of actions make investments more affordable and facilitate their quick return. Beyond their evident positive impacts in removing barriers to international trades (although sometimes hindered by political stances), standards can also significantly increase collaboration opportunities among the companies, especially for small and innovative enterprises, which may benefit from the accessibility to key (standardized) technology solutions that standards can very often guarantee.

Figure 2.10: Standards benefit the environment and safety

Standards benefit the environment and safety by defining requirements, which become widespread in the industry and often referenced by normative regulations. In fact, standards have many positive effects:

- Standards that include sustainability and safety requirements promote the design and realization of more sustainable products and services by providing targets within reach of a broader range of companies as well as consolidated technical guidelines.
- Regulation can leverage standards to impose constraints for safety and sustainability,
- Product labelling that refers to standards/regulations can communicate the level of quality of the products/services in a common, unambiguous, and understandable way, promoting company and product images with customers.

EXAMPLE

One example which is worth mentioning in this respect, is the universal/common charger for mobile phones. Until the second decade of the 21st century there were no common rules about mobile phone chargers. Each producer — and sometimes each phone model — had a different power supply with a different connector. This situation resulted in a lot of waste, a number of inconveniences to the customer, including cost, difficulty in finding replacements, and unclear performance indications, especially concerning energy efficiency during use and especially when on standby (when chargers were plugged in, but not connected to the phone). In 2009, the ITU-T produced the L.1000 Recommendations. They were inspired by previous recommendations by the GSM Association, the Chinese Ministry of Industry and Information Technology, and the Korean Telecommunications Technology Association (TTA). These specified the physical reference structure (in terms of connectors) and main electrical characteristics, including energy efficiency and safety, of the universal charging solution. Nowadays, most mobile phones (and often also other equivalent equipment in terms of energy requirements) use interchangeable power supplies, with real advantages for users (cost, performance, safety) and the environment (waste, pollution).

Figure 2.11: Standards benefit innovation

Standards strongly benefit innovation by promoting the interoperability of products, services, and processes. A standard, by steering the activity of designers, gives producers the opportunity to:

- avoid duplication and reduce development time: don't invent it if it exists; leverage it to start from a higher step in the ladder; by setting basic product requirements, standards provide designers with valuable references that offer a set of consolidated solutions for many key issues
- reduce design costs: by steering design activities, standards provide a shorter development time, with fewer design errors and consequent re-design
- reduce risks: standards allow a product to be designed according to market-driven and largely accepted rules, for increased product success rate

- improve quality: standards define already proven solutions that push up the potential quality of results
- decrease time-to-market: this effect is a consequence of shorter development times and the assured level of conformance with market needs
- open cross-border markets: interoperability guaranteed by standards ensures that products manufactured in one country can be sold and used in other locations
- attract more customers: by giving them the tangible perception of reliable and effective products in an open and competitive market.

To summarize, the above good consequences of standards facilitate the uptake of innovation in the marketplace and concretely enhance the company's propensity to innovate. See Chapter 5 for a complete analysis of the relationships between standardization and innovation.

The positive effects that standards have on economy, environment and innovation are reflected in benefits for both industries and society.

Standards benefit industries (especially newly established ones, as well as Small and Medium Enterprises), by driving and facilitating the development of new technologies, and by ensuring fair competition and potentially large market penetration.

As depicted in Figure 2.12, on the one hand, the positive effects of standards on innovation encourage the development of new advanced products/services, owing to reduced risks and investment and increased market opportunities. On the other hand, the growth in the safety and sustainability of products and production processes makes competition fairer, as a consequence of common and testable targets/ requirements (defined by standards) and the reduction of non-compliance risks (mainly for safety but also, in part, for sustainability). The benefits to the economy and business, with cost reductions, increased efficiency, and an enlargement of trade and potential markets, complete the picture, in which standards really can operate as an effective market booster, especially for new and innovative companies.

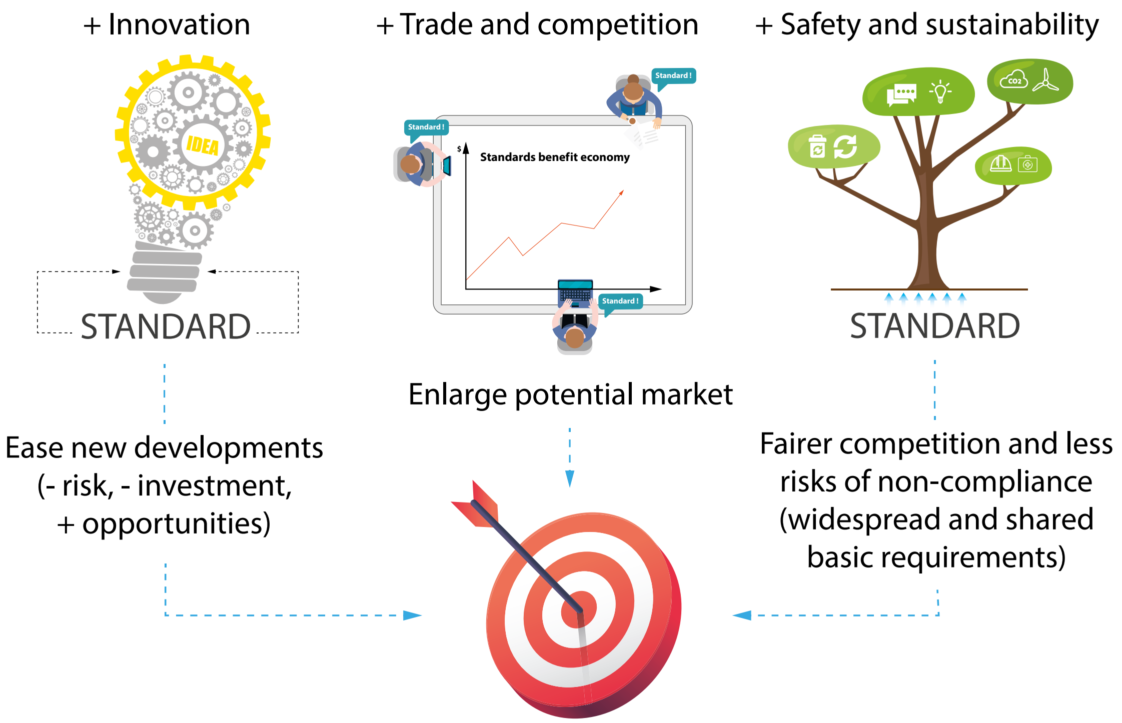

Figure 2.12: How standards can benefit industries

On the other hand, the general benefits that standards have on innovation, the economy and the environment are reflected in society too, i.e. among communities and individuals (Figure 2.13).

As depicted in Figure 2.13, by boosting innovation, standards help satisfy people's needs, and therefore contributes to improving their quality of life. Moreover, by fostering the sustainability and safety of products and production processes, standards contribute to enhancing people's health and safety as well. Finally, by favouring fair competition among industries and the reduction of final product costs, standards can enlarge customers' choice and ensure best "value for money".

As a final consideration, it is also important to note how standards can support regulations. Many countries reference standards in legislation to determine rules about the safety, quality or environmental compatibility of objects, services, and procedures. This approach has many advantages for legislators. They are able to access the specific technical expertise and the resources of the standard makers and can take advantage of the higher (compared to laws and regulations) update frequency of the standards. The relationship between legislators and SDOs can also be explicit and formally stated as part of the creation of laws and requirements, with legislator issuing requests (sometimes also called mandates) for developing standard-supporting specific guidelines. Chapter 3 provides details in this respect.

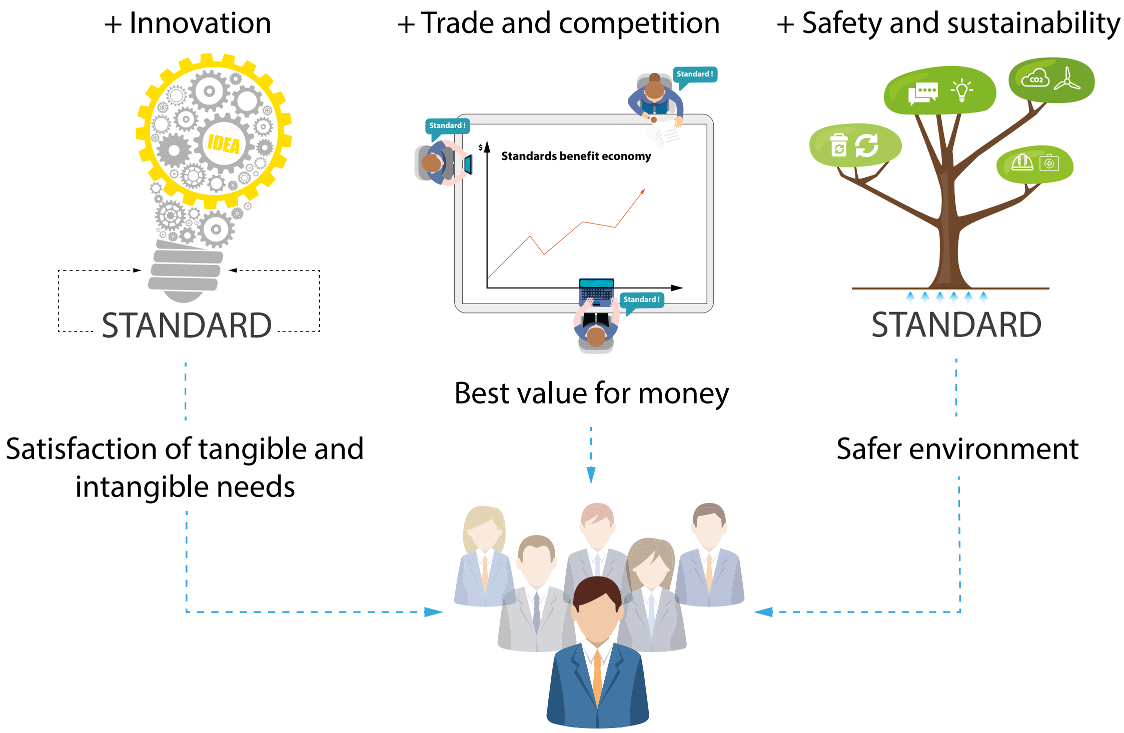

Figure 2.13: How standards benefit society (for both individuals and groups)

Figures 2.12 and 2.13 give an initial, but concrete view of the relevance and the positive effects of standards on both people and the market. Additional and more detailed information about this topic can be found in the next chapters. More specifically, Chapters 5 and 8 discuss the relationships of standards with innovation and economy, respectively.

2.2.2 RISKS

Using standards may also imply some drawbacks and risks. In the following paragraphs, some of the most well-known risks and drawbacks are listed and briefly discussed; moreover, we also present some indications about how SDOs tackle them to reduce their potentially negative occurrence in different contexts.

Especially, but not only, in the scientific arena, there is often the feeling that standards can jeopardize innovation as, when established, they could limit or delay the introduction of new innovative (disruptive) solutions in the market. This drawback mainly may come from the consolidation effect that standards have in some contexts, especially in technology-oriented ones. In this condition, a standard makes access to the specific technology easier, but at the same time (if successful) also makes a solution a semi-obligatory choice, and more difficult to be replaced. Furthermore, introducing innovation into standards (i.e., developing new standards based on innovative technologies) may be complex given the very nature of the standardization processes. As a matter of fact, the same procedures put in place to ensure the fairness of the standards development process and to get the largest consensus among stakeholders may require a long time for these stakeholders to converge to a new solution.

These adverse effects can be strongly reduced or even eliminated by effectively managing the standardization process. The strategy would imply being open and responsive to the market innovation trends and to research impulses from the experts involved in the standardization activities. A relevant example of this effective management can already be found in many ICT contexts, such as Mobile Radio Networks, where standards are continuously evolving (starting from 2G up to the current 5G) and innovation is frequently driven by SDOs working in cooperation with industry consortia, as described in Chapter 3. Moreover, to mitigate this risk, SDOs often establish and support open expert groups to explore innovation and generate new standardization initiatives, including the evolution of current ones.

Figure 2.14: Influence of special interests on standards

A second possible risk, often feared by both consumers and companies (especially SMEs) is the fact that standards might jeopardize fair competition among industries and countries, as SDOs may be politicized, or unduly influenced by "special interests".

In general, it is natural and unavoidable for all (or at least most) of the participants in the standard creation process, to try to uphold the interests of the organizations (companies, country, etc.) that they represent. To minimize this risk, the main actions that SDOs put in place are, on the one hand, to enlarge the participation in the standardization processes to include the maximum number of eligible and competent contributors and, on the other hand, to set and apply fair and transparent rules in managing the standards development processes. Enlarging the participation in standards is a key point to guarantee fairness. Those who do not participate cannot protect their interests. Indeed, this can easily apply to small companies. However, they have the possibility to organize themselves in groups and be represented in the standardization arena without excessive investment (see Chapter 4 for additional details). A second aspect to be considered is related to the right balance between effectiveness and fairness. In fact, a large number of participants in a standard might make consensus more difficult and time consuming, increasing the standard's time-to-market and causing possible failures. In this respect, the role of SDOs is relevant in order to manage all these aspects in the right way and to drive the organization towards the right balance of fairness, technical excellence and timing, while remaining open and all inclusive.

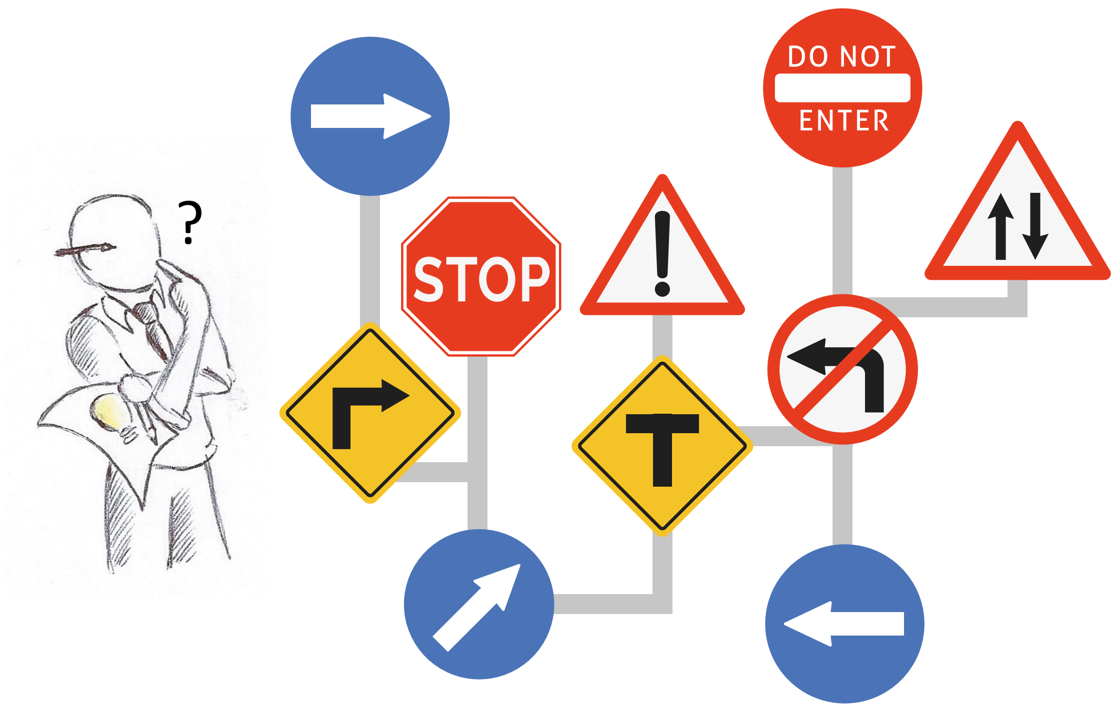

Figure 2.15: A diversified standardization landscape can lead to inconsistencies

The importance of standards in modern times has led to the creation of a large number of SDOs, often (at least partially) overlapping in terms of interests and goals and which may even, in some cases, act as competitors. In this context, a diversified standardization landscape can lead to inconsistencies, as standards produced by different SDOs might cover the same topic or be partially overlapping but offer different solutions. These situations may potentially lead to the production of inconsistent or, at the very least, redundant requirements that could strongly jeopardize the benefits of standardization. Additionally, an uncoordinated and uncontrolled proliferation of standards/SDOs can feed, at least in principle, the previous risk of "unfairness" because some SDOs could be "misused" to support local or specific interests. There are two main actions that aim to mitigate this possible negative behaviour. The first is by the users of and contributors to the standard (besides the fact that the creation of SDOs belong to these same users and contributors), who need to carefully choose the most appropriate SDO. The second, this time by the SDOs, is to promote liaisons among SDOs and to increase collaboration and joint coordination actions.

The three issues presented and discussed are just some of the potential drawbacks of standardization. Other risks and drawbacks will be described in the following chapters of the book. However, if the above- mentioned risks are correctly and effectively managed, the negative effects of standardization will become negligible, and the positive effects will more than outweigh the negative ones.

2.3 ICT STANDARDIZATION LANDSCAPE

The knowledge of the ICT standardization landscape represents a fundamental point for effectively dealing with standards and standardization. A minimum level of understanding of the prominent organizations that define standards is essential to be able to select the correct source of documents (if you are interested in finding standards about a particular topic) or to choose the suitable body to contribute to (if your aim is to contribute to standardization on a specific subject). The key role played by this kind of knowledge is also amplified by the size of the ICT standardization landscape, considering that the number of organizations active around the world is currently quite large, and the relationships among them are often quite complex.

In this section, we provide a basic classification of the SDOs and an overview of the ICT standardization ecosystem, with an introductory description of some of the most relevant players in the field (see also Chapter 3 for additional information about this topic).

As a basic classification to approach the landscape we can consider three basic categories of SDOs types:

- geographical coverage that is the geographic area where standards produced by a certain SDO are expected to be largely accepted and implemented,
- technical scope of activities that is the technical domain the SDO, as per its statutes, focuses on,
- level of recognition from regulatory or political organizations.

Considering that the selection/identification of a suitable SDO is very frequently related to the geographical location of the interests of the standard user/maker, the geographic "coverage" is the first and most simple type of classification. In this respect, we can distinguish three types of SDOs[4]:

- International SDOs
- Regional SDOs
- National SDOs

DEFINITION

International SDOs have members worldwide, sometimes also including representatives of National or Regional standard bodies, and their deliverables have worldwide coverage.

EXAMPLE

As main examples of this category in the ICT field (with some not only restricted to this field), we can cite (see Figure 2.16) the International Telecommunication Union (ITU), the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), the Internet Engineering Task Force (IETF), the IEEE-SA (Standards Association of the Institute of Electrical and Electronics Engineers) and the World Wide Web Consortium (W3C).

Figure 2.16: The logos of the six reference international SDOs

4 *Chapter 3 qualifies the classification of SDOs' scope in terms of international, regional and national, since sometimes standardization practices by SDOs do not fit 100% that theoretical schema. Furthermore, that chapter introduces the mechanisms that support coordination and cooperation of international, regional and national SDOs, their standardization activities and deliverables.*

ITU (www.itu.int) was founded in Paris in 1865 as the International Telegraph Union. It took its present name in 1934, and in 1947 became a specialized agency of the United Nations. ITU is organized into three Sectors (http://www.itu.int/en/about/Pages/whatwedo.aspx): the Radiocommunication Sector (ITU-R), the Telecommunication Standardization Sector (ITU-T) and the Telecommunication Development Sector (ITU-D). Its headquarters are in Geneva (Switzerland), but it also has many areas and regional offices distributed around the world. It includes state members, sector members, and associates from industry, international and regional standard organizations, as well as academia, who are organized in study groups. The ITU-T sector deals with the interoperability of ICT by covering all aspects of electronic design and test specifications. ITU-R coordinates the use of the global radio spectrum and satellite orbits, and ITU-D promotes fair and affordable access to telecommunications and helps stimulate social and economic development.

ISO (www.iso.org) is an independent, international non-governmental organization founded in 1946, when delegates from 25 countries met at the Institute of Civil Engineers in London and decided to create a new international organization "to facilitate the international coordination and unification of industrial standards". Today it brings together members from more than 160 countries and includes hundreds of technical committees and subcommittees in charge of developing standards. The ISO Central Secretariat is located (like ITU) in Geneva, Switzerland. National members are often represented by corresponding national SDOs. For example, the American National Standards Institute (ANSI) is the United States' ISO representative. ISO standards cover several market sectors such as ICT, healthcare, energy and automotive.

IEC (www.iec.ch) was founded in London as a consequence of a decision taken during the International Electrical Congress convened at the World's Fair in St. Louis in 1904. IEC held its first meeting at Hotel Cecil on 26 and 27 June 1906 with Alexander Siemens as Chair. This SDO prepares and publishes International Standards for all electrical, electronic, and related technologies, collectively known as "electrotechnologies". It is based in Geneva like the ITU and ISO and has one local site in each continent. The IEC's members are National Committees, which appoint experts and delegates from industry, government bodies, associations and academia Since 1987, most of the activities related to ICT are conducted jointly with ISO in Joint Technical Committee 1. IEC, ITU, and ISO have established a well-defined set of relationships and agreements and typically operate with quite a high level of coordination on the various topics, often with joint initiatives.

IETF (www.ietf.org), based in Reston, Virginia, is the governing body of the Internet and has the support of other national and international standards bodies. The IETF defines the basic standard Internet operating protocols such as TCP/IP (Transmission Control Protocol/Internet Protocol), the reference communication language for the Internet. There are five main principles that underpin IETF work: (1) an open process, in other words any interested person can participate in the work, (2) technical competence, (3) volunteer core, (4) rough consensus and running code, and (5) protocol ownership (ITU-T, 2018). The IETF operates as part of the Internet Society (ISOC), a non-profit organization founded in 1992 to provide leadership in Internet-related standards, education, access, and policy. Moreover, it is controlled by the Internet Architecture Board (IAB), which is both a committee of the IETF and an advisory body of the Internet Society.

IEEE-SA (standards.ieee.org) is a primary SDO with a large number of active technical standards, ranging from wireless communications and digital health to cloud computing, power and energy, 3D video, electrical vehicle standards, and the Internet of Things. It was created by the Institute of Electrical and Electronics Engineers (IEEE), the American association of Electrical and Electronics Engineers. It brings together and organizes members from all over the world.

The W3C (www.w3.org) mission is to lead the World Wide Web to its full potential by developing protocols, languages, and guidelines that ensure the long-term growth of the Web. W3C is directed by Tim Berners-Lee, inventor of the World Wide Web. W3C, as a non-profit organization, is hosted by the MIT Computer Science and Artificial Intelligence Laboratory (MIT CSAIL) in the USA, the European Research Consortium for Informatics and Mathematics (ERCIM) headquartered in France, Keio University in Japan, and Beihang University in China, and has additional Offices worldwide.

DEFINITION

Regional SDOs include members (industry, academia and national SDOs) from a set of countries that usually share, or are interested in promoting, common practices and regulations.

EXAMPLE

In this category, we can find, for example (Fig. 2.17), ETSI, the European Committee for Standardization (CEN) and the European Committee for Electrotechnology Standardization (CENELEC), the Pacific Area Standards Congress (PASC), and the African Regional Organization for Standardization (ARSO).

Figure 2.17: The logos of some international/regional SDOs

Both **CEN** and **CENELEC** (www.cencenelec.eu) are organizations in charge of developing standards that set out specifications and procedures for a wide range of products and services in Europe. The members of CEN and CENELEC are the National SDOs (also called National Standards Bodies in EU) and National Electrotechnical Committees of all EU member states, plus associated nations (such as Iceland, Norway, Switzerland, and Turkey). European standards approved by CEN and CENELEC are accepted and recognized in all member and associated countries. CENELEC focuses on standardization in the electrotechnical engineering field, in close collaboration with the IEC and ETSI; in particular, CENELEC and IEC formalized the framework of their cooperation through the signature of 1996 Dresden Agreement. CEN also works to remove trade barriers for European stakeholders, such as industry and service providers. CEN has in place a strong technical co-operation with the International Organization for Standardization (ISO); as a result of the Vienna Agreement, signed in 1991, new standards projects are jointly planned between CEN and ISO in order to prevent duplication of effort and reducing time.

PASC (pascnet.org) was established in 1973 and includes most of the countries in the Pacific areas. Its main objectives are to strengthen ISO and IEC international standardization programmes and to improve the ability of Pacific Rim standards organizations to participate in these programmes effectively, to improve the quality and capacity of standardization in economies of the region and to support the improvement of economic efficiency and development through the promotion of standardization.

ETSI (www.etsi.org) is a not-for-profit organization that set up in 1988 by the European Conference of Postal and Telecommunications Administrations (CEPT) in response to proposals from the European Commission. ETSI now includes over 900 members from more than 60 countries in five continents. ETSI is a European Standards Organization (ESO) and it is the recognized regional standards body dealing with telecommunications, broadcasting and other electronic communications networks and services. ETSI supports European regulations and legislation through the creation of Harmonised European Standards. Only standards developed by the three ESOs (CEN, CENELEC and ETSI) are recognized as European Standards. ETSI collaborates and works in partnership with different types of organizations around the world. In particular, it is a partner in the international Third Generation Partnership Project (3GPPTM) for the development of 4G and 5G mobile communications. They also work with partners around the globe in the oneM2M partnership project to develop standards for machine-to-machine communications.

ARSO (www.arso-oran.org) was founded in the 1970s under the Organization of African Unity (OAU). The main goals of this organization are to harmonize national and/or sub-regional standards as African Standards, to initiate and coordinate the development of African Standards (ARS) with reference to products that are of particular interest to Africa, such as agriculture and food, civil engineering, chemistry, and chemical engineering, and to encourage and facilitate the adoption of international standards by member bodies.

DEFINITION

National SDOs (NSDOs or NSB) operate at the single country level and issue country-specific standards; they often collaborate with International and Regional SDOs.

EXAMPLE

A large number of such entities have been set up. European NSDOs are listed on the CEN website (standards.cen.eu/dyn/www/f?p=CENWEB:5) (see, among others, the German Deutsches Institut für Normung [DIN], the French Association Française de Normalisation [AFNOR], and the Italian Ente Nazionale Italiano di Unificazione [UNI]).

Notable NSDOs from outside Europe include the American National Standards Institute (ANSI, www. ansi.org), the Japanese Industrial Standard Committee (JISC, http://www.jisc.go.jp/eng/index.html) and China's Standardization Administration (SAC, http://www.sac.gov.cn/sacen/).

The second classification criterion relates to the SDO's technical scope of activities, which is crucial for those searching for possible standards related to specific items of interest. Searching for SDOs that cover a specific subject may seem, at first glance, an easy task, but it may prove to be more complex than expected. In fact, on the one hand, while each SDO fixes its mission, which is enshrined by its funding statute and also defines the original scope of SDO's work, this mission may evolve over time. One of the main reasons for this, which is particularly applicable to the ICT sector, lies in the evolution of technologies and applications and may easily bring to the overlap of competencies among various SDOs. For instance, with reference to Table 2.1, which provide a simplified overview of some main SDOs' scopes in the ICT field, it is easy identifying some potential overlaps among various organizations: think about the consequence of the spreading of the Internet Protocol (conceived initially as a protocol to build networks of computers and which is the core competence of IETF) to become a foundation of retail communication networks (which originally were in the scope of ITU-T) and to take on the role of key enabler for the automation of new electric power systems (which are the focus of IEC and CEN/CENELEC). Another reason for possible overlaps is the coexistence of Regional, National, and International SDOs that may entirely or partially share common areas of activity.

In summary, in the real world, when looking for standards covering a specific subject, the research will identify a set of SDOs that have addressed the issue and produced relevant documents. Luckily, as already pointed out in the previous paragraphs, the researcher will likely also find a track of collaborations involving SDOs that define common approaches to shared issues. These collaborations may take the form of memberships (for instance, Regional and National SDOs may be members of International SDOs and inherit International SDOs' standards) and agreements, liaisons, and partnerships to cover specific subjects.

Section 2.3 provides some practical suggestions about how to select the most relevant standard documents.

EXAMPLE

Table 2.1 provides the typical technical scopes of activity, relevant to ICT, of some of the main SDOs. Moreover, a non-exhaustive overview of the Information and Communication Technology ecosystem, where International, Regional and National SDOs, Professional Organizations, and Industrial Consortia collaborate through liaisons and Global Initiatives, is represented in Figure 2.18 (see Section 3.2 for a more comprehensive description on this topic).

Table 2.1: SDOs and technical scope in ICT field

ORGANIZATION	TYPICAL TECHNICAL SCOPE OF ACTIVITY
ITU-T	Interoperable telecom specifications including architecture, services, protocols, addressing/numbering plans.
ISO	ICT architecture (OSI model), services, protocols including application layer protocols.
IEC	Electrotechnical standards, incl. connectors, electrical safety, and tests.
ETSI	Interoperable ICT specifications including architecture, services.
CEN	Household appliances, Intelligent Transportation and Mobility, Smart Grids and Smart Metering, Cybersecurity, Blockchains.
CENELEC	Electrotechnical standards, incl. connectors, switches, plugs, sockets, electrical installation, electrical safety and tests, electromagnetic compatibility, communication systems using the electricity supply lines, Smart Grids and Smart Metering,
IEEE	Electrical and Electronics: LANs, MANs (IEEE 802), Emerging technologies (AI, IoT, automotive, robotics, home automation…).
IETF	All Internet-related specifications, including protocols, generic applications, addressing rules (IP, URL, etc.).

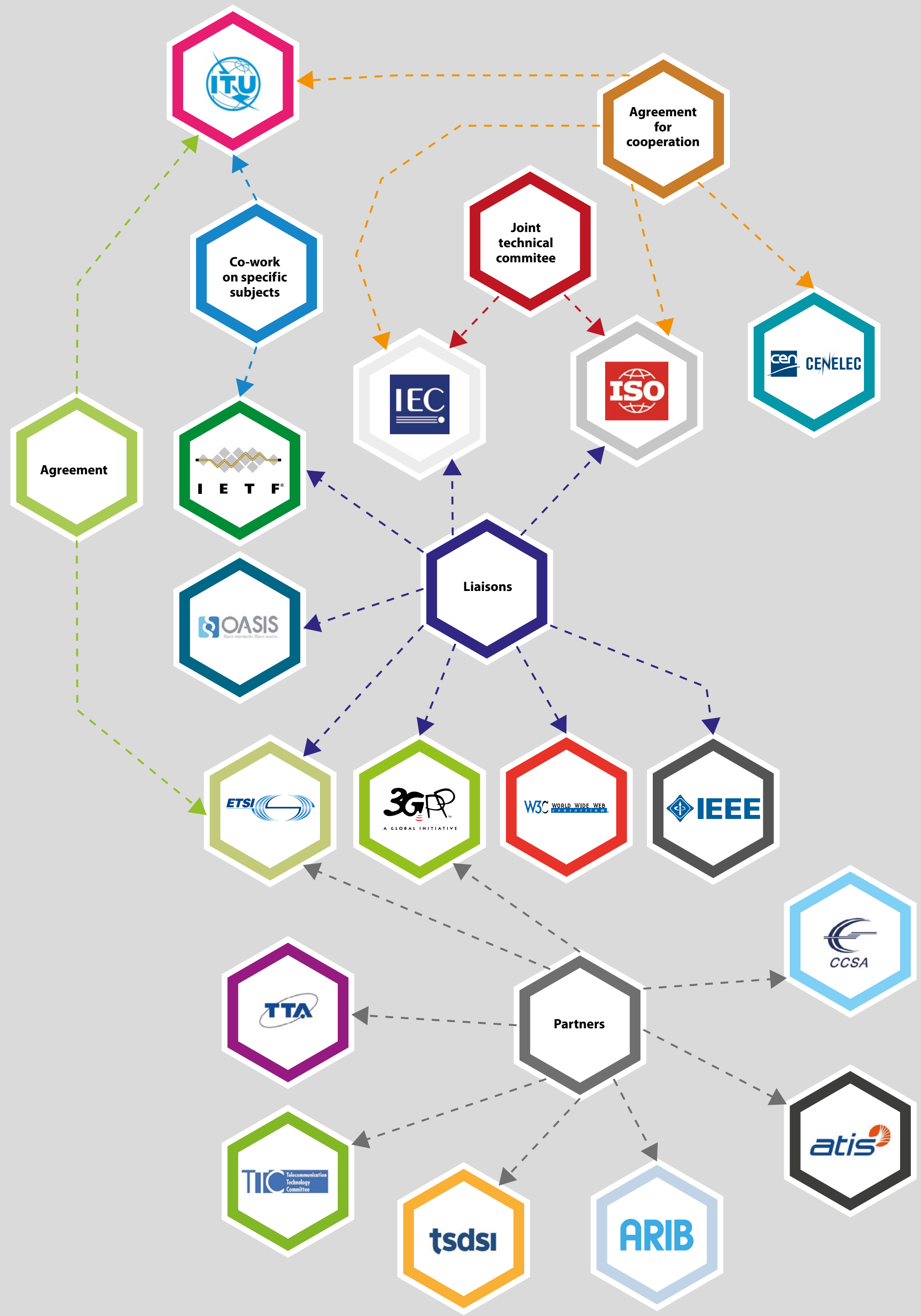

Figure 2.18: An overview of the ICT Standardization ecosystem

In the last classification (recognition by regulatory systems), two types of SDOs are identified: "recognized" SDOs and "not recognized" SDOs. The only relevant difference between them is that the former ones are officially recognized by regulation systems or political bodies as providers of standards, while the latter ones not.

A first example of recognized SDO is ITU, which operates as the United Nations specialized agency for information and communication and is the body through which governments and the private sector cooperate to define global telecommunications networks and services technologies.

A further example of SDOs that are recognized by a political and regulatory entity is given, at European level, by the Regulation 1025/2012 of the European Parliament and Council. This Regulation “establishes rules with regard to the cooperation between European standardisation organisations, national standardisation bodies, Member States and the Commission, the establishment of European standards and European standardisation deliverables for products and for services in support of Union legislation and policies, the identification of ICT technical specifications eligible for referencing, the financing of European standardisation and stakeholder participation in European standardisation”. The Regulation lists a set of reference standardization organisations, with either an international (ISO, IEC, and ITU) or European scope (CEN, CENELEC, and ETSI).

Among the not recognized ones the two most relevant examples are IETF and IEEE organizations, already described in previous examples.

Moreover, we note that SDOs can create groups/projects, possibly also involving industries, for cooperating in the definition of specific standards; two of the most relevant projects of this type are the 3GPP (already cited in an introductory example) and OneM2M.

EXAMPLE

Figure 2.19: 3GPP logo

3GPP (www.3gpp.org) brings together, in a partnership project, SDOs operating in the telecommunication field in countries and regions across the globe (Association of Radio Industries and Businesses [ARIB], Japan, Alliance for Telecommunications Industry Solutions [ATIS], USA, China Communications Standards Association [CCSA], ETSI, Telecommunications Standards Development Society [TSDSI], India, Telecommunications Technology Association [TTA], Korea, Telecommunication Technology Committee [TTC], Japan) and provides their members with a shared environment in which to produce the reports and specifications that define mobile radio technologies. 3GPP covers cellular telecommunications network technologies, including radio access, the core transport network, and service capabilities and hooks for non-radio access to the core network, and for interworking with Wi-Fi networks.

EXAMPLE

Figure 2.20: 3GPP logo OneM2M logo

The purpose of oneM2M (www.onem2m.org) is to develop technical specifications, which address the need for a reference Machine-to-Machine Service Layer that can be embedded within various hardware and software. One of oneM2M's main goals is to actively involve organizations from M2M-related business domains, such as telematics and intelligent transportation, healthcare, utilities, industrial automation, smart homes, etc. The main SDO partners in this organization are the same as 3GPP with the addition of the Telecommunications Industry Association (TIA), USA.

Finally, we must note that, as we also already described in the previous sections, in addition to SDOs, there are other important organizations that do not strictly or entirely use the formal standardization procedures but anyway aim at defining standards in specific areas.

Relevant examples of these organizations consist of industry fora/consortia. They are composed of groups of companies that temporarily join their efforts on specific subjects to realize, accelerate, complement, or promote the development of standards on them. Note that an industrial forum/consortium can develop into an SDO if it consolidates its organization and fully satisfies the formal standardization rules and processes. Among the fora and consortia active in the ICT area, we can quote the Broadband Forum, the Zigbee Alliance, and the European Computer Manufacturers' Association (ECMA).

EXAMPLE

Figure 2.21: Broadband Forum logo

The Broadband Forum (www.broadband-forum.org) is a non-profit industry consortium dedicated to engineering smarter and faster broadband networks. The main aim of this forum is to define best practices for global networks, enable new service and content delivery, establish technology migration strategies, and engineer critical device, service and development management tools in the home and business IP networking infrastructure.

Figure 2.22: Zigbee logo

The **Zigbee Alliance** (www.zigbee.org), established in 2002, is an open, non-profit association of members coming from businesses, universities, and government agencies. Its activities are focused on developing and promoting standards for low-power and open global wireless networks focused on monitoring, control and sensor applications, by also ensuring that quality Zigbee products are available for product manufacturers and their customers through a certified programme.

Figure 2.23: ECMA logo

ECMA (European Computer Manufacturers' Association; https://www.ecma-international.org/) was founded in 1961 by major multinational computer hardware manufacturers present in Europe. Whilst the brand name has been kept, nowadays ECMA's membership has grown it includes companies and academies from around the world. ECMA specifically focuses on standardization topics such as hardware, software, communications, consumer electronics, media, storage, and environmental subjects. ECMA actively contributes to the work of others, by submitting its own standards to ISO, IEC and ETSI for approval and publication.

2.4 THE STANDARDIZATION PROCESS AT A GLANCE

2.4.1 STANDARD–DEVELOPMENT PROCESS

Each SDO sets up its own specific internal organization and procedures to control the life cycle of standards documents. Yet some common features can be noted among various SDOs' procedures, which imply a shared understanding of best practices.

This chapter summarizes and describes the most basic steps of a generic standard life cycle management procedure (Figure 2.24), while a more detailed and deep description of these procedures can be found in Chapter 4.

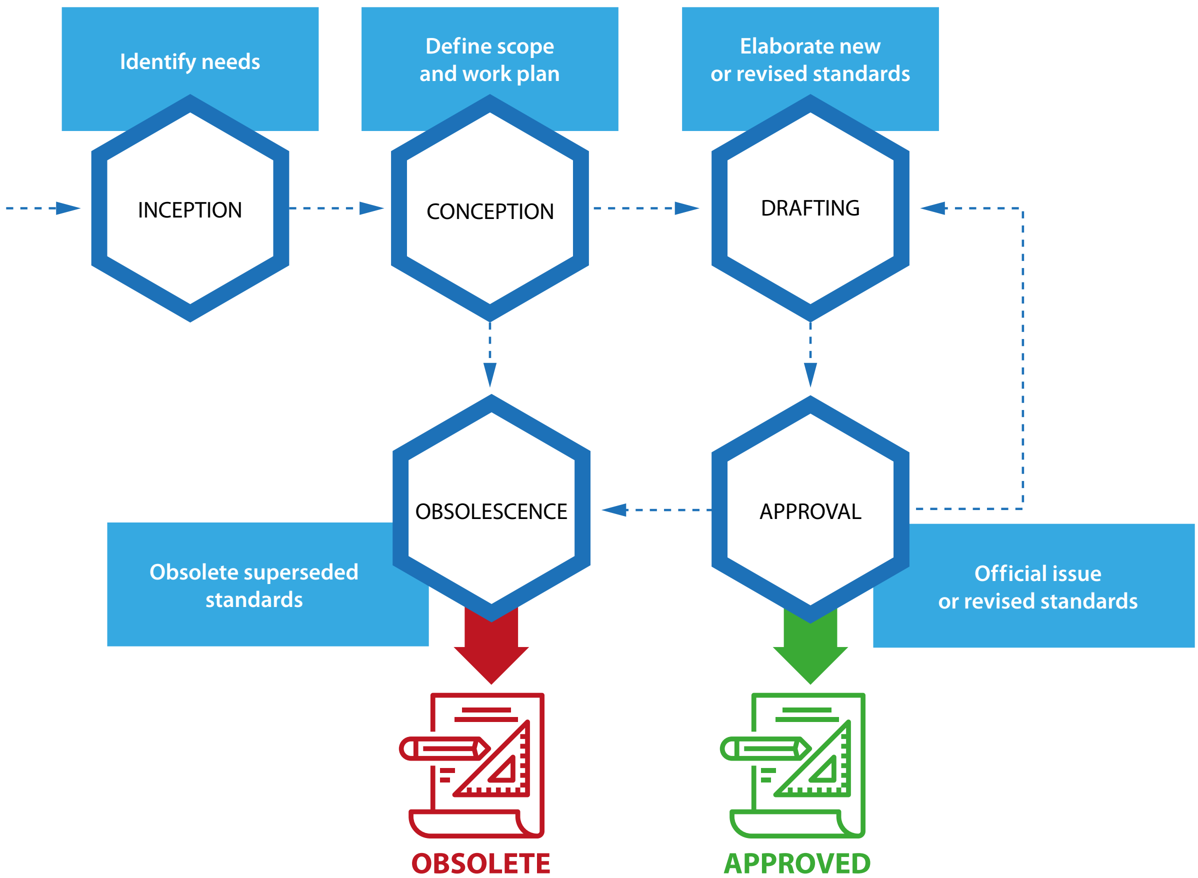

Figure 2.24: Standards life cycle

Step 1 consists of the "Inception phase", which is related to the identification of the need for a new standard and the consequent initiation of the standardization work. New standardization work starts with the submission of a proposal to the SDO. The procedure for submitting a new standardization activity varies from one SDO to another and depends on the SDO's nature and internal organization.

EXAMPLE

For instance, in ITU-T, proposals for new standardization actions can only be submitted by ITU-T members, who represent ITU member states or associated organizations such as industries and academia. Members can address the request to the relevant Study Group (SG) (ITU-T, (c)), i.e. the internal ITU-T established body responsible for technical activities in the relevant area.

In the case of ETSI, the initiative can be taken by 4 full ETSI members (administrative bodies, NSOs, industries, research bodies and academia). Proposals can also come (ETSI, 2021 (c)) (ETSI, 2021 (a)) from components of established ETSI Technical Bodies (TB[5]), Special Committees (SC[6]) and Industry Specification Groups (ISG[7]) and, lastly, from government bodies such as the European Commission (EC) or the European Free Trade Association (EFTA). Proposals compliant with the mandate of an already established TB are first addressed to the relevant TB; other proposals with a broader impact, which suggest a new TB or could change TB scope, have to be submitted to the ETSI Board[8] or, if the proposal involves ETSI Partnership Projects (EPP), to the ETSI General Assembly[9].

A further example worthy of note is the IETF, which relies on straightforward and non-bureaucratic internal processes. The IETF has no formal membership: there is no application form or fee and participation is reserved to individuals (legal entities, i.e. organizations of any kind, are not eligible as members), who can simply register for and attend IETF meetings. An individual can submit a proposal for an IETF specification by participating in the relevant IETF Working Group (WG), either by joining and contributing to the WG mailing list or by attending periodic WG meetings. As an alternative, an "Internet Draft" can be uploaded directly to the online IETF "Internet Drafts Directory" to make it available to the community for informal review and comments (IETF, (b)). To increase the effectiveness of the process, the IETF encourages members to organize unofficial "side meetings" (IETF, 2012), where "groups of interested individuals hold informal get-togethers to discuss and develop their ideas" (IETF, 2012), gather preliminary consensus and develop more stable proposals.

After the inception phase, the proposal for a new standardization action needs to have some form of formal approval from the involved SDO. Subsequently, the SDO needs to prepare a detailed plan for the actual work to be done, while defining how it is to be carried out within its own organization, the time schedule, the final target outcomes, and the allocation of relevant resources. This step (Step 2) is represented in Figure 2.24 by the "Conception" block.

The actual implementation of the Conception step largely varies depending on the internal organization of the involved SDO.

5 *ETSI includes three different types of Technical Body (TB): Technical Committees (TC), which are semi-permanent entities in charge of standardization activities relevant to a specific technology area; ETSI Projects (EP), which are similar to TCs, but are established on the basis of a market sector requirement rather than on a basic technology; ETSI Partnership Projects (EPP), which ETSI establishes with other organizations to achieve a defined standardization goal.*

6 *A Special Committee (SC) is a semi-permanent entity organized around a number of standardization activities addressing a specific technology area or related topic. Special Committees tend to handle coordination, requirement gathering, and very specific support activities rather than drafting standards and specifications.*

7 *An Industry Specification Group (ISG) is an association of industries that share ETSI membership or that have applied for membership; it corresponds to an industry forum built under the auspices of ETSI.*

8 *The GA is the highest decision-making body in ETSI and is composed of the representatives of all ETSI members. The GA delegates day-to-day management activities to the ETSI Board.*

9 *Working Groups are the primary mechanism for development of IETF specifications; they are created to address a specific problem or to produce one or more specific deliverables and are organized in areas; to date, there are seven areas (application and real time, general, Internet, operation and management, routing, security, transport) structured in more than 100 WGs.*

EXAMPLE

For instance, in ITU-T, the involved SG may approve the proposed action by consensus among participants and consequently associate it with an existing or new "study question" and assign the work to a specific Working Party (WP[10]) within the same SG. The team working on a certain "question" is known as the "rapporteur group", which is chaired by the relevant rapporteur. Considering the guidance from the SG, the team determines what recommendation documents and plans are required. The team also does the editing work.

In ETSI's case, if the proposal can be managed at TB level, the relevant TB can approve it by consensus and open a new dedicated Work Item (WI[11]) if at least 4 members commit to supporting the work. The new WI is publicized via the ETSI Website. Members that disagree with the item can oppose its adoption within a 30-day period. Otherwise, the WI is definitively adopted.

Once the new standard proposal has been accepted and the actual work is started, the relevant standardization documents enter a "drafting" phase (refer to Figure 2.24). This phase implies a lot of technical and editorial work that is carried out according to the specific body's internal workflow rules. Once the documents are considered mature and stable, they transit into an "approval" phase (see Figure 2.24) to be officially released. If the outcome of the approval process is negative, a document may transit more than once between the two phases.

EXAMPLE

For instance, in ITU-T, each SG develops its own work plan that includes periodic meetings, where the draft standards prepared by WPs are reviewed to track their development and assess their maturity (ITU-T, (c)). Once a document is considered mature, the SG/WP gives its consent for it to move to the "approval" phase. The approval procedure can follow one of two different paths (Fishman, 2012): the Traditional Approval Process (TAP) for standards having policy or regulatory implications, and Alternative Approval Process (AAP) for all other standards. When AAP is chosen (ITU-T, (a)), the "consented" document is published on the ITU-T website and ITU-T members may review and comment on it. If only editorial comments are received within a four-week period, the document will be considered approved. If members submit substantive comments, the document is sent back to the SG, which sets up a "comment resolution process" to produce the definitive version of the document. TAP (Fishman, 2012) is a longer procedure (see the next chapter for descriptions) in which ITU-T member States play a decisive role.

At ETSI, standards development is carried out within relevant TBs and ISGs, which operate under the provisions of the ETSI directives (ETSI, 2021 (c)) and the guidance of the appointed Chairmen. The evolution of draft standards is regularly revised and tracked against the originally established Work Programme. Once a document is considered stable, it is submitted for approval from the relevant TB or ISG. The following approval steps depend on the type of the standard. As a matter of fact, ETSI may produce a range of different documents (ETSI, 2021 (d)) (ETSI, 2021 (c)), which may have different content and impact, as far as standard-related documentation is concerned.

10 Each SG manages a set of "study questions" that correspond to various technical subjects within its area of responsibility. "Study questions" are assigned to WPs, which include the experts who edit standards documents.

11 A WI consists of a specific standardization task; it normally results in a single standard, report or other document.

ETSI Standards (ES)[12] are approved by all ETSI members by means of the "Membership Approval Procedure". Following committee approval, the document is sent to the ETSI Secretariat, which distributes the document to ETSI members, who can approve or reject the document. European Standards (EN)[13] follow a more complex approval procedure that requires a "public enquiry", followed by a weighted vote reserved for national delegations. Technical Specifications (TS) and ETSI Group Specifications (GS)[14] are approved at committee level. After approval, TSs/GSs are issued to the ETSI Secretariat that will publish the standard.

At the IETF, document drafting is usually performed within WGs, with the strong involvement of WG chairs. WG chairs steer the drafting activities, moderate WG discussions, identify when the WG has reached enough consensus on a specific topic in order for editors to proceed by consolidating it in the draft (published in the online Internet draft directory), selecting meaningful contributions and discarding inappropriate content. Once the draft has reached a good maturity level, the WG recommends its Area Directors (Ads)[15] to proceed to approve it as a standard (IETF, 2013). The request is submitted to the IESG, which will notify the IETF community of the pending IESG consideration of the document to permit a final review by the whole community for a limited period of time. The notification is referred to as "Last-Call notification". It is sent by e-mail to the IETF Announce mailing list. Anyone can submit comments. After the received comments have been revised, the IESG makes its final determination of whether or not to approve the draft, and notifies the IETF community of its decision via an e-mail sent to the IETF Announce mailing list. If the draft is approved, the document is published in the RFC (Request For Comments) directory and deleted from the Internet draft directory.

Once published, a standard is still to be considered a "living" document subject to maintenance and updating, which may be just editorial or even substantive. While editorial maintenance is usually managed as a routine activity within the working group that produced the standard, the introduction of major modifications that impact the content of the document requires the same steps to be followed as to produce a brand-new standard.

The final phase of a standard’s life cycle corresponds to its withdrawal due to obsolescence. A standard withdrawal procedure is triggered following the assessment that new standards already developed or being developed are replacing one or more established standards. Once withdrawn, a standard is usually still retrievable in the SDO’s repository, in order to keep track of normative evolution, although the standard itself is flagged as "historical" or “obsolete”.

12 *The formal output for standardization at the European level; it is intended to meet needs specific to Europe and requires transposition into national standards, or it is produced under a mandate from EC or EFTA.*

13 *ETSI Standard (ES), and ETSI Technical Specifications (TS) contain normative provisions on specific subjects; the difference between ESs and TSs lies in different approval rules; TS, which has a faster approval path, is preferred when there is a need to reduce the time to market (i.e., when the standard is considered urgent). ETSI Group Specification (GS), which may include normative or explanatory material, or both, are produced by ETSI Industry Specification Groups (ISGs). ETSI EN, ES, TS standards are produced by Technical Committees or ETSI Projects.*

14 *Each IETF Area is managed by one or two Area Directors.*

15 *This is the traditional term that refers to IETF standards.*

2.4.2 MAIN CHARACTERISTICS OF A STANDARD

As already explained, standards define some specific characteristics for a specific item (which may be, for instance, a material, a product, a procedure, a process or a service), in order to make such an item meet certain well-defined objectives (which may relate, for instance, to performance or interoperability). We have also seen that they do not aim to fully characterize the items they are dealing with, but just to accurately define the minimum set of characteristics to ensure the defined objectives are met.

SDOs take specific measures to make their standards effectively fit the above-listed scopes and objectives, which means ensuring that documents are clear, unambiguous and not unnecessarily over-prescriptive, and that they only stress the essential requirements for the compliance of the item they are addressing.

In order to ensure that standards have the above-listed characteristics, SDOs define their own guidelines and rules to steer the standards writing process.

Standards writing rules differ from one SDO to another. Yet, as a summary of the indications from various SDOs (refer, as examples, to ISO (ISO, 2016) and ETSI (ETSI, 2020) directions), we can identify some general characteristics that a well-written standard need to have. In the following section, there is a brief description of such characteristics; further and more detailed examples are provided in Section 2.5.3.

Standards must be written while taking the users and the document objectives into account. The user is expected to have technical competence and expertise in the field the standard is related to. The document content should strictly focus on the essential according to the objectives of the standard. The focus on the defined objectives aims to prevent authors from indulging in adding details that, although they may add clarity to the subject and provide additional information to readers, could also produce unnecessary prescriptions.

As a result, standards usually contain little supporting general information about the subject they address (it is usually limited to a short introduction) and, as a consequence, they turn out to be very complicated to non-expert readers and have little instructional value (which they are not intended to have).

The objectives of the standard will be explicitly and clearly stated in the document. This statement provides readers with a concise summary of the subject and the area of application of the standard. Objectives will be put in the relevant context, by describing their rational and possible correlations with other related standards.

Standards must be clear and unambiguous. This implies that documents need to have a well-defined structure, to help readers retrieve relevant information. The language must be plain and sentences must be meaningful and as short and concise as possible. Usage of lists, tables, pictures and specialized notations (i.e. special formalisms to describe requirements) is strongly encouraged, as it adds clarity to the requirements. Though specialized notations may be obscure to newcomers, they are expected to be clear to target readers with the required expertise.

Standards must clearly distinguish among mandatory parts (which actually defines the mandatory requirements for the relevant item to be considered compliant), simple guidelines (something the item is expected to comply with, but which is not mandatory), permissible characteristics (alternative provisions that the item may or may not comply with) and further limited additional parts included for information purposes. This can be achieved in different ways; for instance, by using specific and codified vocabulary, or by segregating content with different impacts in different document sections.

References to other standards have to be carefully organized, so that it is possible to distinguish normative references (i.e., other documents that are directly referenced within normative provisions in the main body of the standard) from informative references (that provide additional information for clarification purposes).

All requirements in a standard (be they requirements, recommendations or permitted characteristics) must be non-redundant and consistent among themselves and with the requirements quoted in the other related standards. Necessary and non-redundant mean that requirements must consist of the minimum set that fully specifies the characteristics of the standardized item according to the objectives of the standard. Consistency may sound like an obvious goal, yet guaranteeing consistency among a (possibly large) set of different standards requires great competence and commitment from the authors. At the same time, when the item to be standardized is complex and demands a large set of requirements, care has to be taken to avoid even partial contradictions among these requirements.

Furthermore, requirements must all be testable, at least in principle. This does not mean that it has to always be practically possible to design and perform tests to check the fulfilment of each requirement, but that the description of requirements has to be properly worded, according to its scope, and provide all information needed to implement (possible) relevant tests. This also implies that standards need to accurately state the possible conditions (if any) that constitute prerequisites for the applicability of the requirements, and the latter must specify the terms of compliance for the item with the required accuracy, depending on the objectives.

EXAMPLE

For clarification, we can consider an example provided by ETSI (ETSI, 2020). Let us compare the following alternative wording for a requirement: a) "When the equipment receives a SERVICE_REQUEST message, it shall respond immediately with a SERVICE_ACK message"; b) "When the equipment receives a SERVICE_REQUEST message, it shall respond with a SERVICE_ACK message within 30 ms". Requirement (a) is not testable, as it lacks necessary information ("immediately" is evidently an inaccurate term). On the contrary, requirement (b) is testable, as it correctly and accurately describes the test conditions ("receiving a SERVICE_REQUEST") and expected behaviour ("respond with a SERVICE_ACK message within 30 ms").

2.5 USING STANDARDS

This section provides a basic overview of the various steps that an individual may follow to identify and use the standards that are relevant to a specific topic of interest. The following procedure is a simple example of how a beginner may proceed for correctly selecting and using documents from standards. Depending on the level of seniority, knowledge, or on the specific goals, the nature and sequence of these steps can change. Moreover, this section does not deal with the decision about the adoption of the standard, including the choice of the most suitable one (if you are interested in learning more on this last topic, see Chapter 6, Section 6.5).

The proposed steps can be summarized as follows:

1) Identify the relevant SDOs involved in the development of a standard related to the specific item
2) Select SDO documents relevant to the item
3) Understand the selected documents' structure and formalisms.

The following sections expand upon and explain these steps.

2.5.1 SELECTING RELEVANT SDOS

As already discussed, the standardization world is rather crowded and includes various types of organizations that may compete or, ideally, collaborate to produce standard reference documents for a broad set of subjects.

SDOs generally produce high-quality technical material that can provide valuable input. In practice, when trying to simplify the search for standard references to define the characteristics of a certain feature, it is worth prioritizing and focusing on the most relevant subset of SDOs and selecting them on the basis of two classification criteria among those provided in Section 2.3:

a) Technical scope;
b) Geographical scope.

TECHNICAL SCOPE

As described before, each SDO has its own specific technical scope, which derives from its official statute, in other words from the common objectives that the members pursue when they participate in making standards. The SDO's technical scope constitutes the main criterion for the identification of standard reference for a certain item. For instance, if an item is related to information telecommunication technology, then ITU-T, ETSI, IEEE, IETF, W3C, and the ISO/IEC JTC1 represent, each for specific aspects, potential references. On the other hand, if the item is related to energy technology, then references may be IEC, CENELEC, and IEEE.

GEOGRAPHICAL SCOPE

Whereas SDOs themselves do not constrain the geographical scope of their specifications, it has been introduced before how each SDO, due to its membership and statute, may be classified according to its geographical area of influence as international, regional, or national. When a new item is to be developed, and standard reference is needed, relevant SDOs are those whose geographical scope encompasses the geographical market at which the item is targeted.

The above-described criteria for the selection of SDOs that are relevant to a certain item is only a simplification. The selection process is actually more complicated and dynamic. In some cases, there may be overlaps among various SDOs, especially with respect to technical scope, because of historical reasons. Sometimes SDOs that share the same technological area can independently develop different (and not necessarily fully aligned) specifications for the same subject. Furthermore, there may be borderline items that may fall into more than one technological area covered by more than one SDO. For instance, IEC and CENELEC standardize telecommunication protocols that are applicable to the control of energy systems, and as such, they partially overlap with the traditional standardization areas of other SDOs. In addition, an SDO's technical scope changes over time, as it can be enlarged to include new technologies.

This sort of competition among SDOs may also produce temporary standard misalignments. Still, SDOs actively cooperate to fix existing and prevent new divergences by setting up common study groups and collaboration instruments, such as liaisons or common standard initiatives (see Section 2.3), and by providing one another with mutual contributions.

Because of the complexity of the standardization institution landscape, SDO activities and relationships need to be continuously monitored to keep the whole picture up to date.

EXAMPLE

For some of the SDOs already introduced in Section 2.3, the following Table 2.2 summarizes the main classification criteria and their main existing contributions to other SDOs.

Table 2.2: SDO classification example

ORGANIZATION	HEADQUARTERS	GEOGRAPHICAL SCOPE	DOMAIN OF ACTIVITY	AFFILIATE ORGANIZATIONS / MEMBERS
ITU	Geneva (CH)	International	Telecoms /ICT	National SDO / Industries / Academia / Government bodies
ISO	Geneva (CH)	International	ICT	National SDO
IEC	Geneva (CH)	International	Electrotechnical	National SDO
ETSI	Sophia Ant (FR)	International (European regional recognition)	Telecoms/ICT	National SDO / Industries / Academia / Government bodies
CEN	Brussels (BE)	Regional (Europe)	ICT	National SDO
CENELEC	Brussels (BE)	Regional (Europe)	Electrotechnical	National SDO
IEEE	New York (US)	International	ICT	Professionals
IETF	Fremont (US)	International	ICT	Professionals

2.5.2 IDENTIFYING SDO DOCUMENTS

Once the relevant SDOs for a specific item have been identified, the next step is the selection of relevant documentation related to standard we are looking for. SDOs produce whole sets of standards, which may include various types of informative documents besides the true formal standards that are available via their websites. Depending on the SDO's specific policy, access to standards may be free or subject to some restrictions. For instance, ITU, ETSI and the IETF guarantee free access to published standards, while IEEE or ISO require the payment of a fee. ITU and ETSI limit access to draft standards to selected and accredited personnel of their members, while the IETF ensures free access to draft documents.

SDO websites usually provide search tools to allow users to navigate through all of their filed documents, which may belong to different categories, such as, for instance, technology roadmaps, product/service requirements, product/service technical specifications, regulations produced on behalf of regulatory bodies and product/service test specifications. SDOs usually assign a different document code to each category, so that it is possible to identify the topic covered by the documents just from their codes.

EXAMPLE

Table 2.3 includes a few examples of the different documentation produced by some major SDOs, such as ITU (in particular, ITU-T, ITU-T, 2006), ETSI (ETSI, 2021 (b)) and the IETF (IETF, (a)).

Table 2.3: Examples of standards classifications

ITU-T	ETSI	IETF
Publications from ITU Telecommunication standardization sector (ITU-T) are coded with format X.nnn, where X describes the document domain, e.g.: A – Organization of the work of ITU- T B – Means of expression: definitions, symbols, classification C – General telecommunication statistics D – General tariff principles E – Overall network operation, telephone service, service operation and human factors F – Non-telephone telecommunication services G – Transmission systems and media, digital systems, and networks	ETSI produces a range of publications, each with its own particular purpose, which is encoded in the first two letters of the document's code, e.g.: EN – the document is intended to meet needs specific to Europe and requires transposition into national standards, or the document is required under a mandate from the European Commission (EC)/European Free Trade Association (EFTA). ES and TS and GS– the document contains technical requirements (the difference between ESs and TSs lies in different approval rules). EG – identifies guidance to ETSI in general on the handling of specific technical standardization activities. TR and GR – the document contains explanatory material.	The IETF's official documents are named RFCs. "RFC" stands for Request for Comments, and this name expresses the IETF's approach to standardization: "the Internet is a constantly changing technical system, and any document that we write today may need to be updated tomorrow". The IETF does not code documents' scope and objectives in their RFC identifier system, which is simply a progressive number.

Because of the complexity and extent of SDO activity, retrieving the right documentation by navigating SDO sites, even when they support users with search engines (which, for instance, allow documents to be searched for based on a subject or keywords), is not an easy task. As such, when it comes to collecting documentation, it is necessary to continuously monitor SDO activities, in order to stay up to date about the evolution of their work on the subject matter.

2.5.3 UNDERSTANDING STRUCTURE AND FORMALISM OF THE STANDARDS

We introduced before the main characteristics of a standard and highlighted how SDOs ensure that their documentation is as clear as possible, in order to avoid any reader misunderstanding. In this section, we provide some hints about how readers need to approach standards. In the following, we deal in particular with ITU-T, ETSI and IETF document writing rules.

A first basic element that a standard must include consists of a clear statement of its objectives and area of application. This statement is usually put in the introductory part of the document.

EXAMPLE

Different SDOs implement the introductory part in slightly different ways.

ITU-T (ITU-T, 2020) instructs authors to include, at the beginning of the document, some introductory material that needs to include a mandatory summary paragraph. The summary must be included "before the main body of the recommendation" to "provide a brief overview of the purpose and contents […], thus permitting readers to judge its usefulness for their work". The summary may be optionally integrated into the following introduction section, which is used to "provide information that the author deems appropriate and that is not already provided in the Summary". The summary and introduction sections are not numbered. The first numbered section of the recommendation (i.e., in ITU-T terms, the first "clause") is the so-called scope, which specifically aims "to define, without ambiguity, its intent or object and the aspects covered, thereby indicating the limits of its applicability".

Similarly, ETSI (ETSI, 2021) includes an unnumbered foreword paragraph at the top of its standards. It is intended to be a "required, informative element" that provides information about, for instance, the technical body that prepared the deliverable, the approval process the document followed, possible relations between the deliverable and other ETSI standards and, where applicable, the main changes the current version of the deliverable is introducing with respect to the previous version. The foreword section may be optionally followed by executive summary and introduction sections, which summarize the contents of the document and give information about the "reasons prompting its preparation". The foreword, executive summary and introduction sections are not numbered. The first numbered item of the document is the scope, which "defines without ambiguity the subject of the ETSI deliverable and the aspect(s) covered, thereby indicating the limits of applicability of the ETSI deliverable or particular parts of it".

It is worth noting that in both ITU-T and ETSI documents, information about scope and applicability can be derived, as explained in Section 2.5.2, from the document code on the first page.

IETF documents (IETF, 2014) must include an abstract section "that provides a concise and comprehensive overview of the purpose and contents of the entire document". The abstract is followed by the introduction section, which is considered the first section of the document body. The introduction "explains the motivation for the RFC and, if appropriate describes the applicability of the document, e.g., whether it specifies a protocol, provides a discussion of some problem, is simply of interest to the Internet community". In RFCs, the use of the title "Introduction" to name such a section is recommended, but "authors may choose alternative titles, such as overview or background". The IETF also includes a specific "Status of this memo" section in the introductory part of its documents, which clarifies many basic characteristics of the documents, namely the document category and what review process the document was subject to.

Further fundamental information that a standard needs to include is a list of other reference documentation the standard is related to. Standards usually include references to other documentation produced by the same SDO or by others. This documentation either provides informative material, such as supplemental information to assist the understanding of the documents, or references documents that provide normative provisions, which are mandatory to claim compliance with the standard.

EXAMPLE

In ITU-T (ITU-T, 2020) recommendations, normative references are listed in the References section, included as the second clause of the recommendation (just after the scope clause). Informative references are, instead, collected in a bibliography section arranged at the end of the recommendation.

Similarly, ETSI deliverables (ETSI, 2021) list references in their second clause (again, after the scope clause); the reference clause is split into two sub-clauses that respectively include normative (clause 2.1) and informative (clause 2.2) references.

In IETF RFCs (IETF, 2014), references are grouped in the specific references section, which "must indicate whether each reference is normative or informative". Note that an IETF RFC not only lists other documents that possibly provide references but also explicitly quotes, just at the top of the document, the list of other RFCs that the document makes obsolete.

SDOs also need to take provisions to ensure that requirements are clear and unambiguous. Such provisions include, for instance, strictly discriminating, within a standard, normative sections from simply informative ones, as well as using codified vocabulary and specific formalisms to clearly express requirements and to highlight, within a normative section, what is actually a requirement, a recommendation (desirable, but not compulsory), a permissible characteristic (alternative provisions that may or may not be met) or parts included for information purposes.

EXAMPLE

The structures of ITU-T, ETSI and IETF documents are designed to take account of the above provisions and ensure a clear separation between the document body, including the normative part, and the scope statement, list of reference documents, and any annexes which may be normative or informative. One of these provisions that aims to make the requirements clear is to include the definitions of the concepts and terms to be used in the standard, after the description in the introductory part.

For instance, ITU-T (ITU-T, 2020) specifies that all standards need to include a definition section, to appear as the third clause of the body of the document and giving "the definitions necessary for the understanding of certain terms used in the recommendation". ITU-T also specifies that the fourth clause of each document needs to list "in alphabetical order all the abbreviations and acronyms from throughout the recommendation". Furthermore, clause 5 of ITU-T documents is reserved for defining or referencing special notations used throughout the recommendation.

Similarly, ETSI (ETSI, 2021) specifies that definitions, symbols, and abbreviations must be listed in the third clause of the body of its recommendations; the clause is split into three sub-clauses (numbered 3.1, 3.2 and 3.3), each devoted to one of the three item types.

As an additional provision to differentiate between normative and informative text, some SDOs define different aims for the different sections of their documents and specify whether they can contain normative requirements or just informative parts and other content.

EXAMPLE

As an example, ITU-T (ITU-T, 2020) clarifies that the introductory part of its recommendations—the part that comes before the scope section as explained above—does not include normative requirements. Mandatory requirements are contained in the main body of recommendations, from clause 6 onwards. In ITU-T recommendations, any annexes, which may expand some matters and are referred to within the main body, are considered to "form an integral part of the recommendation" and therefore may include normative requirements.

In the same manner as ITU-T, in ETSI deliverables (ETSI, 2021), the actual text of the standard starts from clause 4, while preceding parts do not contain normative requirements. Any annexes may or may not include requirements. The content of an annex is clearly stated by adding an indication close to its heading, which identifies it as normative or informative.

Unlike ITU-T and ETSI, the IETF does not provide strict guidance on how to structure RFCs to include parts that explain definitions and acronyms (even if it is a common practice) and segregate normative and informative contents of a document. With respect to acronyms, the IETF (IETF, 2014) just recommends the "expansion of abbreviations on first occurrence".

As a further provision to clarify the text of requirements and discriminate normative from informative parts, as well as to distinguish different requirement types (for instance, mandatory or desirable), SDOs take particular care in defining some specific wording conventions, which may differ from one SDO to another.

EXAMPLE

For instance, ITU-T (ITU-T, 2020) strictly rules "the use of the words 'shall' and 'must' and their negatives 'shall not' and 'must not'", which are verbs reserved "to express mandatory provisions", "i.e., if certain values and/or parts of a recommendation are essential and the recommendation will have no meaning if these values and/or parts are not strictly respected or adhered to".

Similarly, but even more accurately, ETSI (ETSI,2021) defines the actual intended meaning of various verbal forms. ETSI specifies that "shall" and "shall not" are used "to indicate requirements strictly to be followed in order to conform to the standard"; usage of verbs "must" and "must not" is, on the contrary, not allowed. Verbal forms "should" and "should not" are used to indicate "that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited". Moreover, verbal forms "may" and "need not" are used to indicate permitted behaviours or values; "can" and "cannot" "are used for statements of possibility and capability, whether material, physical or causal"; "will" and "will not" are "used to indicate behaviour of equipment or sub-systems outside the scope of the deliverable in which they appear"[16]. Finally, verbal forms "is" and "is not" have to be used only "to indicate statements of fact".

Also, the IETF defines strict terminology to express different levels of requirement (IETF, 2014) (IETF, 1997). In RFCs, some capitalized words may be used for this purpose. "MUST", or the terms "REQUIRED" or "SHALL", mean that the definition is an absolute requirement of the specification. "MUST NOT", or the term "SHALL NOT", mean that the definition is an absolute prohibition of the specification. "SHOULD", or the adjective "RECOMMENDED", mean that "there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course". "SHOULD NOT", or the term "NOT RECOMMENDED", mean that "there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label". Finally, "MAY", or the adjective "OPTIONAL", mean that "an item is truly optional", in other words that "one vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product, while another vendor may omit the same item".

Besides strict document wording rules, SDOs may use suitable formalisms to better clarify requirements. Such formalisms may take the form of simple tables, graphical descriptions such as block diagrams or, in some cases, actual formal languages.

All of these provisions are usually allowed (or even encouraged, in some cases), provided that the chosen formalism, such as block diagrams or formal language syntax, is extensively and unambiguously described within the standard or in further documentation that the standard refers to (i.e. that is appropriately included in the list of "normative" or "informative references").

16 *"For example, in a deliverable specifying the requirements of terminal equipment, these forms shall be used to describe the expected behaviour of the network or network simulator to which the terminal is connected." (ETSI, 2021)*

EXAMPLE

Different SDOs may also have different approaches when considering the usage of formal languages to express standard requirements.

For instance, IETF IESG (IETF, 2001) acknowledges that formal languages are useful tools and does not prohibit their usage. However, it recommends that standard developers continue using English, with formal languages left as a supporting mechanism.

On the contrary, ITU-T (ITU-T, (b)) and ETSI (ETSI, 2021 (e)) promote the extensive usage of formal languages in standards "in order to produce precise and unambiguous formal specifications, which are essential to the quality of the recommendations and their implementations".

2.6 SUMMARY

This chapter introduced some basic concepts and definitions about standards, which the following parts of the book will deal with in greater detail.

Firstly, a very intuitive and practical definition of "standards" has been provided, together with some examples of how standards are widely applied by industries. Then, the chapter gave an overview of the aims of Standards Development Organizations (SDOs), the positive economic and societal impacts their job has, as well as the possible risks and drawbacks an ill-conceived standards development process might bring. This was followed by examples of major SDOs, mainly active in the ICT area and, lastly, a basic description of the characteristics and structure of processes and deliverables for a generic SDO was provided.

Key messages which should be retained from this chapter include:

- In the technology field, standardization to some extent is required to make things developed by different makers' interwork
- Standards may arise either simply because a certain technology asserts itself on the market, so as to become a natural choice for many manufacturers (de facto standard), or because they are developed by organizations that are built for that purpose by adopting formal standardization processes (SDOs) or not (fora, consortia, …)
- The main characteristics of SDOs: they work by building consensus among participants; they follow formal standardization based primarily on the WTO TBT principles.
- Standardization effort benefits innovation, trade and environment; yet there are risks of disadvantages, which SDOs need to manage.
- The standardization landscape is crowded. There are many SDOs, some of them with no hierarchical relationship, whose activities may overlap; however, SDOs work to set up liaisons or common standardization initiatives. SDOs may be roughly classified by geographical coverage, by technical scope of activities, and by their recognition by regulatory systems.
- Each SDO sets its own specific internal processes to develop standards; nevertheless, different SDO processes have common features that allow a generic standard document life cycle to be drawn up.
- SDO deliverables have some specific characteristics: they are specialized documents, intended for expert people; they must be clear and unambiguous and include only necessary, non-redundant and consistent requirements. SDOs ensure these characteristics are achieved through strictly defined document structure and drafting rules.

2.7 QUIZ

1 - WHICH OF THE FOLLOWING STATEMENTS APPLY TO A "DE FACTO" STANDARD?

(See Section 2.1 for hints)

a) *it usually has very little impact, as it is recognized only within a restricted community of users;*

b) *it is based on a winning technological solution, which is widely and independently adopted by different producers/providers within a market segment and products developed on such basis are widely accepted by users/customers;*

c) *it has been agreed through a formal process by members of an established organization.*

2 - WHICH OF THE FOLLOWING STATEMENTS APPLY TO A "SDO STANDARD"?

(See Section 2.1 for hints)

a) *it has been developed through a fair process and by consensus of members of an established organization;*

b) *it establishes mandatory characteristics of a product to be put on the market;*

c) *it strictly and fully rules the design of an item.*

3 - WHAT IS THE DIFFERENCE BETWEEN "REGULATIONS" AND "STANDARDS"?

(See Section 2.1 for hints)

a) *none, as standards "regulate" the characteristics of products;*

b) *regulations define a set of characteristics an item needs to have to access a regulated market, while compliance with standards is on voluntary basis;*

c) *standards only provide a set of best practices to design/develop a specific item and cannot cover critical issues (such as safety or security) that are governed by regulatory bodies.*

4 - HOW ARE REGULATIONS AND STANDARDS RELATED?

(See Section 2.1 for hints)

a) *standards and regulations are the same thing;*

b) *standards are sometimes turned into regulations;*

c) *standards are often referenced by regulations.*

5 - WHAT DO STANDARDS PROVIDE TO PRODUCT DEVELOPERS/DESIGNERS?

(See Section 2.1 for hints)

a) *a thorough set of design rules they are forced to comply with;*

b) *references for a high-quality design;*

c) *a minimum set of requirements in order to make the product meet certain well-defined objectives.*

6 - HOW DO STANDARDS BENEFIT INNOVATION?

(See Section 2.2 for hints)

a) *by defining the products' characteristics related to the most critical aspects, so as to reduce design risks and time;*

b) *by inspiring designers with innovative ideas;*

c) *by constraining designers' choices, so as to speed up the design phase.*

7 - HOW DO STANDARDS BENEFIT THE ENVIRONMENT?

(See Section 2.2 for hints)

a) *by enforcing mandatory safety and sustainability characteristics for marketable products*

b) *by defining widely shared safety and sustainability requirements for products, often publicized to customers through proper product labelling*

c) *by forcing designers to follow detailed design rules that ensure products meet determined safety and sustainability requirements.*

8 - HOW DO STANDARDS BENEFIT THE ECONOMY?

(See Section 2.2 for hints)

a) *by restricting market access to only standard-compliant, high-quality products;*

b) *by enabling economies of scale, encouraging wider and fairer competition and facilitating trade thanks to the definition of widely shared practices;*

c) *by freezing technological evolution, so as to allow producers and customers to get the best return from their past investments in established products.*

9 - HOW DO STANDARDS BENEFIT INDUSTRIES?

(See Section 2.2 for hints)

a) *by facilitating the development of new technologies, by ensuring fair competition among industries and by enlarging products' market penetration opportunities;*

b) *by ruling market access of new products, as they define a mandatory minimum set of requirements that new products must comply with;*

c) *by pacing the technological evolution, so as to consolidate market positions of established industries.*

10 - HOW DO STANDARDS BENEFIT SOCIETY AND INDIVIDUALS?

(See Section 2.2 for hints)

a) *by ruling the market introduction of innovative products, so as to guarantee safety and environmental sustainability;*

b) *by establishing a minimum level of performances for any new product entering the market;*

c) *by promoting innovation, a safer environment and a more competitive market.*

11 - COMPLETE THE TABLE BELOW BY DEFINING THE CHARACTERISTICS OF THE LISTED SDOS ACCORDING TO THE CLASSIFICATION CRITERIA DEFINED IN THE FIRST ROW:

(See Section 2.3 for hints)

SDO	GEOGRAPHICAL COVERAGE	RECOGNIZED (Y/N)	MAIN TECHNICAL SCOPE
ISO			
ITU			
ETSI			
3GPP			
IETF			
ECMA			

12 - LIST THE MAIN PHASES OF THE GENERIC STANDARD LIFE CYCLE AND SUMMARIZE WHAT THEY ARE FOR:

(See Section 2.3 for hints)

PHASE NUMBER	PHASE NAME	WHAT IT IS FOR (SCOPE, MAIN ACTIVITIES INCLUDED IN THE PHASE)
1		
2		
3		
4		
5		

13 - IDENTIFY THE TWO CHARACTERISTICS, FROM THOSE LISTED BELOW, THAT DO NOT DESCRIBE A NORMATIVE REQUIREMENT PART OF A STANDARD:

(See Section 2.4 for hints)

a) *clear, concise and unambiguous;*
b) *widely explained by means of extended examples;*
c) *expressed by means of specialized notations;*
d) *defined by means of references to other standards;*
e) *well justified by means of an extended technical dissertation;*
f) *testable: the description has to be worded so as to provide all needed information to implement (possible) relevant tests.*

14 - DESCRIBE THE TYPICAL CONTENT OF THE VARIOUS SECTIONS OF A GENERIC STANDARD LISTED BELOW:

(See Section 2.3 and 2.5 for hints)

SECTION	CONTENT
SCOPE / ABSTRACT	
REFERENCES	
DEFINITIONS	
BODY OF THE DOCUMENT	
ANNEXES	

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2.8 GLOSSARY

- Standard: A "standard" is "a widely agreed way of doing something". Depending on the specific area of application, "doing something" may be replaced by, for example, "designing a product", "building a process", "implementing a procedure", or "delivering a service".
- Formal Standardization: Formal standardization is a well-defined process, open to any individual or organization, and its results are produced in consensus with all interested parties. Formal standardization is inspired by international directives on standardization, the most important being the principles produced by the Technical Barriers to Trade (TBT) Committee of the Word Trade Organization (WTO). The TBT committee proposed six principles for the development of international standards (see Chapter 4 for details): transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and development dimension.
- Standards Development Organization (SDO): An organization devoted to developing standards and that puts in place well-defined procedures to guarantee a fair development process, which is aimed at building consensus among involved contributors and ensuring the quality of the final deliverables
- SDO standard: A standard developed by an SDO.
- De facto standard: A "de facto standard", also known as "standard in actuality", arises when a winning solution is widely and independently adopted by different industries within a market segment and products developed on such a basis are widely accepted by customers.
- International SDO: International SDOs have members worldwide, sometimes also including representatives of National or Regional standard bodies, and their deliverables have worldwide coverage.
- Regional SDO: Regional SDOs include members (industry, academia and national SDOs) from a set of countries that usually share, or are interested in promoting, common practices and regulations.
- National SDO: National SDOs (NSDOs or NSB) operate at the single country level and issue country-specific standards; they often collaborate with International and Regional SDOs.
- Recognized SDO: SDOs that are officially recognized by regulation systems as providers of standards.
- Standard initiative: An organization that multiple SDOs put in place to coordinate standardization efforts on particular subjects.
- Industrial fora and consortia standards: Standards that are produced by groups of companies that come together temporarily. An industrial forum/consortium can develop to SDO if it satisfies formal standardization principles for a longer term.

2.9 LIST OF ABBREVIATIONS

- 3GPP: 3rd Generation Partnership Project
- AAP: Alternative Approval Process
- AD: Area Director
- ANSI: American National Standards Institute
- ARSO: African Organization for Standardization
- CEN: Comité européen de normalisation— European Committee for Standardization
- CENELEC: Comité européen de normalisation en électrotechnique— European Committee for Electrotechnical Standardization
- DVD: Digital Video Disk
- ECMA: European Computer Manufacturers' Association
- ETSI: European Telecommunications Standards Institute
- IEC: International Electrotechnical Commission
- INCITS: InterNational Committee for Information Technology Standards
- ISO: International Organization for Standardization
- ITU: International Telecommunication Union
- JEDEC: Joint Electron Device Engineering Council
- HD DVD: High Definition Digital Versatile Disc
- HTML: HyperText Markup Language
- IEEE: Institute of Electrical and Electronics Engineers
- IETF: Internet Engineering Task Force
- IP: Internet Protocol
- HDMI: High Definition Multimedia Interface
- ICT: Information and Communication Technology
- LTE: Long Term Evolution
- M2M: Machine to Machine
- NSDO: National Standards Development Organization
- PASC: Pacific Area Standards Congress
- PDF: Portable Document Format
- SDO: Standards Development Organization
- TAP: Traditional Approval Process
- UMTS: Universal Mobile Telecommunications System
- VESA: Video Electronics Standards Association
- W3C: World Wide Web Consortium
- WG: Working Group
- WI: Work Item
- XML: eXtensible Markup Language

2.10 REFERENCES

- Biddle & al., 2010. How many standards in a Laptop? (and other empirical questions). http://ssrn.com/abstract=1619440. Accessed March 2018.
- CEN-CENELEC, 2018. Smart Grids. https://www.cencenelec.eu/standards/Sectors/SustainableEnergy/SmartGrids/Pages/default.aspx. Accessed March 2018.
- ETSI, 2020. A Guide to Writing World Class Standards. https://www.etsi.org/e-brochure/WritingWorldClassStandards/mobile/. Accessed October 2021.
- ETSI, 2021. ETSI Drafting Rules (EDRs). https://portal.etsi.org/Services/editHelp/How-to-start/ETSI-Drafting-Rules. Accessed October 2021.
- ETSI, 2021 (a). Standards making process. https://portal.etsi.org/Resources/Standards-Making-Process/Process. Accessed October 2021.
- ETSI, 2021 (b). Different types of ETSI Standards. http://www.etsi.org/standards/types-of-etsi-standards. Accessed October 2021.
- ETSI, 2021 (c). ETSI directives. https://portal.etsi.org/Resources/ETSI-Directives. Accessed October 2021.
- ETSI, 2021 (d). How does ETSI make standards. http://www.etsi.org/standards/standards-making. Accessed October 2021.
- ETSI, 2021 (e). Protocol Specification Languages. https://portal.etsi.org/Services/Centre-for-Testing-Interoperability/ETSI-Approach/SpecLanguages. Accessed October 2021.
- Fishman, G., 2012. Decision-Making and Approval Procedures: soft and hard decisions. https://www.itu.int/en/ITU-T/tutorials/Documents/201210/Session-06-Rapporteur%20Tutorial%20 1208G-Decision_Making.pdf. Accessed March 2018.
- IETF, (a). IETF Internet Standards web page. https://www.ietf.org/standards/. Accessed October 2021.
- IETF, (b). The Tao of IETF: a Novice’s Guide to the Internet Engineering Task Force. https://www6.ietf.org/tao.html. Accessed October 2021 .
- IETF, 1997. RFC2119 - Key words for use in RFCs to Indicate Requirement Levels. https://tools.ietf.org/pdf/rfc2119.pdf. Accessed October 2021.
- IETF, 1998. RFC2418 - IETF Working Group Guidelines and Procedures. https://datatracker.ietf.org/doc/rfc2418/?include_text=1. Accessed October 2021.
- IETF, 2001. Guidelines for the Use of Formal Languages in IETF Specifications. https://www.ietf.org/iesg/statement/pseudocode-guidelines.html. Accessed October 2021.
- IETF, 2012. RFC 6771 - Considerations for Having a Successful "Bar BOF" Side Meeting. https://tools.ietf.org/html/rfc6771. Accessed October 2021.
- IETF, 2013. RFC 2026 - The Internet Standards Process - Revision 3. https://datatracker.ietf.org/doc/rfc2026/?include_text=1. Accessed October 2021.
- IETF, 2014. RFC 7322 - RFC Style Guide. https://tools.ietf.org/html/rfc7322. Accessed October 2021.

- IETF, 2018. IETF - Mission and Principle.
  https://www.ietf.org/about/mission/. Accessed October 2021.
- ISO, 2016. How to write Standards.
  https://share.ansi.org/ISOT/Other%20ISOT%20Resources/Resources%20for%20Drafting%20Standards/How%20To%20Write%20Standards.pdf. Accessed October 2021.
- ITU-T, (a). ITU Standards approval.
  https://www.itu.int/en/ITU-T/about/Pages/approval.aspx. Accessed October 2021.
- ITU-T, (b). Formal descriptions and Object identifiers databases.
  https://www.itu.int/en/ITU-T/studygroups/com17/Pages/ldt.aspx . Accessed October 2021.
- ITU-T, (c). ITU Standards development.
  https://www.itu.int/en/ITU-T/about/Pages/development.aspx. Accessed October 2021.
- ITU-T, 2006. ITU-T Recommendation web page.
  https://www.itu.int/rec/T-REC/en. Accessed October 2021.
- ITU-T, 2020. Editing Guidelines.
  https://www.itu.int/oth/T0A0F000004/en. Accessed October 2021.

3 THE STANDARDS ECOSYSTEM

LEARNING OBJECTIVES

- Students should understand and apply the different criteria for establishing the classifications of standardization documents and the organizations producing them, especially in the ICT arena.
- Students should be able to describe the role of recognised SDOs, as well as to value the standardization by non-recognised SDOs with well-established procedures.
- Students should identify the characteristics of formal and de facto standardization. Also, students should be aware that there exist processes through which some de facto standards are adopted by SDOs.
- Students should understand the role played in standardization by industrial consortia, including their two-way interplay with SDOs.
- Students should become familiar with the differences between types of standardization documents in terms of their scope and addressed stakeholders, whether they contain requirements (normative documents) or simply provide information, as well as the process leading to their approval/publication. Also, it is important to know about which organizations may produce which type of document, and the definition/purpose of each type of document, which may differ across organizations.
- Students should identify the main categories of ICT standards.
- Students should become familiar with the naming conventions of different SDOs and be able to extract and identify the key characteristics of a document from its name and code.
- Students should understand the necessary agreements among national, regional, and international SDOs aiming to improve the efficiency of standardization efforts. In addition, students should understand that the coordination of standardization activities among SDOs with different scopes is essential and beneficial from business and legal perspectives.
- Students should understand why standards are usually referenced by legislation, and the need to issue standardization requests when a societal need is identified in a specific area.

3.1 INTRODUCTION

As introduced in Chapter 2, the standardization landscape is rich and complex. Its very first definition of "standard" was rather generic: "a widely agreed way of doing something". But then it clarified that, in our context, proper standards are formal documents that are produced by organizations with expertise in the field, which at the same time may be categorized according to their geographical scope, among other characteristics. As described there, hundreds of standards, by dozens of organizations, are needed for a Personal Computer to run.

The current chapter aims to provide some basic concepts to help readers find their way around the standards ecosystem.

Figure 3.1: The complex ecosystem of standardization organizations and the documents they deal with

3.2 STANDARDS ORGANIZATIONS

This section provides readers with key concepts and examples of formal standardisation and the organisations producing it, i.e., the standards development organisations (SDOs). It also introduces de facto standards and the processes through which some of them are published as SDO standards in the ICT field. Finally, it describes the relationship of industry consortia with ICT standardisation.

3.2.1 FORMAL STANDARDISATION AND STANDARDS DEVELOPMENT ORGANISATIONS (SDOS)

Formal standardization is based on well-defined processes, open to any individual or organization, and its results are produced in consensus with all interested parties. As introduced in Chapter 2, formal standardization is inspired by international directives on standardization, the most important being the principles produced by the Technical Barriers to Trade (TBT) Committee of the Word Trade Organisation (WTO). The TBT committee proposed six principles for the development of international standards: Transparency, Openness, Impartiality and consensus, Effectiveness and relevance, Coherence, and Development dimension. These principles are dealt with in depth in Chapter 4.

Organizations doing formal standardization are known as Standard Development Organizations (SDOs), which develop, revise, and withdraw standards. They do it in response to specific industry or societal needs.

Some SDOs are officially recognized by regulatory systems as providers of standards. They are known as recognized SDOs. Sometimes, the corresponding governmental authority invites a recognized SDO to address a topic in the need of standardization.

EXAMPLE

Regulation (EU) No 1025/2012 of the European Parliament and of the Council designates CEN, CENELEC and ETSI as the European Standards Organizations (ESOs).

Sometimes, the expression "de jure" standards is used as an equivalent to SDO standards. However, "de jure" fits only in the case of a subset of these standards, i.e., those that are used by legislation.

Besides the officially recognized SDOs, there are well-respected and long-existing SDOs that are not officially recognized by regulatory systems, but have well-established procedures to ensure the quality of their standards (e.g. W3C, IETF, OASIS, IEEE, OMG).

EXAMPLE

IEEE counts on a specific board (the IEEE-SA Standards Board) to coordinate the development and revision of IEEE standards. This includes approving the initiation of standards projects and reviewing them for consensus, due process, openness, and balance. IEEE 802 is just an example of an IEEE family of standards with a significant impact on society. 802 standards deal with local area networks and metropolitan area networks.

EXAMPLE

European standard EN 301 549 on ICT accessibility requirements, published by the European Standards Organizations, makes explicit references to Web Content Accessibility Guidelines (WCAG), published by W3C.

Public SDOs are created by treaties. This is the case of ITU, which is an agency of the United Nations. Hence, ITU is an example of a recognized, public organization. However, recognized organizations are not necessarily public. In fact, most of them are private. For instance, ETSI is a private, not-for-profit organization. Other examples of official organizations that are private are ISO, IEC, CEN, CENELEC, and ANSI.

3.2.2 DE FACTO STANDARDS

Let's have a look at the following ICT-related items:

- PDF: a document format created by Adobe Systems.
- HTML: a language for describing the structure and content of Web pages. It was originally created by Tim Berners-Lee and is currently published and maintained by W3C.
- Microsoft Windows: an operating system that became an industry standard, and so did its specifications (e.g. the Microsoft Web Services Security specification, WS-Security).

What they all have in common is that they have had a huge impact on society, as they are used by millions of users… They are called "de facto standards", which are common practices adopted by the market, which are not the result of any formal standardization process.

According to Maxwell (2006), a de facto standard is a custom or convention that has achieved a dominant position by public acceptance or market forces (for example, by early entry into the market), and that usually has the attractive characteristic of having been validated by market processes. This effect was analysed by Utterback and Abernathy, who introduced the "dominant design" concept in the 70s (Abernathy and Utterback 1978). They identify key technological features that become a de facto standard. Dominant designs may not be better than other designs; they simply incorporate a set of key features that sometimes emerge due to technological path-dependence and not necessarily strict customer preferences.

Table 3.1 compares characteristics of SDO and de facto standards.

Table 3.1: Comparison of formal and de facto standards (Blind 2008)

SDO STANDARD	DE FACTO STANDARD
• Developed in SDOs • Open and consensus oriented with the option of opposition, which may sometimes lead to lengthy decision procedures • Clear and transparent participation and voting rules	• Dominant design through a standard war or natural selection. E.g. a company achieves a dominant position by public acceptance or market forces • Standardization process with restricted access; homogeneous environment may allow fast decisions • Direct participation of company alliances (e.g. consortia) and individual companies

De facto standards may be documented and then adopted by recognized SDOs, like in the case of HTML (see the example below) and PDF (ISO 32000-1:2008 Document management—Portable document format — Part 1: PDF). Furthermore, de facto standards may considerably influence SDO standards.

EXAMPLE

Tim Berners-Lee described HTML publicly for the first time in 1991. HTML is the language that enables documents to be used and shared by users across the Internet. It was originally composed of 18 elements, which web browsers interpret so that humans can interact with documents containing text, images, other media, and links to other HTML documents.

Later, the IETF published "HTML 2.0". It was the first time that HTML was published as a standard. Since 1996, the World Wide Web Consortium (W3C) has been in charge of maintaining the HTML specification. It was in 2000 that a recognized SDO (ISO/IEC) published HTML as ISO/IEC15445:2000.

3.2.3 CONSORTIA AND STANDARDIZATION

Industrial consortia are alliances of companies operating in the same domain that come together to prepare specifications for products that must be brought to market very quickly. These organisations usually benefit from a lighter process and a lower level of consensus of document approval than the processes that SDO standards go through. In response to the rapid development of ICT systems, many consortia have been created in this sector. Major industry players often consider consortia to be more efficient and more oriented towards the needs of the industry than formal standardization, which —according to them— depends on a cumbersome and time-consuming wide consensus process. The time-to-market of their specifications is expected to be much shorter than formal standardization.

Consortia specifications are different from other documents owned by a single company (for example, Windows as a Microsoft standard) in the sense that they are written by a community. In some cases, a consortium may ultimately prefer to have its specifications become SDO standards, as this provides more confidence and ensures wider adoption by the market. It may bring a whole set of benefits to the developed technology, because it ensures that the specifications comply with quality rules, which are often tighter than what a private group may deliver.

Some SDOs have procedures for referencing and incorporating industrial technical specifications or collaborating in the development of standards with these consortia. These procedures guarantee that the fundamental principles of formal standardization are respected. Furthermore, after their publication as standards, these documents can be updated due to technological evolution through the foreseen standardization process.

DEFINITION

THE PAS PROCESS

The Publicly Available Specification (PAS) procedure is a means to transpose a specification more rapidly into an international standard published by a recognized SDO. This mechanism has primarily been designed to enable ISO/IEC JTC 1 to transpose specifications that originated from consortia into international standards, see more details about ISO/IEC JTC1 in Section 3.3.

The PAS procedure takes into consideration the fact that the specification is already developed at an almost final stage and approved by consensus at consortium level. The procedure includes close scrutiny and approval process by the corresponding SDO committee before the document can be published as a PAS. PAS documents are published by the SDO for immediate use. The standard benefits from the SDO's reputation as a provider of standards for global use and receives increased visibility. A PAS published as a standard is subsequently maintained and possibly evolved by the SDO that applied the procedure. The PAS process allows the document to be available to the market faster and in a lighter way than with the full, regular SDO process.

EXAMPLE

ETSI defines Publicly Available Specifications (PAS) for technical specifications developed by organisations outside ETSI. The ETSI PAS process (ETSI 2017) defines the procedures to adopt specifications written by industrial alliances as ETSI documents, namely ETSI Technical Specifications (TS) or ETSI Technical Reports (TR). It has already been applied to specifications from two different consortia, the Home Gateway Initiative (HGI) and the Car Connectivity Consortium (CCC), presented below.

Based upon the "Home Gateway" as a modular application platform, HGI developed a smart home architecture that enables applications to connect with devices on any home network interface. Following the closure of HGI in June 2016, TC SmartM2M handled the conversion of the three HGI specifications (HGI-ETSI 2016) into ETSI TSs using the PAS procedure and published the three TSs in November 2016.

"HGI consulted closely with ETSI SmartM2M during the development of these key documents. This work complements our own work on smart appliances very well, and we are happy to integrate these HGI requirements into our family of specifications." (ETSI 2016).

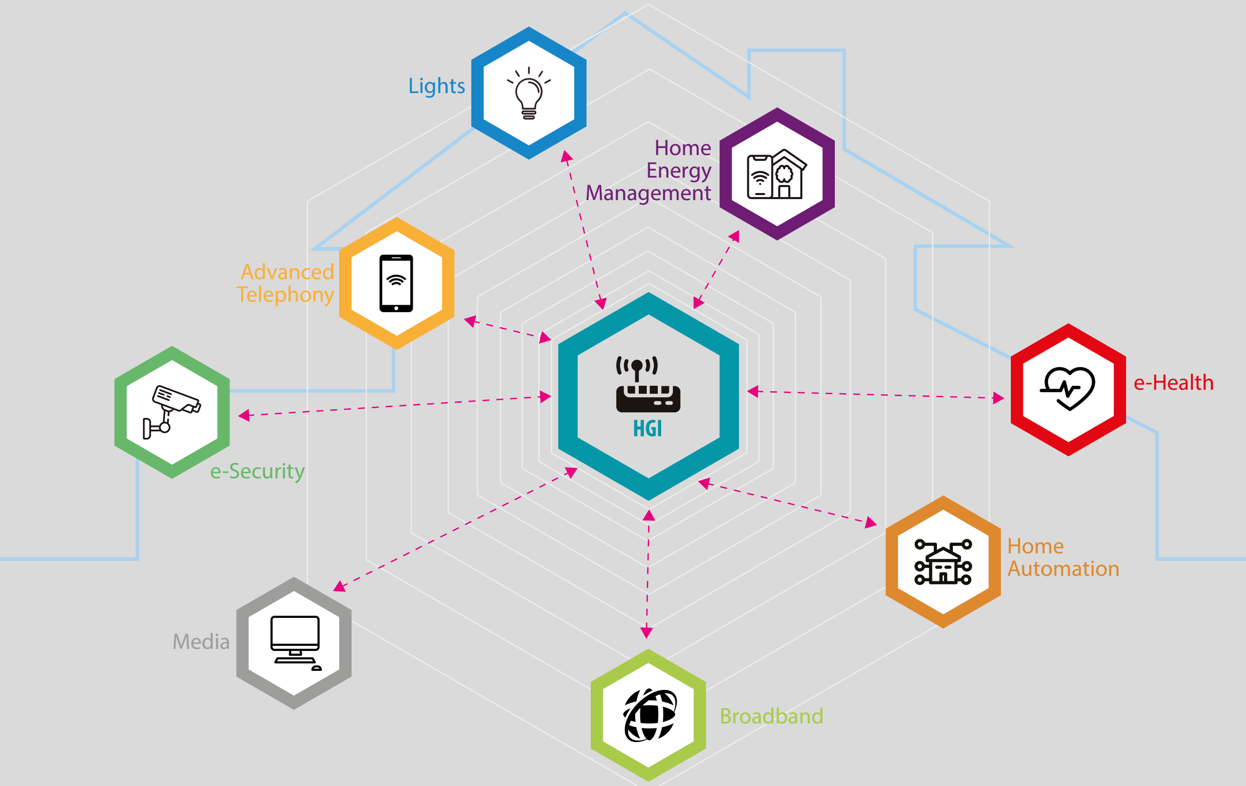

Figure 3.2: Overview of HGI use cases

The CCC (CCC 2016) is a cross-industry collaboration including car OEMs, tier-1 suppliers, phone manufacturers and application developers, who create global solutions for smartphone and in-vehicle connectivity. Developed by the CCC, MirrorLink® is an open standard for smartphone-car connectivity that allows smartphone apps to be displayed on the In-Vehicle Infotainment (IVI) system.

MirrorLink® specifications were released through the ETSI PAS process and published as ETSI TS in October 2017. The addition of MirrorLink® to the list of ETSI standards is expected to facilitate implementation of the technology by manufacturers.

The PAS procedure is offered by ISO as well. The EnOcean Alliance (EnOcean 2017) created a wireless standard to develop self-powered wireless monitoring and control systems for sustainable buildings as well as energy harvesting solutions. The specifications of the Wireless Short-Packet protocol (WSP) for the IoT were later ratified as an ISO/IEC standard.

According to EnOcean, the international standardization is expected to accelerate the development and implementation of energy-optimized wireless sensors and wireless sensor networks, and to open up new markets and areas of application. Moreover, the EnOcean Alliance complemented the standard with dedicated equipment and generic profiles, which describe the data communication of products using the WSP protocol. Developers and manufacturers can therefore benefit from the Alliance's practical experience and years of user education. This has been documented by ETSI (2016).

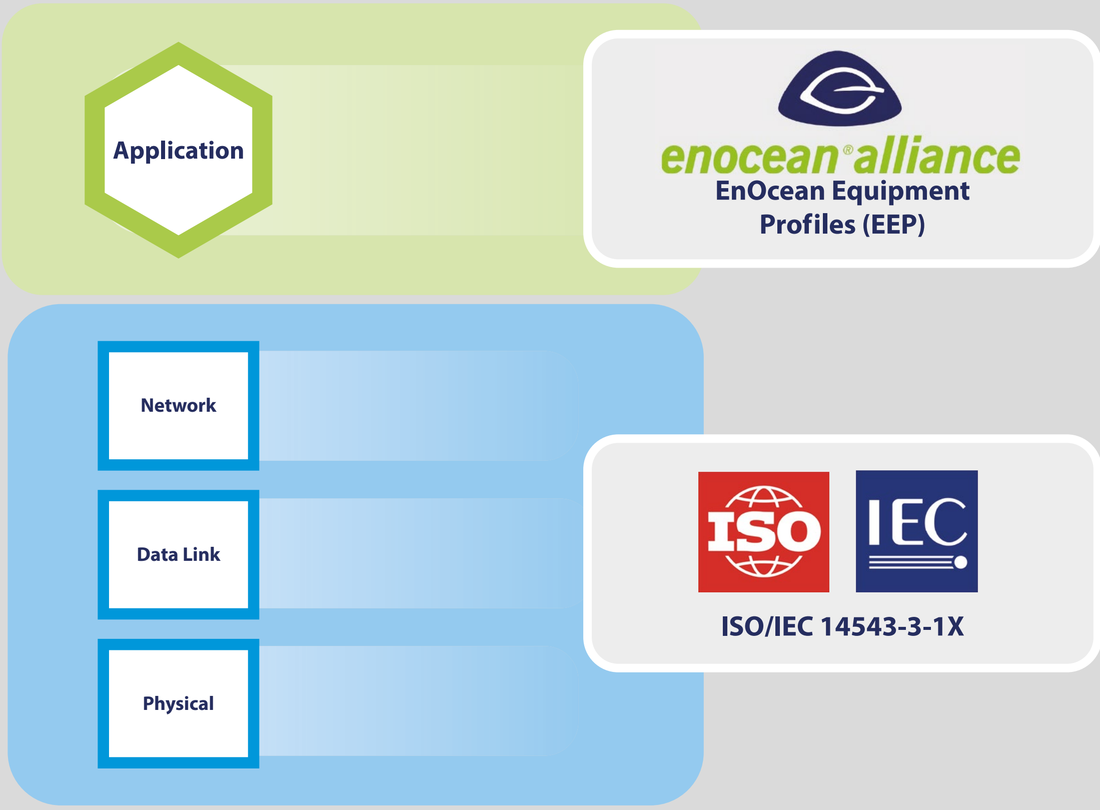

Figure 3.3: EnOcean Alliance standards

There is another relevant component in the relationship between consortia and standardization: SDO standards may be extended by industrial alliances (by industry, in general) to create test suite specifications and promote the involved technology. Their objective is to provide specifications for testing, certification and other related elements of conformity assessment, and ensure that the products, services or systems implemented according to the initial standards meet the standards' requirements.

Conformity assessment activities act as an essential intermediary between standards and the products themselves. The produced test specifications describe the testing methodology used to assess the conformity as well as the conformity assessment process itself. Conformity assessment plays an important role in various areas, including safety control, government procurement, business transactions and product selection by consumers.

Different types of organizations operate third-party certification programmes, for example competent laboratories, trade associations, organizations composed of producers, and testing facilities. For critical products, they may need an accreditation from the regional or national authorities to be allowed to operate.

EXAMPLE

The IEEE 802.11 standard was adopted by the Wi-Fi Alliance to develop the requirements and profiles for certification of WLAN products. The Wi-Fi Test Suite (Wi-Fi 2017) is a software platform designed to support the certification programme development and the certification of the devices themselves.

As another example, the Global System for Mobile Communications Association (GSMA) writes guidelines and specifications to help implementers use the ETSI standards developed by 3GPP. For example, guidelines published address topics such as "Service Provider Device Configuration" (RCC 14 v5.0, published in June 2017), "Device Field and Lab Test Guidelines" (TS.11 v19.0, published in April 2017) and "Smarter Traffic Management" (IG.16, published in March 2017).

3.3 STANDARDIZATION DOCUMENTS: CLASSIFICATIONS AND NAMING CONVENTIONS

The present section introduces readers to the types of standards produced by SDOs, to the main types of ICT standards, as well as to the conventions used to name them.

3.3.1 TYPES OF DOCUMENTS PRODUCED BY SDOS

This section explains the differences between types of standardization documents in terms of their scope and addressed stakeholders, whether they contain requirements or recommendations (normative documents) or they simply provide information, as well as the process leading to their approval/publication. These types of documents are produced by most of the recognised SDOs. However, they may also be published by non-recognized SDOs. The present section also deals with the organizations that are suitable for producing each type of document and describes the definition/purpose of each type of document, which may differ across organizations. Finally, the main characteristics of each type of standardization document are illustrated.

SDOs may produce different types of standardization documents, each with its own particular purpose, and with a specific approval processes. Sometimes, documents are produced with the aim of becoming national or international standards. These documents will require the highest level of excellence in terms of maturity and consensus. In other cases, certain topics may benefit from having a standardization document as a reference, even if that topic has not reached the highest level of either maturity or consensus. In any case, an SDO may produce a document that is useful for that particular purpose, by means of a shorter and more flexible way than the one a higher level standard would demand.

There are different types of standardization documents, which may differ in certain aspects, including:

- Their scope and addressed stakeholders.
- The absence or presence of requirements that could lead to certification.
- The process leading to their approval/publication.

In addition, the type of organization needs to be considered, as: 1) not all organizations are suitable for producing every type of document; 2) the definition/purpose of each type of document may differ across organizations.

Regarding their applicability to compliance processes, standards fall into two general categories: normative and informative (Hatto 2013). Normative documents contain requirements, which must be met in order to claim compliance with the standard. Requirements in a standard are usually worded with the term "shall", while recommendations are worded with "should". Informative documents do not contain requirements. Normative documents may include informative elements, but these must be clearly presented as such.

NORMATIVE DOCUMENTS

As stated above, normative documents contain requirements or recommendations. Standards are the normative documents that have reached wider consensus. Normally, for standards to be approved, they must first go through the most comprehensive and rigorous procedures of the organizations publishing them.

- EXAMPLE: ISO/IEC 27001 Information technology — Security techniques — Information security management systems — Requirements

A technical specification is a document needed by industry in the short term concerning a technical aspect that is still under development, or where it is believed that there will be a future, but not immediate, possibility of agreement on a standard.

- EXAMPLE: ETSI TS 103 645 CYBER; Cyber Security for Consumer Internet of Things

INFORMATIVE DOCUMENTS

A technical report is a document with explanatory material about a topic.

- EXAMPLE: ETSI TR 103 234 Power Line Telecommunications; Power line recommendations for very high bitrate services. This document investigates the capacity of several technologies to distribute streaming services from residential home gateways to set-top box and media servers.

A guide is a document used by standards organizations for providing advice on how to handle specific technical standardization activities.

- EXAMPLE 1: ISO/IEC Guide 71 Guide for addressing accessibility in standards
  - It guides standardizers on how to address accessibility when either producing new standards or revising existing ones
- EXAMPLE 2: CEN-CENELEC and ISO-IEC Guide 17 for writing standards, by taking into account the needs of micro, small and medium-sized enterprises
  - This document guides standardizers on how to take SME needs into account, for instance by making standards "simple and understandable".

DOCUMENTS SPECIFIC TO CERTAIN ORGANISATIONS

Some document types are specific to certain organizations, e.g.:

- ETSI Standard (ES): ETSI uses this kind of document for a standard that is submitted to the whole ETSI membership for its approval. (ETSI n.d.).
- CEN Workshop Agreement (CWA) is an agreement developed and approved in a CEN Workshop (CEN n.d.).
- ISO Workshop Agreement (IWA) is a document developed outside the normal ISO committee system to enable market players to negotiate in an "open workshop" environment (ISO n.d.).
- ISO Publicly Available Specifications (PAS) are published to respond to an urgent market need. They do not call for wide consensus involving all stakeholder groups, but only the consensus of the experts within a working group, or a consensus in an organization outside ISO. PAS are published for immediate use and serve as a means to get feedback for an eventual transformation into an International Standard (ISO n.d.).

3.3.2 CLASSIFICATION OF ICT STANDARDIZATION DOCUMENTS

ICT standardization documents can be classified according to many approaches. Below, a list of categories and examples are provided, in agreement with de Vries (2006) and Hatto (2013).

Terminology standards. These documents compile structured vocabularies, terminologies, code sets and classification systems that most ICT systems rely on, e.g.:

- ITU-T E.800 Definitions of terms related to the quality of service.
- ISO/IEC 17788:2014 Information technology – Cloud computing – Overview and vocabulary

Measurements or test methods. These documents define the objectives and guidelines for testing ICT. They define roles, processes and techniques for testing and measuring. In addition, they provide guides for test planning, implementation and reporting. Examples of such standards are:

- IEEE Std 299-2006 IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures
- ETSI ES 203 228 V1.3.1 (2020) Environmental Engineering (EE); Assessment of mobile network energy efficiency

Specifications. These documents contain a detailed and formal description of a set of characteristics or requirements that are relevant to a specific item. Examples of specifications are:

- ISO/IEC 10918-1:1994 Information technology—Digital compression and coding of continuous-tone still images: Requirements and guidelines
- CLC/TS 50134-9 Alarm systems - Social alarm systems - Part 9: IP Communications Protocol

System architecture. Documents that support the formal description of ICT systems and their components, characteristics and processes. For example:

- ISO/IEC/IEEE 42010:2011 Systems and software engineering—Architecture description.

Reference models. These documents inform the design of the architecture of ICT systems according to a given model, for example:

- ISO/IEC 7498:1994 Preview. Information technology—Open Systems Interconnection,
- W3C Recommendation, 15 December 2004. The Architecture of the World Wide Web, Volume One.

Software and networking standards. There are documents about computer software, including programming languages (e.g. C++ is published as ISO/IEC 14882), Application Programming Interfaces (API) (e.g. ISO 17267 on API for navigation systems for intelligent transport systems), communication protocols (e.g. Wi-Fi IEEE standards), file information and formats (e.g. RFC 8259 JSON).

Quality assurance. These documents provide requirements for managing the quality of projects or systems, such as:

- IEEE 730-2014 – Software Quality Assurance Processes.

The above classification is not strict in the sense that one document may be allocated to more than one category, for example:

- Specifications may include testing procedures to assess whether the requirements are met,
- Documents where systems or reference models are described may include the vocabulary involved,
- Software standards may include requirements.

Horizontal and vertical standards. Another broad classification of standards is related to whether a standard is horizontal or vertical (de Vries 2006). Vertical standards apply to different aspects within an industry sector or entity. Horizontal standards, however, address aspects that are applicable across multiple industries or entities.

EXAMPLE

Example of vertical standards: Standards about social alarm systems and telecare, which are ICT- mediated services aiming to provide safety and wellbeing to citizens, especially to the elderly and disabled. The EN 50134 family of standards about social alarm systems, published by CENELEC, deals with different aspects of social alarms, such as the vocabulary and terms, the technical requirements for their devices (sensors, panic buttons, home units, etc.), and their interconnections, etc.

Example of horizontal standards: Standards about electromagnetic compatibility (EM), the IEC EN 61000 family of standards about EM addresses aspects that include terminology, descriptions of electromagnetic phenomena and the EM environment, measurement and testing techniques, and guidelines on installation and mitigation.

Given their nature, vertical standards normally reference horizontal standards. For instance, electromagnetic compatibility (EM) standards apply to many different pieces of electrical equipment of all kinds, such as mobile phones and social care alarm devices.

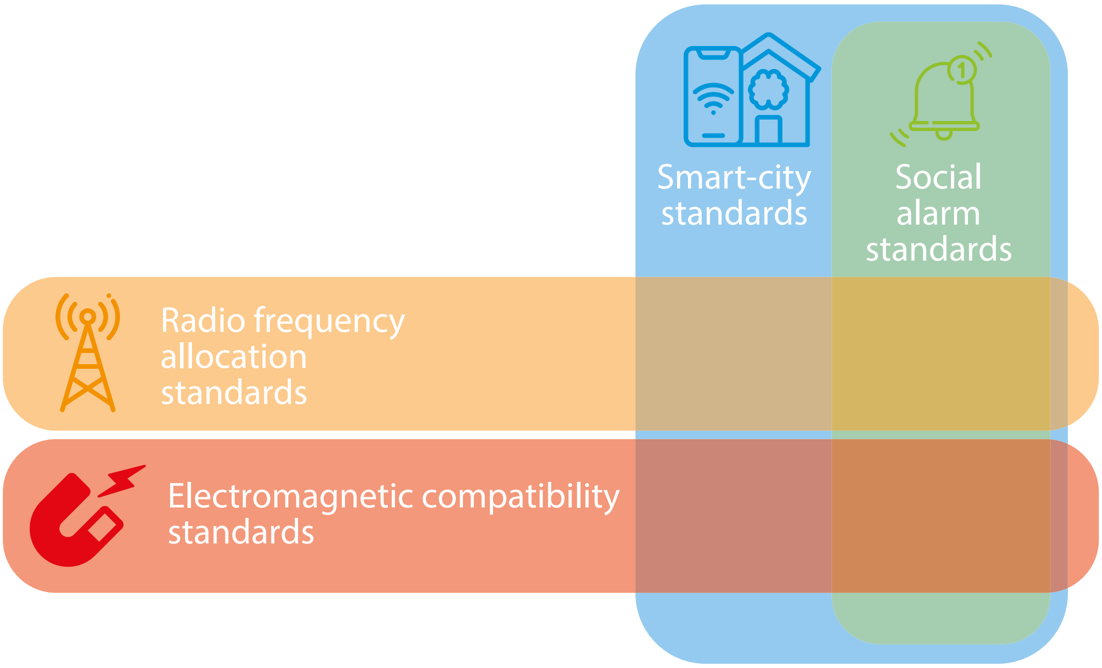

Figure 3.4: Illustration with examples of horizontal vs. vertical standards

3.3.3 NAMING CONVENTIONS FOR STANDARDIZATION DOCUMENTS

This section deals with the naming conventions of different SDOs. Furthermore, it shows how to extract and identify several characteristics of a document from its name, including the title, the SDO that published/adopted the document, the type of standardization document, whether the document belongs to a family of standards, the version of the standard, as well as the date/year the document was published.

Some issues concerning naming conventions are significant. First, different SDOs have different naming conventions. Furthermore, different countries or regions may use different naming conventions, either for the standards published by the SDOs operating in that geographical context or for the standards adopted from SDOs with a wider scope, such as international standards. For instance, harmonized standards are a special type of standard used in the European Union that we will address later on in this chapter. Finally, the names of standards may differ slightly depending on whether they are given directly by the publishing SDO (e.g. the standard itself or the institutional database) or by external sources, such as the standard's citations by a report or journal, which may have specific citation guidelines or restrictions.

The name of a standardization document may contain information about:

- The SDO (or SDOs, in the case of a joint publication) that published it.
- Other SDOs that might have adopted the standard after it was originally published.
- The type of document, for instance if it is an international, regional or national standard, a specification, technical report, etc.
- Whether the document belongs to a family of standards.
- Whether it is a harmonized standard (i.e., a special type of standard in the European Union, which will be introduced later on in this chapter).

- The version number of the standard that indicates whether it is a draft or final version and informs whether the document adds major, technical or editorial changes to the previous version.
- The year of publication of the document.
- The title of the standard

EXAMPLE 1

EN 45502-2-3:2010 Active implantable medical devices—Part 2-3: Particular requirements for cochlear and auditory brainstem implant systems

What information can we obtain from this name?

- The "EN" prefix indicates that it is a European Standard.
- The code of the standard "45502-2-3" indicates that it includes the 2nd and the 3rd documents of a standard family ("45502").
- It was published in 2010.
- The family name is "Active implantable medical devices".
- The title of the standard itself is "Part 2-3: Particular requirements for cochlear and auditory brainstem implant systems".

The name of the standard does not tell us which organization developed it. Each European Standard is identified by a unique reference code that contains the letters "EN", without stating which of the three recognized European SDOs (CEN, CENELEC or ETSI) published it. Furthermore, the name does not provide any indication as to whether previous versions of this standard exist.

EXAMPLE 2

ETSI TS 102 412 V12.1.0 (2019-06) "Smart Cards; Smart Card Platform Requirements Stage 1" (Release 12)

What information can be obtained from this name?

- The "ETSI" prefix indicates that this document was published by ETSI.
- The "TS" prefix indicates that it is a technical specification.
- The code of the standard is 102 412.
- This is version 12.1.0 of the standard (which is confirmed by the "Release 12" in the title). ETSI uses three numbers (x.y.z) to indicate its document versions. The first final version of a document will be Version v1.0.0. Subsequent final documents will increase the first number "1.x.x" of the version number (1.a.b, 2.c.d, etc.). In these examples, a and c indicate the corresponding "technical" version numbers, while b and d indicate the corresponding "editorial" version numbers.
- It was published in June 2019.
- The document is part of the "Smart Cards" family of standards.

Nevertheless, it is not clear whether there is a unique code for this family of standards. In fact, ETSI allocates consecutive numbers to their individual standards, irrespective of whether they are part of a family or not.

EXAMPLE 3

ISO/IEC 27002:2013 Information technology—Security techniques—Code of practice for information security controls

What information can be obtained from this name?

- The "ISO/IEC" prefix indicates that this standard was published jointly by ISO and IEC, as part of the JTC 1 agreement.
- The code of the standard is 27002.
- This document belongs to a family of standards named "Information technology—Security techniques", the 27000 series. Another example of a document in this family is ISO/IEC 27005— Information technology—Security techniques—Information security risk management.

This is an international standard (IS), but this information is not explicitly stated in the title of ISO documents. Should the document belong to any other category (e.g. Guide, Specification, etc.), this would be made explicit in the document name (e.g. ISO Guide 82:2014 Guidelines for addressing sustainability in standards, ISO/IEC TR 14143-5:2004 Information technology—Software measurement—Functional size measurement—Part 5: Determination of functional domains for use with functional size measurement).

EXAMPLE 4

DS/EN ISO/IEC 27002:2017 Information technology – Security techniques – Code of practice for information security controls

What information can be obtained from this name?

- The "DS/EN ISO/IEC" prefix indicates that this standard was first published by ISO/IEC, then adopted as a European Standard (EN), and then as a Danish standard (DS)

EXAMPLE 5

ETSI has produced several different versions of the ETSI EN 302 054 standard. Let's have a look at a subset of them:

- ETSI EN 302 054 V2.2.1 (2018-02) Meteorological Aids (Met Aids); Radiosondes to be used in the 400,15 MHz to 406 MHz frequency range with power levels ranging up to 200 mW; Harmonized Standard for access to radio spectrum
- ETSI EN 302 054 V2.1.1 (2017-10) Meteorological Aids (Met Aids); Radiosondes to be used in the 400,15 MHz to 406 MHz frequency range with power levels ranging up to 200 mW; Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
- Draft ETSI EN 302 054 V2.1.0 (2017-05) Meteorological Aids (Met Aids); Radiosondes to be used in the 400,15 MHz to 406 MHz frequency range with power levels ranging up to 200 mW; Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
- ETSI EN 302 054-2 V1.2.1 (2015-10) Meteorological Aids (Met Aids); Radiosondes to be used in the 400,15 MHz to 406 MHz frequency range with power levels ranging up to 200 mW; Part 2: Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/ EU
- ETSI EN 302 054-1 V1.1.1 (2003-03) European Standard (Telecommunications series) Electromagnetic compatibility and Radio spectrum Matters (ERM); Meteorological Aids (Met Aids); Radiosondes to be used in the 400,15 MHz to 406 MHz frequency range with power levels ranging up to 200 mW; Part 1: Technical characteristics and test methods

What information can be obtained from the names in the above list?

The standard was a European Standard (EN), and therefore a SDO standard, since its first version was published. Version 2 of the document was approved as a harmonized standard, as it reads in the document title. Furthermore, the deliverable was originally a two-part standard, but in version 2 it became a single-part standard.

Regarding the different versions of the standard, and based on the version numbering system used by ETSI, we can say the following:

- There has been one major revision of the standard (from version 1.x.x to version 2.x.x). After an analysis of the document titles, we can conclude that this major revision included the transformation of the originally multi-part standard into a single-part standard.
- The first approved document for version 2 of the document was version V2.1.1, which has editorial differences to V2.1.0. According to its name, version V2.1.0 was only published as a draft, but it was not finally approved as an ETSI deliverable.
- After V2.1.1, V2.2.1 was published. There are technical differences between them.

3.4 NATIONAL, REGIONAL AND INTERNATIONAL STANDARDIZATION: COOPERATION AND COORDINATION

The present section firstly reminds and qualifies the basic concepts about the different geographical scopes of standardization that were introduced earlier in this book. Then, it describes the mechanisms that support coordination and cooperation of international, regional and national SDOs, their standardization activities and deliverables. Among these mechanisms, this section addresses the national and regional adoption of SDO standards that were originally published with a wider geographical scope.

3.4.1 THE GEOGRAPHICAL SCOPE IN STANDARDIZATION

As introduced in Chapter 2, recognized SDOs have a national, regional or international scope, as do the standards they produce, e.g.:

- ISO, IEC and ITU are international standard organizations, with a worldwide scope.
- CEN, CENELEC and ETSI are officially recognized as European bodies for standardization; PASC is a regional SDO in the Pacific Area.
- UNE is the national SDO in Spain, ANSI in the United States, and BIS in India.

However, sometimes standardization practices by recognized SDOs do not fit 100% the theoretical schema introduced above. For example, SDOs produce standards with a scope that goes beyond their alleged geographical coverage. For instance, ETSI is an official SDO within the European Union. However, it also publishes standards that are adopted globally, such as the GSM family of standards for mobile communications. Another interesting case is that some standards-related organisations do not produce standards themselves. PASC is an independent and voluntary organisation of Pacific Rim National Standards Bodies, including National SDOs from Australia, Canada, Colombia, China, India, etc. This regional organisation does not produce standards, but it supports the participation of the region's SDOs in the ISO and IEC activities. Finally, some countries have de-centralized models of standardization: in the United States there are around 200 organisations producing and maintaining standards, which are accredited by the American National Standards Institute (ANSI) as developers of American National Standards (ANS). However, ANSI is the only official representative of the United States at ISO and IEC.

3.4.2 THE BASICS OF COORDINATION AND COOPERATION

The need for coordination among different levels is inherent to the spirit of standardization. The objective is to ensure that organizations make the best use of their resources, to support information exchange, to increase the transparency of procedures, and to reduce the possibility of duplicating work unnecessarily at a national, regional or international level.

National SDOs (NSOs) represent their own countries' standardization activities in SDOs with a regional or international scope. They support national experts to track regional and international standards, and they also adopt international standards as national standards. There is only one NSO per country.

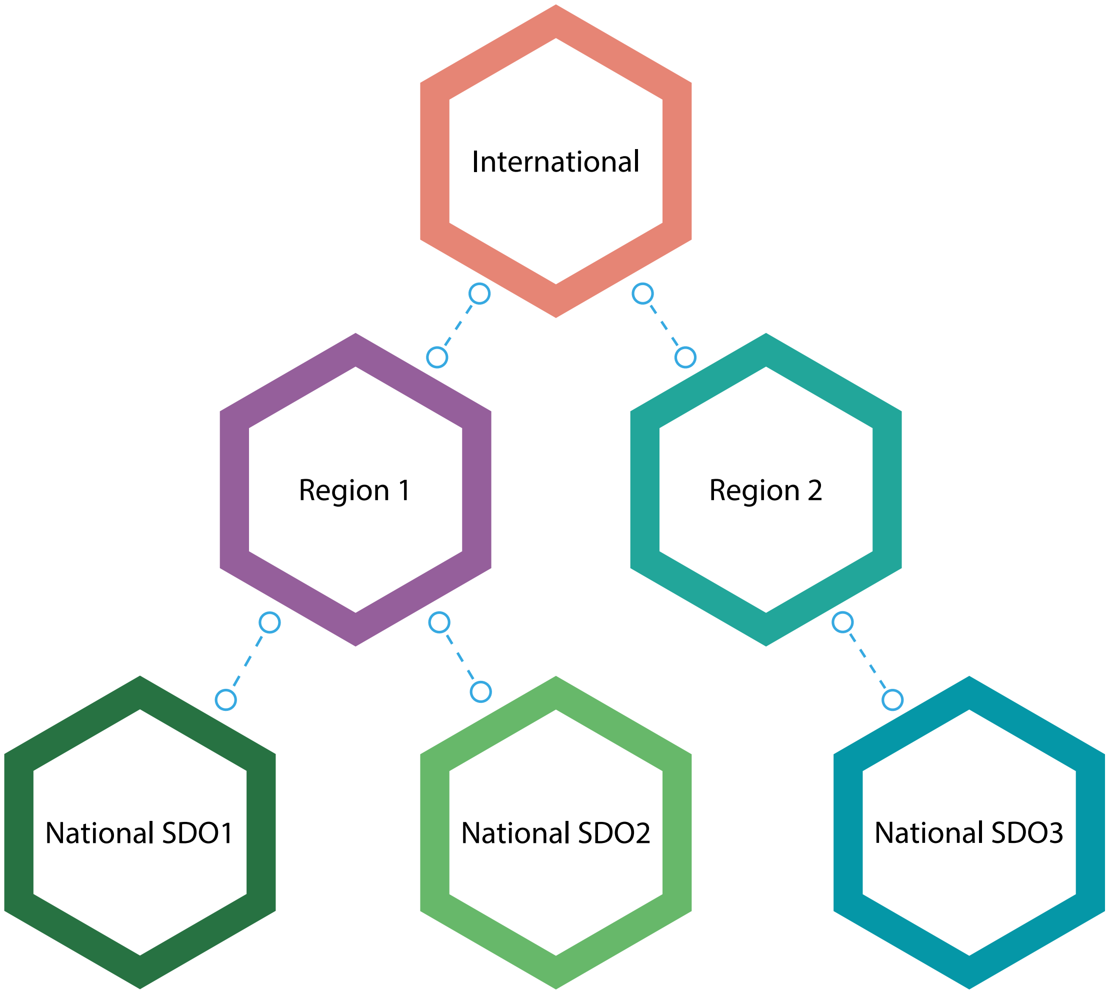

Figure 3.5: Hierarchy of SDOs according to their geographical scope

The typical stance when seeking coordination among different levels of standardization is that international standardization takes precedence over regional standardization, which in turn takes precedence over national standardization. One of the objectives of standardization carried out at higher levels (i.e. international and regional) is to harmonize standardization coming out from lower levels (i.e. regional and national, respectively). The ideal process is for approved international standards to be simultaneously adopted as regional standards, and then as national standards in the countries in that region. However, that requires a previous agreement among the SDOs at the different levels (national, regional and international). SDO agreements also tend to recognize standardization with a narrower scope (regional, national), which may have particular needs to be considered when adopting standards with a wider scope. Furthermore, membership of SDOs in organizations with a wider geographical scope is also relevant to coordination: it is commonplace for national SDOs to be members of their corresponding regional SDOs; and for national and regional SDOs to be members of their corresponding international SDOs.

When national SDOs adopt European and International standards, they have the advantage of a wider geographical scope, covering in principle the whole world in the case of international standards. Purely national standards may exist. However, they are only a small part — often less than 10% — of the national SDO portfolio of standards.

3.4.3 COORDINATION AMONG EUROPEAN AND NATIONAL STANDARDIZATION ACTIVITIES

The EU Regulation 1025/2012 recognises that European standardization promotes the competitiveness of enterprises, the global competitiveness of European industry, the economic interpenetration on the internal market, as well as the development of new and enhanced products, including the protection of the environment and of human health. Furthermore, this regulation aims to avoid conflicts among national standards, as they could cause technical impediments in the European internal market. Therefore, it calls for the regular exchange of information between the national SDOs, the European SDOs and the Commission, about their current and future standardization activities. In this respect, the "standstill" is a relevant concept in European coordination of standards. It entails an obligation for the national SDOs to not take any action, neither during the preparation of a European Standard (EN), nor after its approval, that could prejudice the intended harmonization and, in particular, not to publish a new or revised national standard that is not identical to an existing EN. For the sake of transparency and the achievement of good coordination, both European and their national member SDOs periodically (at least annually) publish their work programmes and the list of approved/adopted standards.

Once a European SDO (either CEN, CENELEC or ETSI) has approved a standardization project where a standard is to be developed, the generic process of coordination with national SDOs can be summarized as follows:

- Drafting: a standardization group within a technical committee of a European SDO drafts the document.
- Voting and commenting: the corresponding technical committee and the national SDOs voice their perspectives in the draft and submit their votes and comments.
- Publication and national adoption: when a standard is approved by a European SDO, it is transposed and announced by each national SDO. Where national legislation exists, it should be mentioned in an annex to the standard. Importantly, national standards that conflict with the new European Standard are withdrawn. The adoption of an EN can be done either by mere endorsement, by publishing a national standard with identical text, by translating the standard into the national language, by publishing an endorsement sheet, or by an announcement in the national member's official journal. The default national adoption dates for an EN vary between three to six months after publication by the ESO. There are guidelines for the naming and numbering of European Standards that are adopted nationally. In addition, there may be applicable requirements for distributing and selling adopted European standards nationally. For instance, when EN 50134-3:2012 "Alarm systems—Social alarm systems—Part 3: Local unit and controller" was approved by CENELEC, it automatically became a national standard in each of the CENELEC member countries (e.g. BS EN 50134–3 in the United Kingdom).

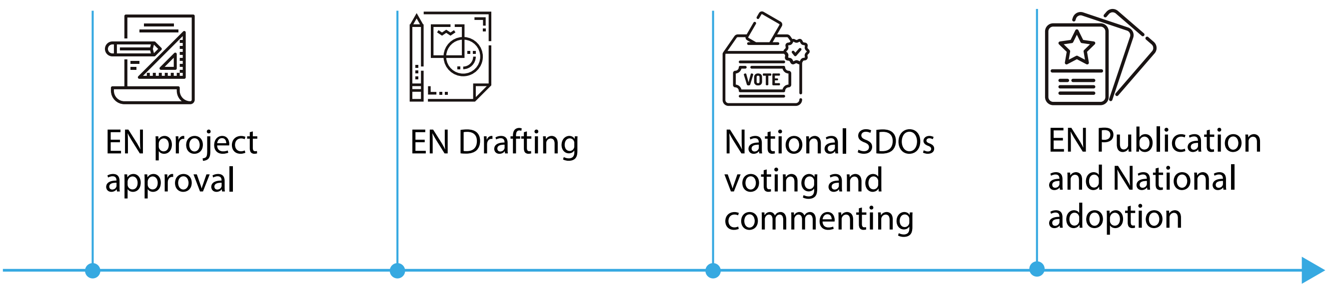

Figure 3.6: The process of coordination of an EN project with national standardization

In those cases where the European SDO decides to exclude certain aspects from the scope and application field of the future EN that are relevant to the national SDO, the latter is free to publish the additional aspects as national standards. In any case, the national SDO has to ensure that this national standard is not in conflict with the aims of European standardization and will not create barriers to trade.

Details about the obligations, rights, and processes of national SDOs in relation to European Standards are provided in the following documents:

- (ETSI 2021)
- (CEN, CENELEC 2008)
- (CEN 2016)

EXAMPLE

Each national SDO member of CEN, CENELEC and ETSI has adopted the European Standard EN 301 549, which was published in response to Mandate 376 of the European Commission. Standardization requests (formerly referred to as mandates) are one of the paths for the generation of standards in Europe.

3.4.4 COORDINATION AMONG EUROPEAN AND INTERNATIONAL SDOS

As described in Figure 3.7, there are cooperation and coordination agreements between international and European SDOs.

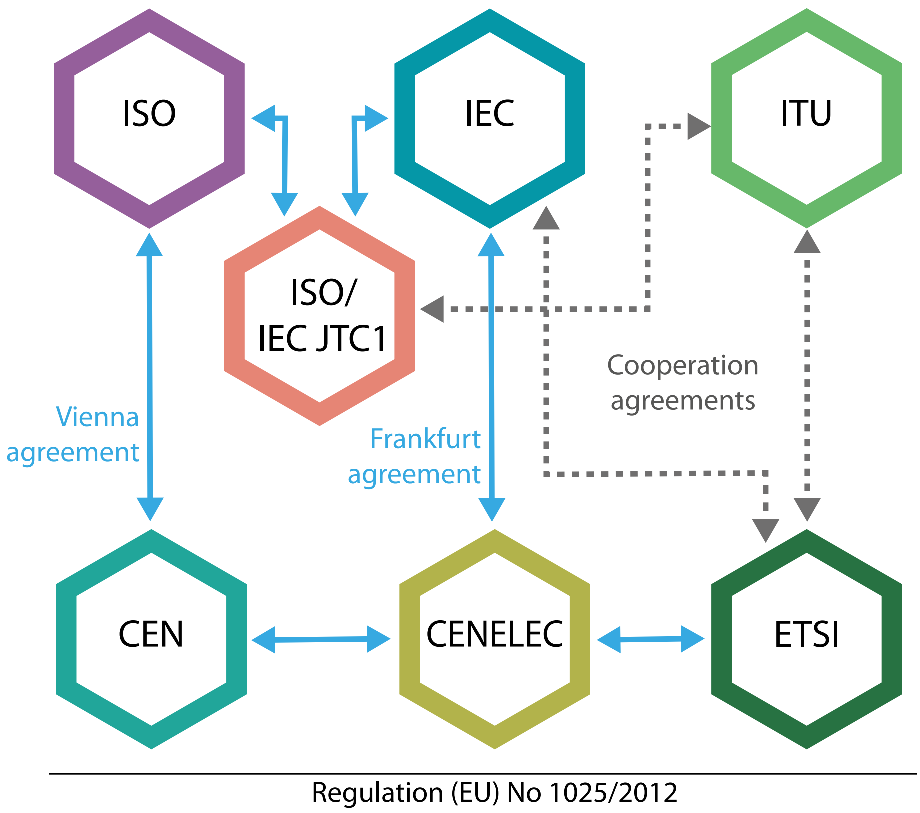

Figure 3.7: Cooperation and coordination agreements between European and international SDOs; modified from Jakobs (2008)

COORDINATION BETWEEN ISO AND CEN (VIENNA AGREEMENT)

The Vienna agreement (ISO and CEN 2001) is an agreement on technical cooperation between ISO and CEN. The latest version of the Vienna Agreement came into effect in 2001, superseding both the 1991 version of the Vienna Agreement and the earlier 1989 Lisbon Agreement.

In further detail, the agreement underlines that international standardization takes precedence over national standardization (ISO and CEN 2016). ISO standards are simultaneously approved as a European Standards, and they are adopted by each National SDO that is a member of CEN. In addition, National SDOs that are members of CEN must withdraw any pre-existing conflicting national standards. For instance, ISO 9001:2015 Quality management systems — Requirements was automatically adopted as a European Standard (EN ISO 9001:2015) and nationally by member states such as Spain as a Spanish standard (UNE-EN 9001:2015).

The agreement also recognizes that the single European market may have particular needs, for example in the case of standards for which there is no international need currently recognized, or standards that are urgently required in the European Union, but which have a lower priority at international level (ISO and CEN 2016). In these cases, the agreement permits European standards to be made available for voting and commenting by all ISO member bodies at the enquiry and formal approval stages. This allows non-European ISO members to participate in the technical work of CEN and, where appropriate, to approve those standards as International Standards. Reasons for implementing this procedure have to do with the fact that parties without current representation in CEN might be affected in the future by the contents of a European Standard.

Furthermore, the Vienna Agreement provides three main modes of cooperation between ISO and CEN:

- By correspondence/exchange of information;
- By mutual representation at meetings;
- By parallel approval of standards at international and European levels.

Approximately 30% of CEN standards are developed under the Vienna agreement.

COORDINATION BETWEEN IEC AND CENELEC (FRANKFURT AGREEMENT)

In 2016, IEC and CENELEC signed the Frankfurt Agreement (IEC and CENELEC 2016), which confirms their "agreement on common planning of new work and parallel voting" that started in 1996 with the Dresden Agreement. The agreement has had a significant impact on the activities of these organizations, as around 80% of all European electrotechnical standards are identical to or based on IEC International Standards. Moreover, new electrical standards projects are jointly planned between CENELEC and IEC and, where possible, most are carried out at international level. For instance, the international standard IEC 62236-3-2:2008 "Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus" constitutes a technical revision and is based on the European standard EN 50121-3-2:2006.

The latest version of the agreement includes several updates that aim to simplify the voting processes carried out in parallel and to increase the traceability of international standards adopted in Europe thanks to a new referencing system.

3.4.5 GUIDANCE FOR THE REGIONAL OR NATIONAL ADOPTION OF INTERNATIONAL STANDARDS

ISO/IEC Guide 21 provides guidance on regional or national adoption of international standards and other international deliverables. It has two parts:

- Part 1: Adoption of international standards, and
- Part 2: Adoption of international deliverables other than international standards (i.e., Technical Specifications and Technical Reports).

This guide provides methods for the adoption of international standards (and other international deliverables) as regional or national standards. Furthermore, it defines a system for indicating the degree of correspondence between international standards and their national or regional adoptions. It also gives the rules for the adoption of international deliverables other than international standards, and provides indications for numbering regional or national standards that are identical adoptions of international standards (and other international deliverables).

3.4.6 OTHER EXAMPLES OF COORDINATION AND COOPERATION

COORDINATION BETWEEN ISO AND IEC

ISO/IEC JTC 1 was created in 1987 as a merger between ISO/TC 97 (Information Technology) and IEC/ TC 83 (Information technology equipment), with IEC/SC 47B (Microprocessor systems) joining later. The intention was to bring together in a single committee the ICT standardization activities of the two parent organizations in fields of mutual interest, in order to avoid duplicated or possibly incompatible standards. The mandate of JTC 1 was to develop base standards in information technology, upon which other technical committees could build. This would allow for the development of domain- and application-specific standards that could be applicable to specific business domains, while also ensuring the interoperation and function of the standards on a consistent base (ISO and IEC n.d.). Later on, in 2009, ISO/IEC Joint Technical Committee 2 (JTC 2) was created for the purpose of "standardization in the field of energy efficiency and renewable energy sources". The standards produced by a JTC are identified with both SDO names and can be obtained from either ISO or IEC catalogues.

The guide for ITU-T and ISO/IEC JTC1 cooperation (ITU and ISO/IEC 2014) contains a set of procedures for cooperation between ITU-T and ISO/IEC JTC 1. It is written in an informal style, much like a tutorial, to be a practical, educational and insightful reference for both leaders and participants in cooperative work.

COOPERATION BETWEEN ITU AND ETSI

ITU and ETSI have established a Memorandum of Understanding (ITU and ETSI 2016) where both SDOs have agreed to strengthen information exchange and cooperation, including:

- An iterative process where ETSI submits input documents to ITU study groups and other groups.
- The exchange of information on areas of mutual interest.

GPP AS AN EXAMPLE OF INTERNATIONAL COORDINATION

3GPP (3rd Generation Partnership Project) is composed of ICT SDOs (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as organizational partners, and provides its members with a stable environment to produce reports and specifications about mobile communication technologies, a field in constant evolution.

Once these deliverables are approved by 3GPP, each organizational partner adopts and publishes these deliverables with identical text. Furthermore, organizational partners take decisions on the creation or discontinuation of Technical Specification Groups, as well as the approval of their scope and terms of reference.

Figure 3.8: SDOs that are partners of 3GPP

The organizational partners may invite other organizations as market representation partners in 3GPP. These market representation partners do not take part in the definition of specifications, but offer market advice to 3GPP, providing a consensus view of market requirements. 3GPP is presented here from the perspective of international cooperation among SDOs. Chapter 4 offers more details about this organisation.

EXAMPLE

3GPP is an initiative for international coordination of different ICT SDOs working in mobile communication technologies. This example describes how a 3GPP document is adopted by ETSI, an SDO that is member of 3GPP.

First, a new document is created by inserting the text of the 3GPP specification into the ETSI deliverable template. Second, the ETSI title page is added, including the specification title and code. Third, the administrative page, the ETSI Intellectual Property (IPR) information, the Foreword and the final history pages are added. Finally, the document is made available for free download from the ETSI website. When so requested by the European Commission, the document may be adopted as a European Standard (EN).

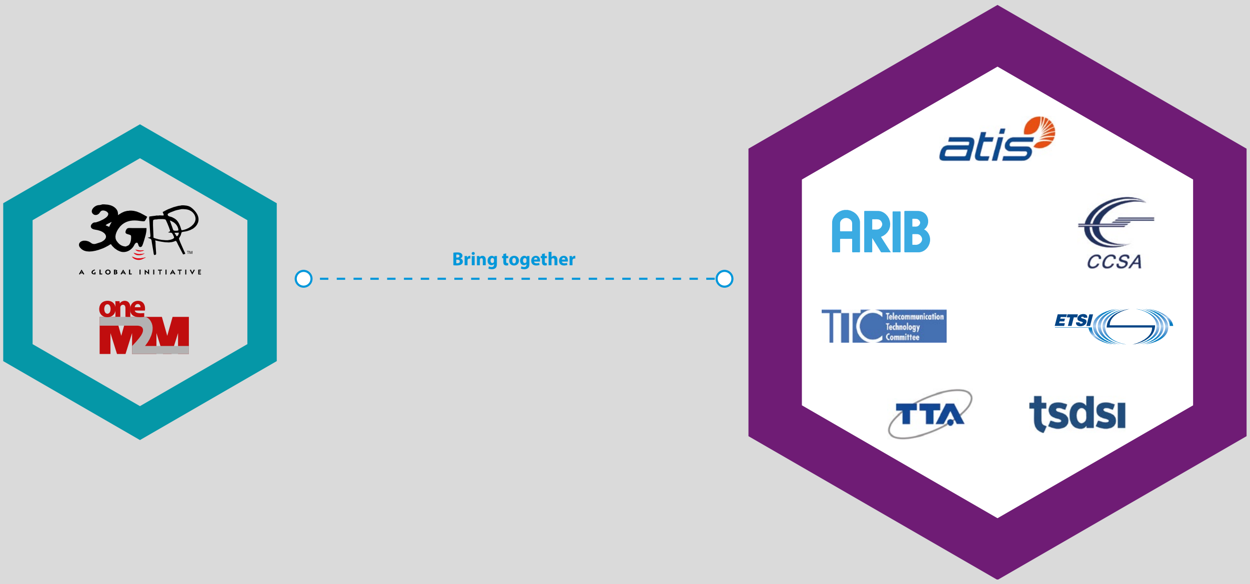

Figure 3.9: Link between 3GPP and its organizational partners
OneM2M has a similar model (e.g. TIA is brought in as a Partner)

The adoption process means that, for example, 3GPP TS 23.401 version 14.7.0 Release 14 was published by ETSI as ETSI TS 123 401 V14.7.0 and oneM2M TS-0001 version 2.10.0 Release 2 was transposed as ETSI TS 118 101 V2.10.0.

3.5 STANDARDS SUPPORTING REGULATION, LEGISLATION, AND POLICY MAKING

Governments establish policies through regulations, laws, and other instruments. Policies are intended to deliver better economic and social outcomes and thus enhance the life of citizens. When implementing policies, authorities are regularly required to define technical specifications to be complied with. They basically have three options for doing so:

- Developing their own specifications.
- Using the technical specifications contained in existing standards.
- Requesting new standards to be developed for this purpose.

3.5.1 REGULATIONS REFERRING TO STANDARDS

Referencing standards avoids the need of regulations having to describe technical attributes such as requirements on performance, on testing limits, etc. Furthermore, it simplifies their content and it increases their common understanding. Hence, referencing standards contributes to improving efficacy and efficiency in public administration.

Regulations can reference standards in several ways, including the following: by copying the technical specifications or parts of the standards, by mentioning them implicitly or explicitly, with the title and with/ without the date, and with an optional, privileged or binding reference. It is recommended that regulations only refer to the relevant standard and avoid citing parts from it.

Is ensuring compliance with the referenced standard the only way to comply with the regulation? Not always. Sometimes, adherence to technical requirements is mandatory, including the required implementation of standards and specifications. On other occasions, these standards and specifications serve as references for fulfilling the essential requirements of the regulation. In the latter case, the implementation of the referenced standards and specifications is optional: by complying with the referenced standard, a product or service has "presumption of conformity" with the corresponding regulation. However, a manufacturer might find alternatives to the standard that also allow compliance with the regulation principles. However, anyone using them might be asked to demonstrate their validity for this purpose.

Regulations referencing standards may then add further details that are relevant for following the law. Enforcement of specific regulations may be entrusted to and exercised by specific entities appointed for that purpose. Furthermore, a regulation may allow penalties and sanctions to be imposed with immediate effect if the regulation is not observed.

Regarding the types of standardization documents that are suitable to be referenced by regulation, it may depend on the country. Generally speaking, legislators have freedom of choice. Normally, standards and technical specifications are used for this purpose.

Public procurement is also a tool used by governments to implement their policies. It refers to the process by which public authorities, such as government departments or local authorities, purchase work, goods or services from companies. Chapter 8 provides more details about public procurement, and its relationship with standardisation.

3.5.2 STANDARDIZATION REQUESTS

Sometimes governments identify standardization needs, and they invite the corresponding recognized SDO to produce standards in support of specific policies or legislation. As an example of this use, the European Commission invites the European Standardization Organizations (ESOs) to produce standards through Standardization Requests. About a fifth of all European standards are developed following a standardization request (standardization requests were formerly referred to as standardization mandates) from the European Commission to the European Standardization Organizations (ESOs). The process can be summarized as follows:

- Draft requests are drawn up by the Commission through a process of consultation with a wide group of interested parties, including ESOs, social partners, consumers, small- and medium-sized enterprises (SMEs), industry associations and EU countries. Before being formally sent to the ESOs, they are submitted for a vote to the "Committee on Standards". This committee was set up by the Regulation (EU) 1025/2012 to support the Commission in this process. If the outcome of this vote is positive, the Commission adopts the request as a Commission Implementing Decision.
- The ESOs, which are independent organizations, have the right to refuse a request. The cause for the refusal could be, for example, that in their opinion standards cannot be produced in a specific area. Due to the preceding consultation process, however, standardization requests are rarely refused.
- The standardization requests issued by the European Commission are available in a specific database.

EXAMPLE

In 2005, the European Commission sent a standardization request, called Mandate 376 (M/376), to the ESOs (CEN, CENELEC and ETSI). Mandate 376 (standardization mandates are currently known as standardization requests) was an instruction to assist with the harmonization of public procurement practices in Europe by developing a standard that specifies the functional accessibility requirements for publicly procured ICT products and services, so that they can be used by citizens with and without disabilities.

The main output resulting from Mandate 376 was the standard EN 301 549 "Accessibility requirements suitable for public procurement of ICT products and services in Europe", published in 2015. This standard contains requirements that, when fulfilled, ensure that ICT products and services are accessible to people with and without disabilities.

One year after the standard was published, the "Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies" was approved. Article 4 of Directive (EU) 2016/2012 is entitled "Requirements for the accessibility of websites and mobile applications" and reads:

"Member States shall ensure that public sector bodies take the necessary measures to make their websites and mobile applications more accessible by making them perceivable, operable, understandable and robust."

Furthermore, the Directive references standard EN 301 549 as follows:

- "content of websites that fulfils the relevant requirements of European standard EN 301 549 V1.1.2 (2015-04) or parts thereof shall be presumed to be in conformity with the accessibility requirements set out in Article 4 that are covered by those relevant requirements or by parts thereof."

However, in 2017 a new request (M/554) was issued by the European Commission to CEN, CENELEC and ETSI to produce a new version of the EN 301 549 standard that would become a harmonized European standard (see Section 3.4.3, below). That new version should address, among other things, uncovered aspects of the accessibility of mobile applications that are relevant to the Directive. The harmonized European standard EN 301 549 V3.2.1 (2021-03) contains, inter alia, a table which maps the relevant provisions from the standard to the accessibility requirements set out in Article 4 of Directive (EU) 2016/2102.

Compliance with a harmonized standard confers a presumption of conformity with the corresponding essential requirements set out in Union harmonisation legislation. Does the latter mean that ensuring compliance with EN 301 549 v3.2.1 is the only way to be in conformity with the accessibility requirements set out in Article 4 of the Directive? No, it doesn't. What it means is that the relevant clauses of EN 301 549 should be considered as the minimum means of putting the requirements in Article 4 of the Directive into practice (i.e. Perceivability, operability, understandability and robustness of a website or of a mobile application). In effect, there might be alternatives to the standard that also allow compliance with these principles. However, anyone using them should demonstrate their validity for this purpose.

3.5.3 EUROPEAN UNION'S HARMONIZED STANDARDS

DEFINITION

As per the EU Regulation 1025, 2012, a harmonized standard is a European standard developed by a recognized European Standards Organization: CEN, CENELEC, or ETSI, created following a request from the European Commission to one of these organizations.

In the European Union, harmonized standards are developed for the purpose of being referenced by regulation. They are voluntary and imply the presumption of conformity: compliance with these standards is the recommended but not exclusive method to meet essential requirements, e.g. for CE marking.

Adherence to harmonized standards carries with it the presumption of conformity with essential requirements. Conformity to harmonized standards can be used to demonstrate that products, services, or processes comply with relevant EU legislation: the use and correct implementation of these standards is assumed to be sufficient indication that the relevant essential requirements have been met.

However, implementation of these harmonized standards remains voluntary: manufacturers, other economic operators and conformity assessment bodies are free to choose other technical solutions, but then need to demonstrate compliance with the mandatory essential requirements.

The references of harmonized standards are published in the Official Journal of the European Union (OJEU); it is a precondition for legal validity of the harmonized standards and references to them, including the presumption of conformity. (EC 2018b).

EXAMPLE

Radio Spectrum Regulatory Framework

Figure 3.10 illustrates the European Radio spectrum regulatory environment (ETSI-ECC 2016).

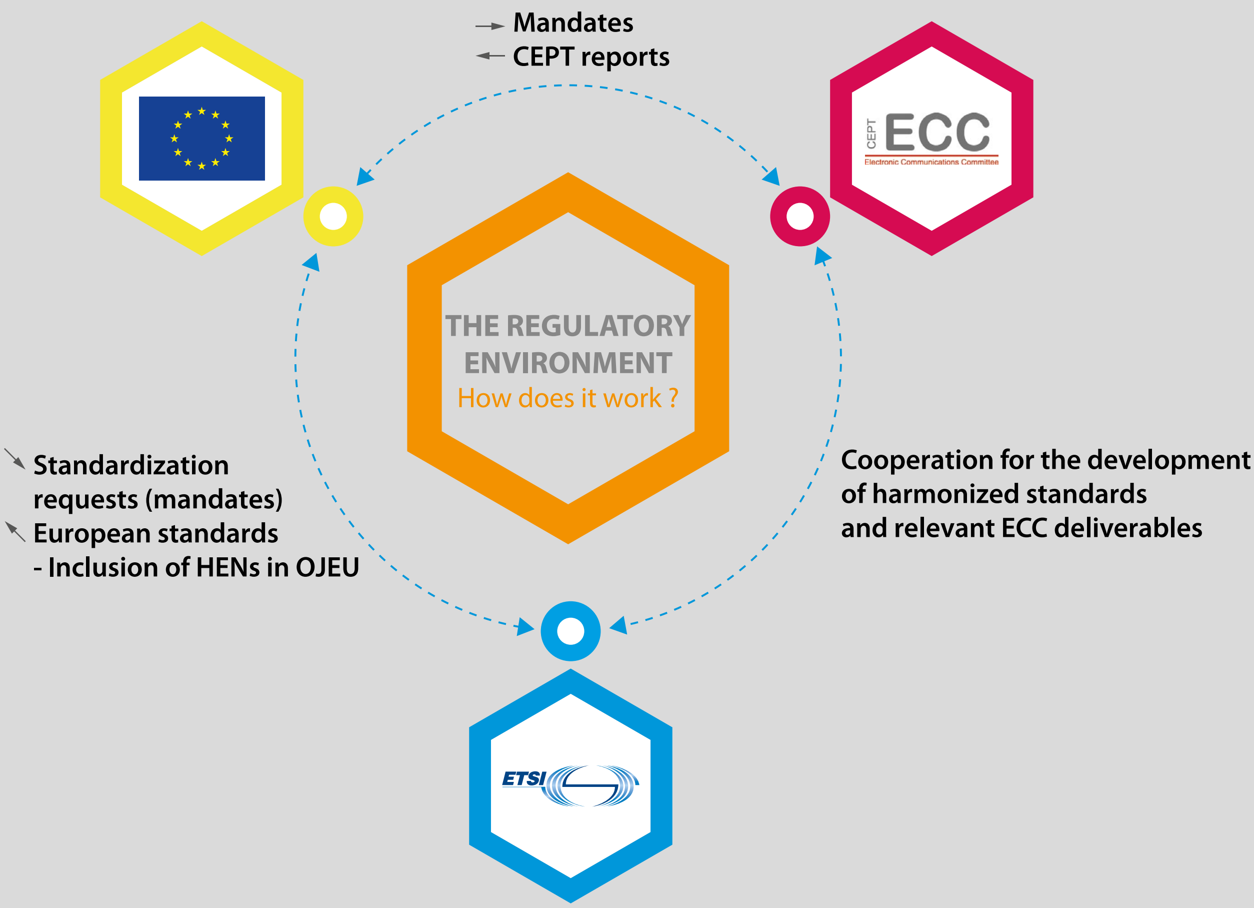

Figure 3.10: European radio spectrum regulatory environment

The radio spectrum regulation framework is a typical example of this collaboration between authorities and SDOs. It associates three entities: the European Commission (EC), the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT), and ETSI as an ESO. The CEPT and the ECC bring together radio spectrum experts delegated by 48 countries, including the EU member states. One of the ECC's main objectives is to harmonize the efficient use of the radio spectrum across Europe.

- The EC, via its Radio Spectrum Committee (RSC), requests the CEPT to conduct technical studies in order to develop technical measures related to the radio spectrum to be implemented at the European community level. Such measures may be specifications or other documentation on specific technologies and their application. For example, System Reference Documents advise on the need for an allocation of spectrum, in particular when either a change in the current frequency usage, or a change in the regulatory framework for the proposed band, is needed to accommodate a new radio system or service.
- ETSI, as an ESO, receives standardization requests from the EC. The appropriate ETSI working groups prepare standards to be approved as harmonized standards in collaboration with the ECC and specify how products can comply with the requirements of the EC and EFTA (European Free Trade Association, a regional trade organization and free trade area consisting of four European states: Iceland, Liechtenstein, Norway and Switzerland).
- The ECC/CEPT prepares CEPT reports in response to the requests received from the EC.
- The application of harmonized standards referenced in the Official Journal of the European Union (OJEU) enables manufacturers and service providers to benefit from a presumption of conformity with the requirements of the EC Directives, and thus to be able to market their radio devices within the EU.

The Radio Equipment Directive (RED) (EU 2014) is a typical application of the regulatory environment described above. Its provisions have been applicable since 13 June 2016.

Any provider that wants to place transmitting or receiving radio equipment on the European market and operate it using the radio spectrum must meet the requirements of the relevant directives and regulations. In the EU, the manufacturer or distributor of a device bears full responsibility for placing it on the market. The RED specifies the requirements to be met by products with radio equipment in order to be sold and put into service.

The RED places additional emphasis on efficient and effective use of the spectrum: radio equipment needs to demonstrate its receiver and transmitter performance, as both are considered to affect the efficient and effective use of the spectrum. As a consequence, broadcast TV & radio receivers are now specifically included in the scope of the RED to ensure efficient operation.

Harmonized standards developed after the RED allow manufacturers to enter the market with a presumption of conformity.

EXAMPLE

CE Marking

The European CE marking regulation is another example of a regulation referencing standards.

"CE" is the abbreviation of "Conformité Européenne", or "European Conformity". The official term now used for labelling is "CE Marking" and is included in all EU official documents (EC 2018a). It is an indicator of a product's compliance with EU legislation and enables the free movement of products within the European market. By affixing the CE marking on a product, a manufacturer is declaring, on their sole responsibility, conformity with all the applicable Directives and therefore ensuring free circulation for that product throughout the European Economic Area (EEA, the Member States of the EU and EFTA countries), as well as Turkey.

The requirements of the CE Marking process are as follows:

- Identify applicable directive(s)
- Identify the harmonized standards concerned
- Verify the product's specific requirements
- Identify whether a conformity assessment by a notified body is necessary
- Test the product's conformity with the relevant requirements and, if necessary, have tests performed by a notified body
- Establish the required technical documentation
- Affix the CE marking and complete the Declaration of Conformity

CE marking does not indicate that a product has been approved as safe by the EU or by another authority, neither does it indicate the origin of a product. Furthermore, CE marking does not automatically guarantee the parameters of individual product characteristics: manufactured products might deviate and not conform to the relevant requirements due to changes in the requirements, changes to the product or poor-quality production.

Due to the size of the combined EU and EFTA markets, CE marking has an influence that goes well beyond the market: for example, it is not uncommon to find CE marking on products (also) sold on the American market.

3.6 CASE STUDY: THE REVISION OF A NATIONAL STANDARD ABOUT TELECARE, FROM THE ICT ACCESSIBILITY PERSPECTIVE

The UNE 158401 standard was approved in 2007 by UNE, the Spanish official SDO. The objective and scope section of the document reads as follows: "This standard specifies the minimum requirements and the level of service that the telecare service must meet, both in its domiciliary and mobile versions. This standard does not cover the requirements for the applied technology".

Public administration agencies in the country, usually local authorities, or regional government in the case of telecare provision, hire private companies through calls for tenders. These companies provide the telecare services and equipment to eligible end users. In the calls for tenders, the professional and technical standing of the companies are assessed against the telecare standard. There are several hundreds of thousands of citizens from that country who benefit from telecare to enhance their safety and wellbeing. Hence, the economic and social impact of this standard is significant.

In early 2016, nine years after the first version of the standard was published, the telecare committee decided to revise the document. By that time, the committee was composed of social representatives of the telecare arena, including public administration, service providers and manufacturers of telecare equipment.

The document was in need of an update, as both the service model and the technology had evolved quite a lot in recent years. At the time the revision began, telecare was much more advanced than it used to be: a single panic button that allowed the end user to make a hands-free phone call to request help from an operator. In 2016, existing technology and services could detect and alert users in case of fire, extreme temperatures, and user falls. It was also possible to identify and pick up on behavioural patterns that might indicate a deterioration of users' physical or cognitive abilities to live on their own. Furthermore, telecare was increasingly using IP and web technologies as a complement to traditional phone communications.

According to its scope section, the original version of the standard did not cover technology aspects of telecare. Stakeholders agreed that the standard should be revised to include requirements about technology aspects such us minimum battery life and the minimum set of events that should be detected and transmitted by telecare sensors, etc.

However, in this case study we focus on one single aspect of technology: the accessibility of telecare devices to citizens with and without disabilities. Considering that a significant percentage of potential beneficiaries of telecare have a disability, lack of accessibility requirements within the standard stood as a major barrier for the impact and quality of telecare services in the country.

Shortly before the revision of the telecare standard was agreed, standards and regulation on ICT accessibility were changing fast in the EU. The standard EN 301 549 V1.1.2 (2015-04) "Accessibility requirements suitable for public procurement of ICT products and services in Europe" had been approved in April 2015, following standardization request 376 issued by the European Commission (these requests were formerly known as mandates). M376 asked the three ESOs (CEN, CENELEC and ETSI) to deliver "a European Standard specifying for all ICT products and services within each of the technical areas the corresponding requirements for accessibility". One year later, the European Parliament and the Council approved Directive 2016/2102 on the accessibility of the websites and mobile applications of public sector bodies. The Directive explicitly states that the content of websites and mobile applications that fulfil the relevant requirements of European standard EN 301 549 V1.1.2 (2015-04) shall be presumed to be in conformity with the Directive's accessibility requirements. Furthermore, by the end of December 2015, the proposal for a new

European Directive on accessibility (the European Accessibility Act) was approved by the European Commission. The Act (that was finally approved in 2019) would complement Directive 2016/2102 and bring additional accessibility requirements applicable to the telecare realm.

In parallel to what was going on in the telecare committee, the members of another standards committee on "ICT accessibility" learnt that the telecare standard was being revised. In fact, this was a combination of coincidence and informal communications among standardization experts working in different committees. The two committees had not previously established formal contact, and therefore were not automatically notified by the SDO information system about each other's activities.

This committee on ICT accessibility was composed of accessibility advocates who were up to date on standardization and regulatory news on the subject of ICT accessibility in the EU. They realized that the revision process was a good opportunity to include requirements about ICT accessibility.

Regarding the accessibility inputs to the standard revision, the process can be summarized as follows:

- The ICT accessibility committee conducted desk research that revealed that there were not any European or International standards published specifically on telecare accessibility, except an ETSI Guide on human factors of telecare services (ETSI EG 202 487). Hence, EN 301 549 and ETSI EG 202 487 were used as the primary references to prompt comments for the revision of the telecare standard.
- The convenor of the ICT accessibility committee (the person responsible for arranging and organizing its meetings and activities) was designated as the delegate in the telecare committee. Being a delegate means attending telecare committee meetings, introducing and negotiating the comments submitted, receiving automatic notifications on meeting schedules and minutes, as well as on updates to committee documents.
- The negotiations about accessibility requirements were long and complex. Especially in the beginning, the proposals to include accessibility requirements in the telecare standard: a) were not fully understood by the telecare professionals within the committee, b) entailed real challenges for the telecare manufacturers and providers participating in calls for tenders, as the services and devices would have to comply with the accessibility requirements, c) might imply higher costs for the public administrations funding the services.
- At the beginning of the revision process, a training session was held on the application of EN 301 549 accessibility requirements to telecare. The session was structured around real case studies submitted by telecare stakeholders (either public administrations or providers). The aim was to train delegates on the rationale of user-accessibility needs as well as on the technical solutions required to address them.
- The negotiations had to reach a consensus: Not all of the accessibility contributions were ultimately included in the telecare standard as requirements (i.e., with the term "shall"). Those that were not achievable in practice for the industry at that time were included as recommendations (i.e., with the term "should"). A further revision of the standard would transform recommendations into requirements when feasible.

In the end, the telecare committee considered that the accessibility contributions added value to the revised standard:

- More citizens with disabilities will benefit from telecare services, leading to a growing telecare market.
- By integrating ICT accessibility solutions into their products, telecare providers and manufacturers are innovating their service portfolio.

Relationship of the case study with the learning objectives of the textbook:

- Standards published by recognized SDOs are used as technical references in public procurement processes.
- Standards need to be revised from time to time because of changes in technology and/or societal needs.
- The relevance of the information contained in the "objectives and scope" section of standards.
- Pros of SDO standardization:
  - Committees that are open to all stakeholders reflect the real needs of society in the standards they produce.
  - Committees from different standardization areas may cooperate, provided that their activities are openly and publicly disseminated.
  - Liaisons between different standardization committees and the use of information systems for notifications ensure effective communication among committees.
- Cons of SDO standardization:
  - Reaching consensus takes time, especially when different stakeholders are represented in the committee.
  - Different knowledge domains and backgrounds across committees may imply different "languages and cultures".
- Standardizers should be up to date on the most recent standards and regulations in their area.
- Negotiation and communication are soft skills that standardizers should possess.

3.7 SUMMARY

This chapter provides readers with key concepts and examples to orientate themselves in the complex landscape of standardization.

Firstly, it provides readers with key concepts and examples of formal standardisation and the organisations producing them, the standards development organisations (SDOs). It also introduces de facto standards and the processes through which some of them are published as SDO standards in the ICT field. The relationship of industry consortia with ICT standardisation is also described.

Then, it introduces readers to the types of standards produced by SDOs, the main types of ICT standards, as well as the conventions used to name them.

Next, the basic concepts about the different geographical scopes of standardization are reminded and qualified. It also introduces the mechanisms that support coordination and cooperation of international, regional and national SDOs, their standardization activities and deliverables. Among these mechanisms, this section addresses the national and regional adoption of standards published by SDOs with a wider scope.

Finally, the links among regulation and standardization are outlined. The benefits of establishing technical specifications through referencing standards are highlighted, and several hints of how this references should be done are also included.

3.8 QUIZ

1 - RECOGNIZED SDOS ARE:

(See Section 3.1 for hints)

a) *Organizations with a sole mission to publish standards that are referenced by regulation.*
b) *Organizations that have been elected by the corresponding Parliament (e.g., National Parliament, European Parliament, etc.)*
c) *Public organizations that have been created by treaties.*
d) *Officially recognized by regulatory systems as providers of standards*

2 - FORMAL STANDARDISATION:

(See Section 3.1 for hints)

a) *Is the process to produce de facto standards.*
b) *Is undertaken by SDOs.*
c) *Is only undertaken by officially recognized SDOs.*
d) *Produces documents that companies and public organizations must comply with.*

3 - NON-RECOGNIZED SDOS:

(See Section 3.1 for hints)

a) *May have well-established procedures to ensure the quality of their standards.*
b) *Only produce private standardization documents.*
c) *Produce standards that may later be published by recognized SDOs.*
d) *Approve regulatory documents.*

4 - DE FACTO STANDARDS:

(See Section 3.1 for hints)

a) *Cannot ever become formal standards.*
b) *Have been previously approved by a public SDO.*
c) *Are conventions that have achieved a dominant position.*
d) *Usually have the characteristic of having been validated by the market.*

5 - THE CONCEPT OF DOMINANT DESIGN:

(See Section 3.1 for hints)

a) *Is the main topic of an ISO Guide that addresses the coordination of SDOs.*
b) *Is related to the key technological features that transform a document into a de jure standard.*
c) *Is always based on the best user experience of technology.*
d) *Is related to the key technological features that become a de facto standard.*

6 - EXAMPLES OF DE FACTO STANDARDS ARE:

(See Section 3.1 for hints)

a) *PDF.*

b) *Asynchronous communication.*

c) *ISO 9001.*

d) *HTML.*

7 - REGARDING PUBLIC AND PRIVATE SDOS:

(See Section 3.1 for hints)

a) *Only public SDOs may adopt de facto standards as formal standards.*

b) *Public SDOs are usually created by treaties.*

c) *Generally speaking, private SDOs are commercial companies that publish private standards.*

d) *Only public SDOs are eligible as recognized SDOs.*

8 - WHAT IS THE PROCEDURE USED TO RELEASE AN INDUSTRIAL SPECIFICATION AS A FORMAL STANDARD?

(See Section 3.1 for hints)

a) *Adoption.*

b) *Transposition.*

c) *Publicly available specification.*

d) *Regulation.*

9 - REGARDING NORMATIVE AND INFORMATIVE STANDARDIZATION DOCUMENTS:

(See Section 3.2 for hints)

a) *Normative documents contain requirements, which must be met in order to claim compliance with the standard.*

b) *Requirements in a standard are usually worded with the term "must".*

c) *Informative documents contain information and requirements.*

d) *The term "should" is used to include recommendations*

10 - THE NAME ETSI ES 201 873-11 V4.7.1 (2017-06) GIVES THE READER THE FOLLOWING INFORMATION ABOUT THE STANDARDIZATION DOCUMENT:

(See Section 3.2 for hints)

a) *It is part of a family of standards.*

b) *It is a European Standard.*

c) *It needs to be revised before June 2019.*

d) *It has been approved by ETSI.*

11 - THE NAME NF EN ISO/IEC 15416 AUGUST 2003 GIVES THE READER THE FOLLOWING INFORMATION ABOUT THE STANDARDIZATION DOCUMENT:

(See Section 3.2 for hints)

a) *It has been previously approved by ISO/IEC.*

b) *The document was originally approved as an International Standard, then as a European Standard, and then as a National Standard.*

c) *It is document 416 within the 15000 family of standards.*

d) *It was published in 2003.*

12 - INDICATE WHICH OF THE FOLLOWING STATEMENTS ARE TRUE, REGARDING THE CLASSIFICATION OF ICT STANDARDS:

(See Section 3.2 for hints)

a) *The ITU-T Recommendation I.112. Vocabulary of terms for ISDNs belongs to the "terminology standards" category.*

b) *The standard ISO/IEC 24800-4 File format for metadata embedded in image data (JPEG and JPEG 2000) belongs to the "System management standards" category.*

c) *The UML specification belongs to the "Communication reference models" category.*

d) *The 802.3 IEEE Standard for Ethernet belongs to the "software and networking" category.*

13 - REGARDING VERTICAL AND HORIZONTAL STANDARDS:

(See Section 3.2 for hints)

a) *The ISO/IEC 27001 standards on information security management are vertical standards.*

b) *The ETSI GSM family of standards are an example of horizontal standards.*

c) *The smart grid standards belong to the category of vertical standards.*

d) *The standards applicable to the food and drink industry are horizontal standards.*

14 - REGARDING COORDINATION AMONG DIFFERENT LEVELS OF STANDARDIZATION:

(See Section 3.3 for hints)

a) *International standardization takes precedence over regional standardization.*

b) *National standardization takes precedence over regional standardization.*

c) *Regional standardization takes precedence over national standardization.*

d) *Regional standardization takes precedence over international standardization.*

15 - REGARDING COORDINATION AMONG DIFFERENT LEVELS OF STANDARDIZATION:

(See Section 3.3 for hints)

a) *Agreements among the corresponding SDOs make it possible for approved international standards to be adopted as regional standards, and then as national standards.*

b) *Agreements tend to recognize that standardization at a narrower scope may have particular needs that need to be considered when adopting standards with a wider scope.*

c) *Approved international standards are usually adopted as regional standards, and then as national standards.*

d) *Approved national standards are simultaneously adopted as regional standards, and then as international standards.*

16 - ABOUT THE STANDSTILL CONCEPT:

(See Section 3.3 for hints)

a) *It is a process through which national standards are approved as international standards.*

b) *It is the process through which SDOs are officially recognized by the European Commission.*

c) *It entails an obligation for national SDOs not to take any action that could prejudice European standard harmonization.*

d) *It is a tool to support coordination between European and national standardization activities.*

17 - REGARDING THE PROCESS OF COORDINATION AMONG EUROPEAN AND NATIONAL SDOS:

(See Section 3.3 for hints)

a) *Once a European standard is approved, conflicting national standards are withdrawn.*

b) *First, national SDOs submit their contributions or national perspectives on the standard's topic and scope; these contributions inform the drafting of the first version of the European standard, which is undertaken by the European SDO.*

c) *European SDOs translate the approved EN into the languages of all of the nations where the standard is adopted.*

d) *First, a standardization group within a technical committee of a European SDO drafts the document, then national SDOs submit their votes and comments about the draft.*

18 - THE VIENNA AGREEMENT:

(See Section 3.3 for hints)

a) *Establishes that international standards are simultaneously approved as European standards.*

b) *Establishes that any pre-existing conflicting national standards must be withdrawn.*

c) *Recognizes that the European Single Market may have particular needs.*

d) *Was signed between ITU and ETSI, and underlines the fact that international standardization takes precedence over national standardization.*

19 - AS A RESULT OF THE FRANKFURT AGREEMENT:

(See Section 3.3 for hints)

a) *Around 80% of all European electrotechnical standards are identical to or based on IEC International Standards.*

b) *New electrical standards projects are jointly planned between CENELEC and IEC.*

c) *All European electrotechnical standards are identical to or based on IEC International Standards.*

d) *All European electrotechnical standards are identical to or based on ISO International Standards*

20 - WHAT IS THE AVERAGE PROPORTION OF EUROPEAN STANDARDS IN AN EU COUNTRY?

(See Section 3.3 for hints)

a) *Less than 10%*

b) *Between 10% and 50%*

c) *Between 50% and 90%*

d) *More than 90%*

21 - STANDARDIZATION REQUESTS FROM THE EUROPEAN COMMISSION:

(See Section 3.4 for hints)

a) *Are drafted by the European Commission after consulting social representatives.*

b) *Can be refused by the European SDOs, but this situation is quite rare.*

c) *Must be previously approved by each Member State.*

d) *Need to be ratified by the European Parliament.*

22 - STANDARDIZATION REQUESTS FROM THE EUROPEAN COMMISSION:

(See Section 3.4 for hints)

a) *Are translated into all the official languages of the European Union, and then approved as directives.*

b) *Are requests to the European Standardization Organizations to develop standards.*

c) *Are transformed into de facto standards by non-official SDOs.*

d) *Are transformed into de facto standards once their adoption is universal.*

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3.9 GLOSSARY

- Alliance: Organization gathering companies operating in the same domain, which gather to achieve a common objective, e.g. the production of specifications for a specific technology.
- Directive (European Union): A directive is a legal act of the European Union that requires member states to achieve a particular result without dictating the means of achieving that result.
- Drafting: Iterative writing of the different clauses of a draft standard.
- Guide: Documents used by standards organizations for guidance on how to handle specific technical standardization activities.
- Specification: Set of rules that competing products must comply with to enable their interoperability.
- Standardization stakeholder: Parties impacted by the publication of standards, e.g., corporate organizations, user groups or national authorities.
- Technical body: Generic term designating technical committees, sub-committees and working groups that bring together delegates to produce standards.

3.10 LIST OF ABBREVIATIONS

- 3GPP: Third Generation Partnership Project
- AFNOR: Association Française de Normalisation (French Standards Association)
- ANS: American National Standard
- ANSI: American National Standards Institute
- API: Application Programming Interface
- ARIB: Association of Radio Industries and Businesses
- ATIS: Alliance for Telecommunications Industry Solutions
- BIS: Bureau of Indian Standards
- BS: British Standard
- BSI: British Standards Institution
- CCC: Car Connectivity Consortium
- CE (Marking): Conformité Européenne (European Conformity)
- CEN: Comité Européen de Normalisation (European Committee for Standardization)
- CENELEC: European Committee for Electrotechnical Standardization
- CEPT: Conférence Européenne des Postes et des Télécommunications
- CWA: CEN Workshop Agreement
- EC: European Commission
- ECC: Electronic Communications Committee
- EEA: European Economic Area
- ETFA: European Free Trade Association
- EM: Electromagnetic Compatibility
- EN: European Standard
- ES: ETSI Standard
- ESO: European Standards Organization
- ETSI: European Telecommunication Standards Institute
- EU: European Union
- GSMA: Global System for Mobile Communications (GSM) Association
- HGI: Home Gateway Initiative
- HTML: HyperText Markup Language
- IAB: Internet Architecture Board
- ICT: Information and Communication Technology
- IEC: International Electrotechnical Commission
- IEEE: Institute of Electrical and Electronics Engineers
- IETF: Internet Engineering Task Force
- IS: International Standard
- ISO: International Organization for Standardization
- ISO/IEC JTC 1: Joint technical committee 1 of ISO/IEC
- IT: Information Technology
- ITU: International Telecommunication Union
- ITU-T: International Telecommunication Union—Telecommunication Sector
- IWA: ISO Workshop Agreement.
- JTC: Joint Technical Committee
- M2M: Machine-to-Machine
- MoU: Memorandum of Understanding
- NSO: National Standards Organization
- OASIS: Not-for-profit consortium, the acronym stands for Advancing Open Standards for the Information Society
- OEM: Original Equipment Manufacturer
- OJEU: Official Journal of the European Union
- OMG: Object Management Group
- PAS: Publicly Available Specifications
- PAS (ISO): ISO Publicly Available Specification
- PASC: Pacific Area Standardization Conference

- PDF: Portable Document Format
- RED: Radio Equipment Directive
- RFC: Request for Comments
- RSC: Radio Spectrum Committee
- SC: Sub-Committee
- SDO: Standards Development Organization
- SME: Small or Medium-sized Enterprise
- Std: Standard
- TBT: Technical Barriers to Trade
- TC: Technical Committee
- TR: Technical Report
- TS: Technical Specification
- TV: Television
- UML: Unified Modelling Language
- UNE: Spanish Association for Standardization
- US: United States
- W3C: World Wide Web Consortium
- WCAG: Web Content Accessibility Guidelines
- WG: Working Group
- WI: Work Item
- WLAN: Wireless Local Area Network
- WS-Security: Microsoft Web Services Security specification
- WSP: Wireless Short-Packet (protocol)
- WTO: World Trade Organization

3.11 REFERENCES

- Abernathy, W. J., & Utterback, J. M. (1978). Patterns of innovation in technology. Technology Review, 80(7), 1–47.
- Blind, K. (2008). The Influence of Companies' Patenting Motives on their Standardisation Strategies. 13th EURAS Workshop, Sweden, June, 16.
- CCC (2016). Car Connectivity Consortium. http://carconnectivity.org. Accessed 15 November 2017.
- CEN. (2016). Implementation of European Standards - ENs not corresponding to national standards on a one-to-one basis. CEN. https://boss.cen.eu/reference%20material/guidancedoc/pages/impl.aspx. Accessed 20 October, 2021.
- CEN. (n.d.). CWA - CEN Workshop Agreement. https://boss.cen.eu/developingdeliverables/cwa/pages/. Accessed 20 October, 2021.
- CEN, CENELEC. (2008). CEN/CENELEC Guide 12. The concept of affiliation with CEN and CENELEC. CEN, CENELEC.
- de Vries, H. J. D. (2006). IT Standards Typology. https://www.igi-global.com/gateway/chapter/4654. Accessed 20 October, 2021.
- EnOcean (2017). EnOcean Wireless Standard. https://www.enocean-alliance.org/what-is-enocean/enocean-wireless-standard. Accessed 20 October, 2021.
- ETSI. (2016). Version numbering system. ETSI. https://portal.etsi.org/Services/editHelp/How-to-start/Document-procedures-and-types/Version-numbering-system. Accessed 20 October, 2021.
- ETSI. (n.d.). Types of standards. https://www.etsi.org/standards/types-of-standards. Accessed 20 October, 2021.
- ETSI. (2016) Home Gateway Initiative smart home specifications published by ETSI, ETSI Press Release, November 2016. http://www.etsi.org/news-events/news/1150-2016-11-home-gateway-initiative-smart-home-specifications-published-by-etsi. Accessed 20 October, 2021.
- ETSI (2017). Publicly Available Specifications (PAS). http://www.etsi.org/about/what-we-do/publicly-available-specifications-pas. Accessed 20 October, 2021.
- ETSI-ECC (2016). The European regulatory environment for radio equipment and spectrum, an introduction.
  Version 2.1, July 2016.
- European Commission (2018). CE Marking. https://ec.europa.eu/growth/single-market/ce-marking_en. Accessed 20 October, 2021.
- European Commission (2018). Harmonised standards. http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards. Accessed 20 October, 2021.

- European Union (2014). Radio Equipment Directive. "Directive of the European Parliament and of the Council of 16 April 2014 on the on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC". Directive 2014/53/ EU. April 2014.
  Available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0053&from=EN. Accessed 20 October, 2021.
- Hatto, P. (2013). Standards and standardisation: A practical guide for researchers. European Commission, Publications Office of the European Union.
- HGI, ETSI (2016). Home Gateway Initiative transfers smart home related requirements to ETSI. https://www.etsi.org/newsroom/news/1082-2016-04-home-gateway-initiative-transfers-smart-home-related-requirements-to-etsi Accessed 20 October, 2021.
- IEC, & CENELEC. (2016). IEC - CENELEC Frankfurt Agreement. IEC-CENELEC. http://www.iec.ch/about/globalreach/partners/pdf/IEC-CENELEC_Frankfurt_Agreement%7B2016%7D.pdf. Accessed 20 October, 2021.
- ISO. (n.d.). ISO deliverables. ISO.
  https://www.iso.org/deliverables-all.html.
  Accessed 20 October, 2021.
- ISO, & CEN. (2001). The Agreement on technical cooperation between ISO and CEN (Vienna Agreement). ISO-CEN.
  https://isotc.iso.org/livelink/livelink?func=ll&objId=4230458&objAction=browse&sort=subtype. Accessed 20 October, 2021.
- ISO, & CEN. (2016). The Vienna Agreement FAQs. ISO-CEN.
  https://boss.cen.eu/media/CEN/ref/va_faq.pdf. Accessed 20 October, 2021.
- ISO, & IEC. (n.d.). ISO/IEC JTC 1 — Information Technology. ISO-IEC.
  https://www.iso.org/isoiec-jtc-1.html. Accessed 20 October, 2021. Accessed 20 October, 2021.
- ITU, & ETSI. (2016). Memorandum of understanding between ETSI and ITU. ITU-ETSI.
  https://www.itu.int/en/ITU-T/extcoop/Documents/mou/MoU-ETSI-ITU-201605.pdf. Accessed 20 October, 2021.
- ITU, & ISO/IEC. (2014). A.23 : Guide for ITU-T and ISO/IEC JTC 1 cooperation. ITU-ISO/IEC.
  https://www.itu.int/rec/T-REC-A.23-201406-I%21AnnA. Accessed 20 October, 2021.
- Wi-Fi (2017). Certification: Wi-Fi Test Suite.
  http://www.wi-fi.org/certification/wi-fi-test-suite. Accessed 15 November 2017. Accessed 20 October, 2021.

4 THE PRODUCTION OF STANDARDS

LEARNING OBJECTIVES

This chapter has the following objectives regarding the standardization scene (including both the standardization process and the standardization structure and operation):

- students should understand the development process and methodology for producing high-quality standards.
- students should learn about important guiding principles, such as consensus, impartiality, which are applied during the different phases of standard writing.
- students should be able to identify the most important management bodies and their roles inside SDOs, e.g. the technical management board and the chief executive officer.
- students should understand which are the most important parties in the SDO structure, as well as in technical committees, for instance the chair of a committee.
- students should know how to initiate a new standard and how to become a member of an SDO.

This chapter has the following objectives regarding the activities and skills of standardization professionals (SP), i.e. ICT workers who contribute to standardization:

- students should know and understand the most relevant capabilities that make them efficient towards the activities of a technical body (in the context of active participation in standardization).
- students should understand the necessary skills to develop as a future a delegate.
- students should learn the main tasks that SPs have to perform during standardization meetings, in the interval between standardization meetings and inside their company or organization.
- students should know how to cooperate with different company departments (e.g. marketing, sales) to achieve the most out of standardization.
- furthermore, students should understand the additional duties of a national SDO delegate.

4.1 INTRODUCTION

This chapter addresses several topics related to the development and methodology used to produce standards of high quality.

It first sets the standardization scene (including both the standardization process and the standardization structure and operation) by introducing the underlying code of good practice of formal standardization and the different criteria that should be satisfied to ensure the high quality of a standard. The process of producing standards is described in detail and illustrated with several examples of different methodologies, as well as the structuring of SDOs that are responsible for providing a suitable environment. This chapter considers all types of SDOs, recognized or not, and may even apply to non-formal standardization in some cases. Examples of the standardization process (e.g. CEN/CENELEC) are provided, and all of the key stages, events and outcomes are described by means of a timeline, to learn about the structure and operation of an SDO as well as all of the key internal players, together with their tasks and responsibilities. Concerning the standardization process, the composition of the working group (e.g. companies, academics, users, and further external stakeholders) are discussed. Further concepts such as consensus and other important guiding principles and rules in the standardization process are explained. In addition, other areas/concepts surrounding the standards development process (e.g. implementation, adoption, usage, technology, and standard updates) are explained.

As standards are written by standardization professionals, this chapter describes their roles in the standardization process as well as the technical and personal capabilities that enable them to carry out their daily tasks. The notion of "standardization professional" (SP) is introduced as the general concept of an individual active in standardization tasks. Standardization experts (SE) are a sub-category of SP who contribute to the content of standards. Their relevant technical skills, experience and soft competencies are discussed and linked to the tasks they fulfil. The tools used to execute these tasks are also introduced.

Finally, this chapter presents the main activities and duties of standardization professionals and how they interact with their peers, both inside the standardization group and within their own company. Their main tasks are explained in both situations. These tasks include, for example, the coordination of internal and external (vs. their company) standardization activities, the preparation of draft documents, and new requests for national and international standards together with subject matter experts. According to the role played in the standardization process, these activities may also include the tracking and monitoring of standardization deadlines and ensuring the approval of new standards. Managing the internal portfolio and repository of standards and the communication of the standardization work to other colleagues are also performed inside the company. In addition, these tasks are discussed for representatives of organization types other than industry, such as academia, researchers or national SDO delegates.

4.2 THE STANDARDIZATION SCENE

4.2.1 INTRODUCTION

The standardization scene relates to both the standardization process and the standardization structure and operation. A standard describes technical solutions, and its preparation strongly depends on various organizational aspects and social ramifications. To prepare standards, some fundamental principles and quality requirements should be respected. Some of them have already been described in Chapter 2, Section 2.4.2, "Main characteristics of a standard", for example clarity of the content. Nevertheless, other criteria should be fulfilled as well: openness, transparency, impartiality, consensus, relevance to market needs, and avoiding duplication and competition among SDOs. These criteria are presented in the first part of this section. Indeed, the implementation of standards is voluntary and all the above characteristics can help increase their level of adoption.

Different steps allow the comprehensive standardization of a technology, a function or a system. These steps can be standardized in dedicated documents or grouped in more integrated documents. Such documents range from feasibility study reports to testing specifications. The production of a standard follows a well-defined procedure that may vary, depending on SDO policies. Generally, the procedure covers activities starting from inception and ending in the publication and maintenance of a document. These activities are described in the second part of this section.

SDOs are organizations with a well-defined structure designed to manage and administer the activities of their members. Becoming a member of an SDO requires adherence to a set of rules, which vary depending on the organization. The way SDOs are governed, including the internal structure of a technical committee, is described in the last part of this section. Knowledge of governance is essential for success in standardization.

4.2.2 CODE OF GOOD PRACTICE FOR THE DEVELOPMENT OF INTERNATIONAL STANDARDS

As already described in Chapter 2, standardization is based on a set of fundamental principles and mechanisms to foster the production of standards. These principles were first described by ISO (ISO 1994) and were identified as a supplementary key point to the World Trade Organization's (WTO) Committee of Technical Barriers to Trade (TBT) agreement G/TBT/1 of 1995 (WTO 1995). After the second triennial review of the agreement, the Committee adopted a decision containing a slightly modified set of basic principles that it considered of major importance for international standards development. These principles were seen as equally relevant to the preparation of international standards, guides and recommendations for conformity assessment procedures. These principles can be found in annex 4 of the G/TBT/9 review document (WTO 2000) and are integrated in annex 2 of the further revisions of the G/TBT/1 (WTO 2019) which gathers the WTO decisions and recommendations since 1995. SDOs and formal standardization are expected to fulfil these principles. Over 200 SDOs apply the code and its principles for the development of international standards, guides and recommendations. Industry fora and consortia often apply these principles, or at least part of them, in their methodology as well. The TBT principles, which have slightly been extended by some of the SDOs and in literature (WTO 2011, ANSI 2020), address transparency, openness, impartiality, consensus, effectiveness, relevance, development dimension, and coherence. Respecting these principles is especially important for standardization that will be referenced by regulations. This explains why authorities often prefer to mandate and use standards published by recognized SDOs, which fully adhere to these principles. Indeed, industrial alliances often have their own set of rules and usually prefer a faster adoption of their specifications, as compared to SDO standards. In alliances, membership and participation of delegates may be restricted to a specific industry group (Jakobs 2008), which may result in a lower level of enforcement of fundamental principles such as openness and transparency.

In the following sections, we explain these principles, policies and best practices. This section is based on the TBT report, but not only, to give a broader view of these main principles. Furthermore, following the explanation of each of the principles, we give an additional view of how these principles could have been circumvented, or even trampled, in some seldom cases of real life to serve specific interests. Due to the high economic impact of standardization, the real-life process is not systematically as perfect as it should be.

TRANSPARENCY

Transparency is achieved if the draft standard is made easily available to all of the working group members throughout its development steps with sufficient time to give them the opportunity to submit comments.

Transparency implies that these comments will be collected, considered, and discussed. Transparency also means that notification of standard proposals is given at an early stage, and that approved standards are published in a timely manner after their adoption. The SDO work programme is published, together with the list of standards under development, and kept updated. New standard proposals announce their precise scope and objectives. The policies adopted for the governance and activities of the organization, as well as the rules of the standards development process, should be easily accessible to all the members and users of the standard.

However, in some real-life cases, a standard might be put forward for approval at very short notice, with little notification given to peer working group members, who are deprived of the opportunity to read and carefully analyse the document prior to its approval.

OPENNESS

The openness of the standardization process means that the process is easily accessible on a non-discriminatory basis to any interested stakeholder at all stages, from SDO policy development and standard draft commenting, to the approval and dissemination of the standards. A monitoring system is set up to periodically verify the status for potential revision and obsolescence of the different standards.

Industry fora/consortia may disregard this principle and have closed meetings and membership restricted only to companies with a specific industry interest. Access to the standards, whether under development or even approved, may be limited to paying members only. In contrast, SDOs often provide access to their approved standards for a paying fee or even offer it for free.

IMPARTIALITY

An impartial process is managed by a group of diverse stakeholders with varied interests so that the group avoids being influenced, for instance by funding or by an interest group. The standard development process will not give privilege to, or favour the interests of particular suppliers, countries, or regions.

SDO rules grant identical basic rights to all participants of standardization work, although special additional rights may be granted in specific cases. Any interested party, directly or indirectly affected by the activity, is able to propose a new standard, submit comments and contributions at any stage of the development process. They can also express their views or ask for the revision of an outdated document.

On this matter, Intellectual Property Rights (IPR), such as patents, are a very sensitive topic. SDOs often require that known IPRs be declared as early as possible, in order to be able to take appropriate action, such as selecting another technology or ensuring fair and reasonable terms and licensing conditions for all implementers/users (see Chapter 7).

However, it might be possible for a standard that it is proposed purely to satisfy the interests of a particular supplier or governmental entity. Alternatively, a major player who dominates the market might be reluctant to have any standard at all and might try to slow down the process by adopting a difficult and demanding attitude.

BALANCE

A balanced standardization process is achieved if all representatives are allowed to express their positions and comments, and every representative's opinion is considered. This principle may also be considered as part of the impartiality principle.

According to this principle, the development process does not favour the interests of a specific provider, country, or region. The platform used for standards development is neutral and equally accessible to all parties. All interests are taken into account, whether they are private or public, economical, societal or environmental. Committee officials are required to adopt a neutral position in their tasks.

It might happen, however, in some cases and against the balance principle, that the valid opinion of a participant is noted and not further considered to be part of the standard because it hampers the objectives of a specific interest group. SDO governing rules tend to avoid this situation.

CONSENSUS

Consensus is obtained if a standard is approved by a large majority of the group of stakeholders. Every effort is made to reach unanimity. The views of all stakeholders are taken into account, even when they are diverging; no sustained opposition is expressed on a substantial issue. SDO development rules aim to reconcile conflicting arguments, including a fair mechanism for raising objections and enabling discussions until a large majority of the participants can achieve an acceptable compromise. Tough negotiations to reach the compromise often occur in parallel and outside of the official SDO meeting before the result is brought to the meeting and discussed again. In any case, consensus does not necessarily mean unanimity. When full consensus cannot be achieved, the approval of a standard may be obtained for example, through a voting process. This depends on the SDO's established procedures.

In practice, actions might be taken to silence the objections of one or a group of stakeholders, for example by providing the final version at very short notice, which facilitates the adoption of a disputed standard. Groups of members might block approval by unexpectedly bringing many "rarely participating" members into a voting situation.

EFFECTIVENESS

Standards should be developed when they have been proven as feasible and appropriate, based on scientific and technological developments. It is well-known in the field that specifications are not fully stable until products are commercialized (see e.g. beta tests). Standards requiring performance indicators from the technology or specifying interfaces between entities are considered more efficient and appropriate than descriptive or design standards. Moreover, the high quality of standards ready to be published is checked by independent reviewers. Some SDOs request that proofs of concept be developed before the approval of the related standards.

Some standards are, however, developed to describe a very emergent technology, which is not yet mature, but whose supporters want to reach the market early and prevent the development of other competing technologies. Because the future market and market positions are still unclear, economic interests may favour ambiguities in that standard. It is thus good practice, when drafting a standard, to validate it with experience from a few implementations and testing events.

RELEVANCE

Relevance means that a standard should respond to market and regulatory needs. Standards enable implementation by different providers and competition in the market. They do not try to distort the global market and do not hinder innovation and future evolutions of technologies. Impact risk assessment studies may help determine whether adverse effects can be expected. At the SDOs, IPR policies ensure transparent procedures and strategy plans are periodically revised to analyse and follow the market evolution and their stakeholders' needs.

Nevertheless, it might happen that a stakeholder tries to develop a standard to consolidate its position in the market. In a published case, two sub-committee officers provided a misinterpretation of the standards, which weakened the competitiveness of one of the providers. In the US, the Federal Trade Commission (FTC) has identified examples of standards and certification documents that had the effect of restraining trade or deceiving customers (Breitenberg 2009).

DEVELOPMENT DIMENSION

According to the development dimension principle, the standardization process is open to all interested parties and encourages the participation of developing countries. For example, the SDO permanent staff provides additional technical assistance and capacity to contribute to the concerned delegates. According to this principle, the standardization process should be neutral and not favour characteristics of specific countries or regions when different needs exist in other parts of the world. Another important point is that the process remains market driven rather than regulatory driven and should not fulfil the needs of a specific national authority.

However, it might happen in practice that, as recognized by the "Technical Barriers to Trade" (TBT) agreement (WTO 2000), technical regulations and standards are published to protect domestic industries.

COHERENCE

When respecting the coherence principle, an SDO pays attention to avoid duplicating the work of another SDO. The standardization contributes to the coherence of the market and prevents the introduction of a technology and/ or ICT solution that conflicts or overlaps with the standards developed in another SDO.

Collaboration and cooperation rather than competition with other SDOs is essential. Coherence also means that national SDOs do not develop their local standards in parallel to those of the regional organization where they belong. In Europe for example, this process is called "standstill" (CEN 2017). Cooperation can be established at different levels, such as liaison or exchange of information between committees and/or sub-committees (see Section 4.2.5), or creating a collaborative team shared by the two SDOs or coordination groups where work programmes are exchanged and discussed. Partnership projects are yet another instance of such cooperation. The projects coordinate the activities of regional SDOs and industry consortia. A well-known example in ICT is 3GPP, which produces standards for mobile communications (see Section 4.5).

However, it might happen in the practice of standardization that SDOs or consortia are requested by competing interest groups to work in parallel towards standards for technologies targeting the same market. They claim to rely on the market to select the "winning" one, but in reality, they fragment it and hinder its development. Furthermore, a large number of industrial consortia have been or are being created in the ICT domain, which is evolving at a fast pace. Coordinating their work, in parallel to the activities of the SDOs, represents a huge challenge.

EXAMPLE 1

For example, the Global Standards Collaboration (GSC) group annually brings together the world’s leading telecommunications and radio standards organizations to share work programmes and other information in a number of technical areas.

EXAMPLE 2

In the US, many private and public SDOs are active in all types of ICT domains. NIST is a federal agency, of which one of the missions is to promote innovation and competitiveness. On the other hand, ANSI serves as the coordinator of the private sector standardization system and also accredits that an organization can be recognized as SDO, as it complies with WTO TBT principles. Both organizations have signed a MoU, which defines their respective roles and their cooperation objective to strengthen US standards.

Finally, recognized SDOs must guarantee the viability and stability of the standardization process and of their IT infrastructure in the long run, even at times of budget restrictions. They have to handle large volumes of data, documents, delegates, and communications. They have to ensure proper funding, while enforcing fundamental principles such as openness and impartiality through balanced governance rules.

With the same objective and to apply these principles, several non-recognized SDOs, namely IEEE, IAB (Internet Architecture Board), IETF, Internet Society and W3C, endorsed the "Openstand" principles in 2012 (OpenStand 2012). Their application of the principles did apply to the standardization processes that supported the creation of the Internet and Web:

- Cooperation between SDOs, whereby each SDO respects the autonomy, integrity, processes, and intellectual property rules of the others.
- Due process: no one party dominates or guides standards development. Standards processes are transparent and opportunities exist to appeal decisions. Processes for periodic standards review and updating are well defined.
- Broad consensus: processes allow for all views to be considered and addressed, such that an agreement can be found across a range of interests.
- Transparency: SDOs provide advance public notice of proposed standards development activities, the scope of work to be undertaken, and conditions for participation. Easily accessible records of decisions and the materials used to reach those decisions are provided. Public comment periods precede final standards approval and adoption.
- Balance: standards activities are not exclusively dominated by any one person, company, or interest group.
- Openness: the standardization process is open to all interested and informed parties.
- Collective empowerment and commitment to strive for standards that:
  - are chosen and defined based on technical merit, as judged by the contributed expertise of each participant;
  - provide global interoperability, scalability, stability and resiliency;
  - enable global competition;
  - serve as building blocks for further innovation; and
  - contribute to the creation of global communities, benefiting humanity.
- Availability: the contents of standards are made accessible to all stakeholders for implementation and deployment. Furthermore, if the contents of the standards are involving patented technologies, then the SDOs have defined procedures so that standards users can implement them under fair terms. Chapter 7 provides more information about this topic.
- Voluntary adoption: standards are voluntarily adopted. It is the market that determines success of the various technologies.

Moreover, the implementation of these principles carries pros and cons. They give rise to questions about how effectively they can be put into practice. Their descriptions in the previous paragraphs already gave examples of how they are sometimes circumvented in real life. Some questions were also put forward in literature papers (Maxwell 2006, Cerri 2007) about the openness of the standardization process.

- How open is the process of choosing to develop, and ultimately developing, a standard? Who can participate and under what terms? Does the process ensure that all participants can affect the standard? Is the process well documented? Who owns and manages the standard? Is there a single party that has special rights to it?
    - Pros: opening the effective participation in the standardization process to any organization minimizes the possibility that a standard reflects only the interests of a limited set of stakeholders. Having representatives of civil society on board contributes to addressing consumer needs such as privacy, security or cost.
    - Cons: the higher the level of participation, the more difficult it is to reach consensus, and therefore, the more likely it is that the standard will not be approved in time to address the needs of a rapidly changing technological context.
- Is the standard publicly disclosed in its entirety? Is the document publicly available, either free of charge or for a nominal fee? What terms and conditions govern its implementation? Does the standard contain proprietary technology that must be licensed? Will royalties be charged and on what basis will they be determined? Is it possible to extend and reuse the standard in other open standards?
    - Pros: As an example of the benefits of having publicly available, free-to-use standards, the growth of the Internet would not have been as rapid without universal availability of TCP/IP protocols or HTML. It also prevents ICT lock-in, e.g. the situation where due to a missing piece of essential information about the system, a public authority cannot easily change providers after the end of a contract (European Commission 2013). Based on a survey by the EC (Galasso 2015), the most used countermeasures to tackle ICT lock-in are "to define ICT strategies and architectures on open source and open standards".
    - Cons of openness: It is indeed difficult to develop standards with no proprietary technology involved, for instance in the case of a technology that has proven to solve a technological issue. Hence, there is intense debate within SDOs about whether to include proprietary technology, and how this should be done.

4.2.3 OBTAINING STANDARDIZATION RESULTS OF GOOD QUALITY

A standard specification is made up of a set of requirements, which guarantee compliance of the products that voluntarily implement it. In addition to the code of good practice presented in the previous section, the content and quality of the requirements of a standard's specifications can have a strong impact. Poorly written standards can cause additional transaction costs, reduce product safety and quality, and create barriers to trade (Breitenberg 2009). They can also constrain innovation, entrench inferior technologies, and prevent the development of interoperable products and systems. Accordingly, high-quality standards should fulfil the following set of measures for the requirements they contain:

- The requirements are necessary. They specify only what is required to implement and meet the standard's objectives, rather than how to achieve them. They do not impose a particular approach to implementation and rather permit the development of a variety of competing implementations of interoperable products or services.
- The requirements are unambiguous. They are technically credible and it is impossible to interpret the normative parts of the standard in more than one way. Rationale statements may be associated with the requirements to explain the criteria used in their development and provide relevant information to the developers.
- The requirements are comprehensive and accurate. The requirements are of high quality. They contain all the information necessary to understand their meaning, either directly or by reference to other documents.
- The requirements are precise. They are expressed clearly and concisely, written in plain language, without unnecessary details that might confuse readers and hinder implementation.
- The requirements are well structured. The individual elements of the requirement are all included in an appropriate manner and are easy to read and understand. Normative (i.e. prescriptive) parts are clearly differentiated from informative (i.e. descriptive) parts of the standard. Designated keywords indicate the different requirement levels.
- The requirements are consistent. There is no contradiction among the different requirements within the standard, nor with any other related standards.
- The requirements are validated by prototype implementations and are testable. There are clear and obvious means of devising a test to demonstrate that an implementation complies with the requirements.
- The requirements are easily accessible. The standard is available to the general public and is developed, approved, and maintained via a collaborative and consensus-driven process. Policies should ensure that patented technology or copyrighted material has been declared and is accessible in a fair manner.
- The requirements are up to date. The standard is well-maintained and supported by the responsible committee. Maintenance, evolution, or withdrawal needs are regularly assessed.

4.2.4 THE PROCESS OF PRODUCING STANDARDS

This section first presents the different steps for the holistic standardization of an ICT system. A system is often made of several entities and typically requires the publication of several standards, including technical reports, functional specifications, interface specifications and testing specifications. The section later focuses on the different steps involved for the production of one single standard document.

The exhaustive standardization of an ICT system usually follows a well-proven methodology that includes several stages, first described in ITU Recommendation I.130 (ITU-T 1988) for the ISDN standards, but has been adopted since by a large number of other standardization groups. Its main concepts are shown in Figure 4.1.

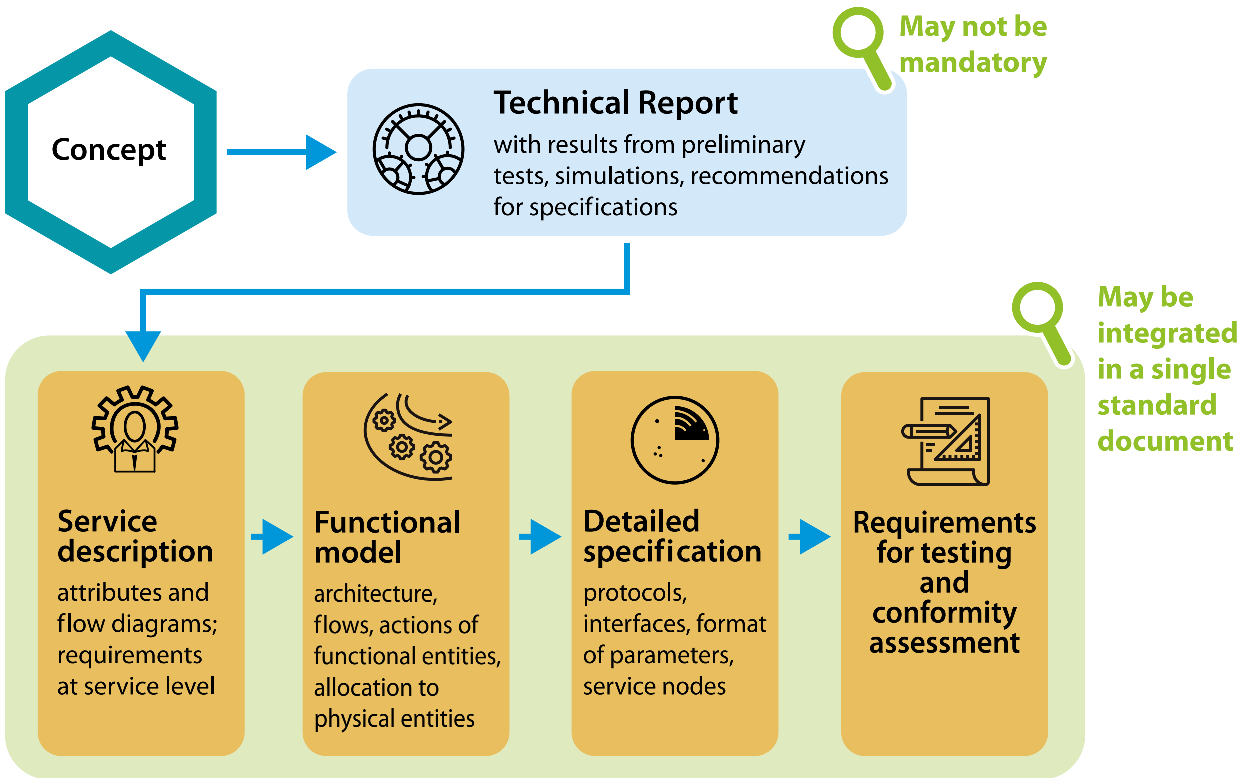

Figure 4.1: Typical methodology for the standardization of an ICT system

The purpose of the ITU Recommendation is to provide a method for the development of the standards specifying the different components involved in the system and the services offered to users, as well as to define the system capabilities needed. It promotes a systematic development process. Its main objectives are to give a common framework and tools to be adopted for the service description and to show how ISDN protocols and network resources for providing such services can be defined. Beyond network protocols, the guidelines and process that this recommendation contains can be applied to very different ICT contexts.

The design process is divided into three stages of activity, typically resulting in a corresponding series of specifications.

Stage 1 is a general description of the service offered by the ICT system to users and its objectives from the user's perspective. At this stage, the standard does not go into technical details, but includes a description of the service in terms of the perceptions of users receiving or involved in the service, of its parameters. A dynamic description of the service using flow charts is drawn, picturing it from activation to completion of the service.

Stage 2 develops a functional model to meet those objectives. This model includes the architecture of the system broken down into functions with their capabilities and their information interactions to support the service described in stage 1. Each information flow is described with the semantic meaning and content exchanged. The functions required to provide the service are grouped into components. The actions performed by the components are represented as list or as a sequence of actions. The functional components and information flows are allocated to physical entities.

Stage 3 develops a specification of the detailed technical requirements, based on the information flows obtained from stage 2. These detailed specifications include the messages exchanged to support the information flows as well as their internal elements and the procedures for the exchange.

In addition to these three stages, it is common practice to publish test specifications or conformance test suites for each of the standards developed in stage 3, applied to the requirements in the standard. They are particularly helpful for the specification developers and need to be available by the time the standard is implemented in commercial products.

Other standardization groups which used this recommendation have sometimes added a preliminary stage. This additional stage consists in a technical study to evaluate the different options that can be envisioned and the feasibility of the features to be developed. This technical study often leverages results from preliminary proofs of concept and simulations, and provides recommendations for the system to be standardized. The ITU Recommendation has been taken as a reference by many groups developing ICT systems, even in domains different from the initial recommendation objectives.

Depending on the size of the system to specify, the standard may be written as a single integrated document or as a set of several documents, each focusing on a specific part of the whole system. The preparation and publication of each of these documents follows a very well-defined procedure, described in the next section.

STANDARDIZATION PROCESS, FROM INCEPTION TO PUBLICATION

This section now focuses on the development of one standard. It follows a well-defined procedure that can be more or less formal depending on the type of organization. For instance, a standard developed by an industrial alliance is often written and published faster than a standard produced under formal standardization. Some SDOs (e.g. ISO) distinguish the phases in the standards development process by attributing tags to documents to indicate their degree of maturity.

The main phases of this procedure were introduced in Section 2.4, which provided an overview of the standardization process. There are five phases: (1) inception, (2) conception, (3) drafting, (4) approval and publication and (5) maintenance which are detailed below. The presentation is generic and is illustrated with examples which show the different approaches adopted by SDOs for this process, starting with the top-down approach for the standards development phases. Next, the bottom-up approach is presented in the IETF example, followed by a description of other possible models, based on an object-oriented approach or on implementation.

PHASE 1: INCEPTION TO IDENTIFY NEEDS

The process starts when a group of SDO delegates identifies the need for a concept or process to be standardized, or for a standard to be updated. They find other interested delegates who can help define the scope and convince the committee that the project is worthwhile. Indeed, a standard is the result of the collaboration and consensus of a group. The tasks related to the proposed standard need to be identified and submitted to the relevant committee. The state of maturity of the technology to be specified has to be verified. A standard produced too early for an emergent technology may quickly become out of date because there is little certainty about how the technology will develop, and the scope cannot be precise enough. On the contrary, a standard that is published too late risks being ignored in favour of earlier, competing standards or proprietary solutions. A compromise then needs to be made on the appropriate moment to start the standardization.

PHASE 2: CONCEPTION TO DEFINE THE SCOPE AND WORK PLAN

The group of initiators submits the proposal for a new standardization project to the best-suited technical body, using the appropriate form, and tries to trigger its interest. It prepares a document with a proposal including a clear scope describing the purpose of the target document and an estimated schedule with realistic milestones to track its progress. A Standardization Expert (SE) who is knowledgeable about the topic is put forward as document editor (sometimes named rapporteur). This is completed by a list of SDO members who support the project and are willing to help prepare the standard document. The presentation of this project includes insights on the proposed work and its technical content.

The committee endorses the proposal as a work objective if it considers that the standard is really valuable, or objects to the continuation of the process if certain criteria are not met. Once approved, it carefully considers how to pursue the work, particularly which sub-committee or project team will be in charge and what category of standard to create, based on the information received. A new item is then included in the committee and in the SDO work programme.

If the proposal is not endorsed, several options may apply, for example: a) the proposal lacked sufficient details and may be improved and represented at a later step; b) the proposal has a major issue which was highlighted during the discussions and may be simply dropped; c) the committee identified a better suited committee to host the project, where the proposal can be presented again. As for any non-approved projects, the possible options in this case are numerous.

PHASE 3: DRAFTING TO PREPARE THE NEW OR REVISED STANDARD.

The standard document editor (hereafter called rapporteur) prepares an initial outline of the document, describing all of the sections, i.e. the structure and planned content of the standard document. S/he distributes the work among contributors, who volunteer to write the clauses of the outline, and later collects the contributions from interested organizations. The different contributions are gathered in a draft standard, which should reflect the group's decisions.

Specific drafting meetings may be needed to review and discuss details of the content. An early review of the outline and of the draft document may be used to identify and solve potential conflicts at an early stage. Successive versions are circulated until the delegates agree on the content. IPRs should also be declared at an early stage to ensure that the standard is developed with a technology that is fairly accessible to all implementers.

Test development, implementations, prototypes, and field tests of the standard should be run in parallel to its drafting. Implementers can then provide useful feedback about the standard to its developers, including extensions, guidelines, and best practices to avoid inconsistencies and ambiguities. Some SDOs organize interoperability events, where providers interconnect prototypes and check for inconsistencies as well as conformance to requirements. The more stable the standards are, the more valuable they are and the more suited they are to repeated use.

At this stage, in some SDOs, the draft remains internal to the sub-committee or project team (depending on the SDO structure) and is not distributed or published externally. In other SDOs (for example IETF), it is made public to collect as many comments as possible and improve its content. Milestones are periodically and carefully screened to ensure that deadlines are respected, in order to meet the market needs and timing and keep the resources spent at a reasonable level.

PHASE 4: APPROVAL TO ACHIEVE CONSENSUS ON THE DRAFT STANDARD AND OFFICIAL PUBLICATION.

When the draft is ready in a stable form, it is circulated within the project team for comments. Raised issues may be tracked separately to monitor their resolution. Change requests and comments are analysed and evaluated, and their follow-up is integrated into the document. Resolution meetings and an iterative process may be needed to achieve agreement on the content of the draft.

The final version of the draft is submitted for approval to the sub-committee and, when applicable, shared with the parent committee. The (sub-)committee allocates a well-defined period of time to the committee members to review the latest version of the document and make their decision: approve, comment, oppose or abstain. The final and formal approval decision can be obtained during a meeting or using electronic tools. The objective is to reach a unanimous agreement or, if not possible, at least consensus. If this cannot be achieved either, a vote is organized, while the sustained opposition from some of the committee members is recorded for later referral.

Once the standard has been formally approved, the draft is sent for final editing and quality check procedures. The final editor is a standardization professional who may be or not part of the SDO permanent staff (see Section 4.3.2). S/he ensures correct formulation and presentation of the text in accordance with the SDO rules, including linguistic quality. Only editorial corrections are made at this stage, in collaboration with the rapporteur and selected members of the drafting group. No technical updates can be made. Once this is achieved, the document is sent for publication as a standard.

PHASE 5: STANDARD MAINTENANCE TO UPDATE, EVOLVE OR WITHDRAW STANDARD CONTENT

Standards have to be kept updated in order to ensure that they remain relevant in the context of changing market or regulatory needs, and new scientific and technological developments. This is an important part of the viability of a working standard. Some SDOs trigger an automatic review of the validity of the standard after a pre-defined period, for instance every five or ten years. Corrections may be needed at different levels. Such corrections may include technical or editorial corrections of inconsistencies, issues in the concept or content of the standard, extension of the standard's domain of use, and evolution of the technology and/or of other standards in the committee or in peer technical bodies.

If the need for corrections or maintenance of the standard is identified during the review or because flaws are discovered, the whole process is restarted. The actions that may happen at this point are to publish an amendment, update the standard, create a new standard, withdraw an obsolete standard, or downgrade the current standard to an inactive status. If the standard has been referenced by another standard, the latter may be impacted and needs revision as well. If the standard is referenced in a regulatory text, the procedure takes into account the transition period required to amend the reference.

EXAMPLES

At CEN/CENELEC

The standardization process at CEN/CENELEC is a typical application of the top-down standards development approach described in the previous paragraphs, where a standard is written after its main concept has been accepted by the committee (see IETF example for a bottom-up approach). The different phases are identified as: a) proposal from relevant national members, technical bodies, the EC or the EFTA secretariat; b) drafting and consensus building; c) public enquiry from national members and partner organizations, followed by a formal vote; consideration of comments; d) approval and final ratification; and finally, f) publication of the standard and announcement for national endorsement (see Figure 4.2).

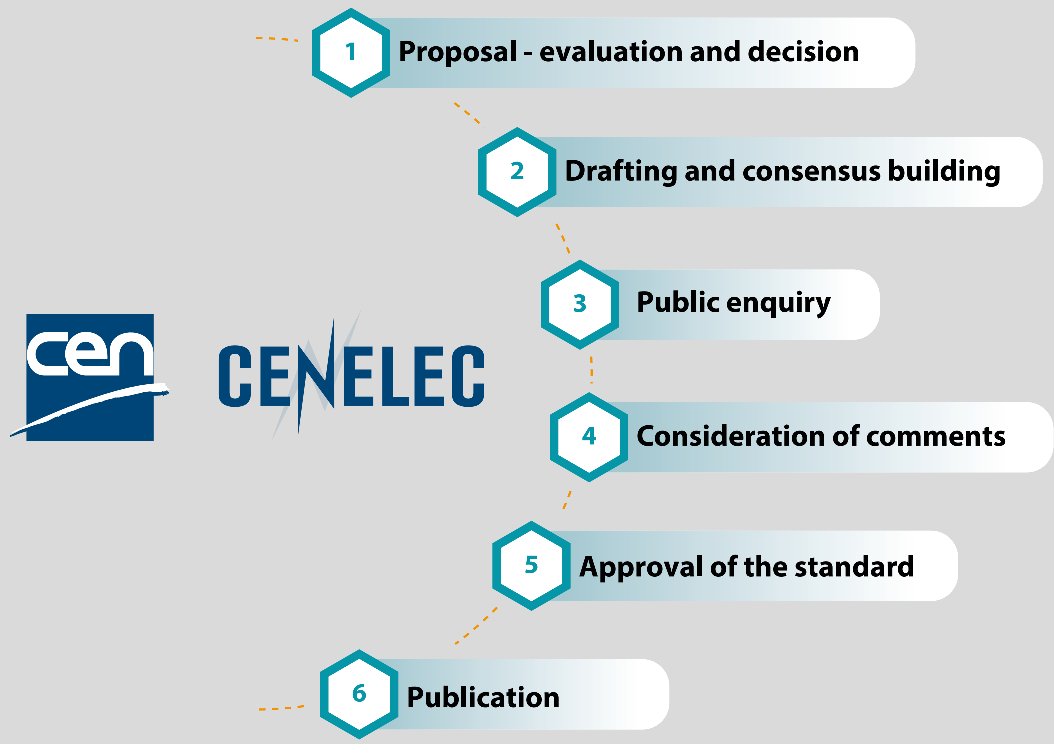

Figure 4.2: Standardization process at CEN/CENELEC (CEN 2016)

At ETSI

ETSI standards development process follows a top-down approach as well. The key phases of the ETSI standards development process are described in ETSI (2020) and are illustrated in Figure 4.3.

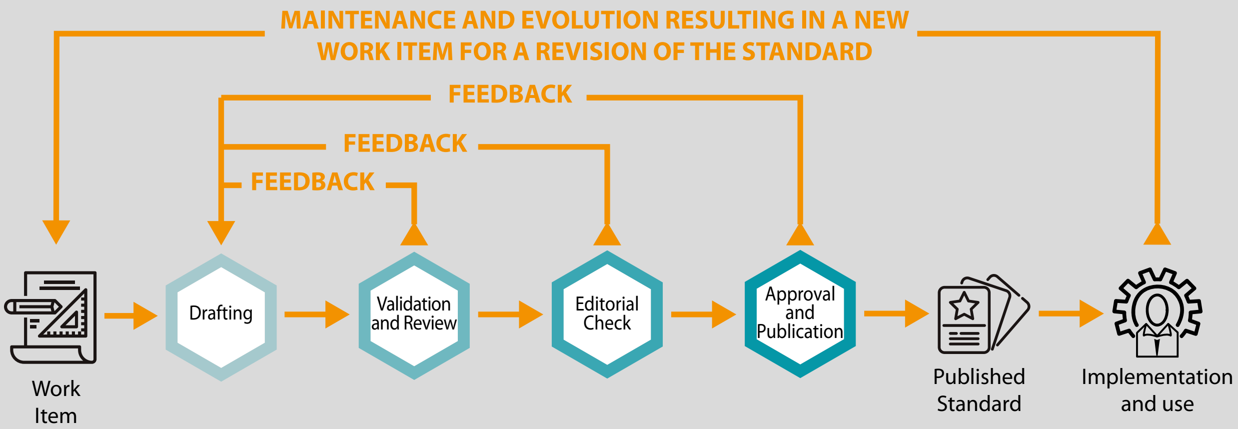

Figure 4.3: Standardization process at ETSI (ETSI 2020)

At IETF: getting an RFC published

The IETF adopts a bottom-up process (IETF 2012; IETF 2015) where new proposals are submitted as drafts by individual participants to a working group and are commented and revised until they become an Internet Draft (I-D). Draft proposals are usually reviewed by the WG before being accepted as a WG item, although the chairs have the final decision. When agreed after the "WG Last Call", the draft is sent to the Internet Engineering Steering Group (IESG) for further updates. It is later submitted for review to the entire IETF community, which triggers discussions on remaining issues and their solutions. After approval, it is published as an RFC by an organization named RFC Editor.

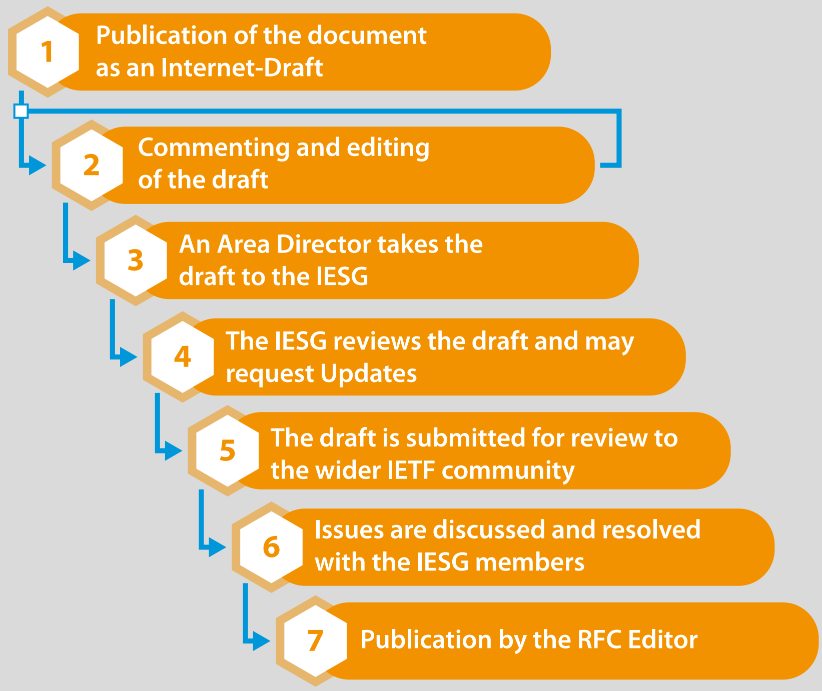

Figure 4.4: Standardization process at IETF

At HL7

HL7 (Health Level Seven) is an international community of experts in healthcare subject matter and information scientists collaborating to create standards for the exchange, management and integration of electronic healthcare information. It was established to develop a protocol for the exchange of healthcare information in clinical settings. HL7 adopts a different process based on the object-oriented development of information models. Figure 4.5 shows the diagram of the primary models and development steps specified by the HL7 Version 3 Message Development Framework (Beeler 1998).

The first model developed is the Use Case Model, which identifies actors and events as well as how they behave in specific use cases. It enables the identification of the key concepts, subject classes and relevant states, which are described in the information model. This is a critical element of the process, as it is based on a single reference model shared by all the HL7 standards. The information model is used to create an Interaction Model, which specifies the sub-systems that communicate using HL7 messages and how they interact. Finally, the Message Design Model specifies the message format needed to meet the interaction requirements. The development process is cyclical, as different models developed are refined and new features are introduced.

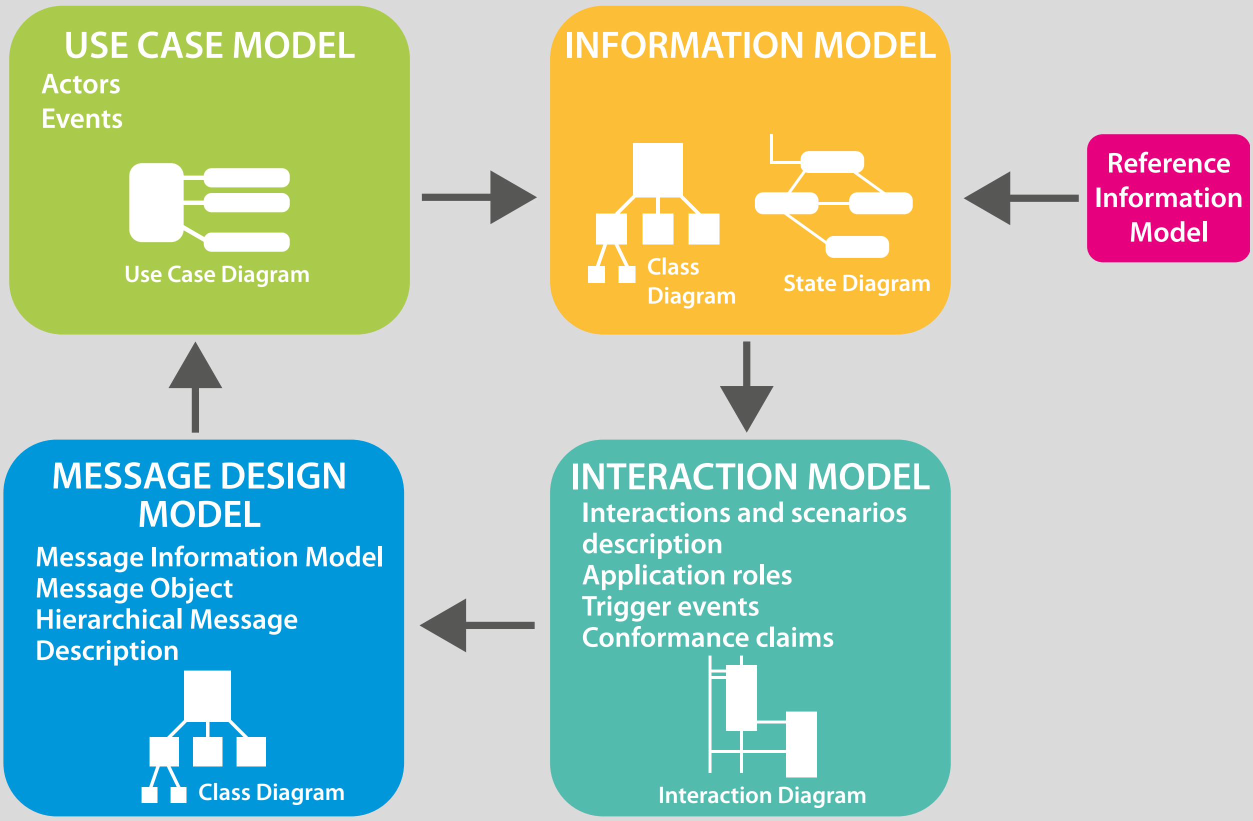

Figure 4.5: Standardization process based on models and an object-oriented methodology

The Integrative Design Model

The Integrative Design Model defines another standardization process based on a cycle of user-developer relations. The cycle is built on three phases: development, deployment and local enactment (or validation). Standardisation activities (design) occur continuously throughout all three phases (Millerand & Baker 2010). User involvement and user-developer relations step in throughout the whole standards development life cycle.

The model also highlights that user-developer resources — and negotiation processes for their allocation — are an enabling factor which is critical for successful collaborative work.

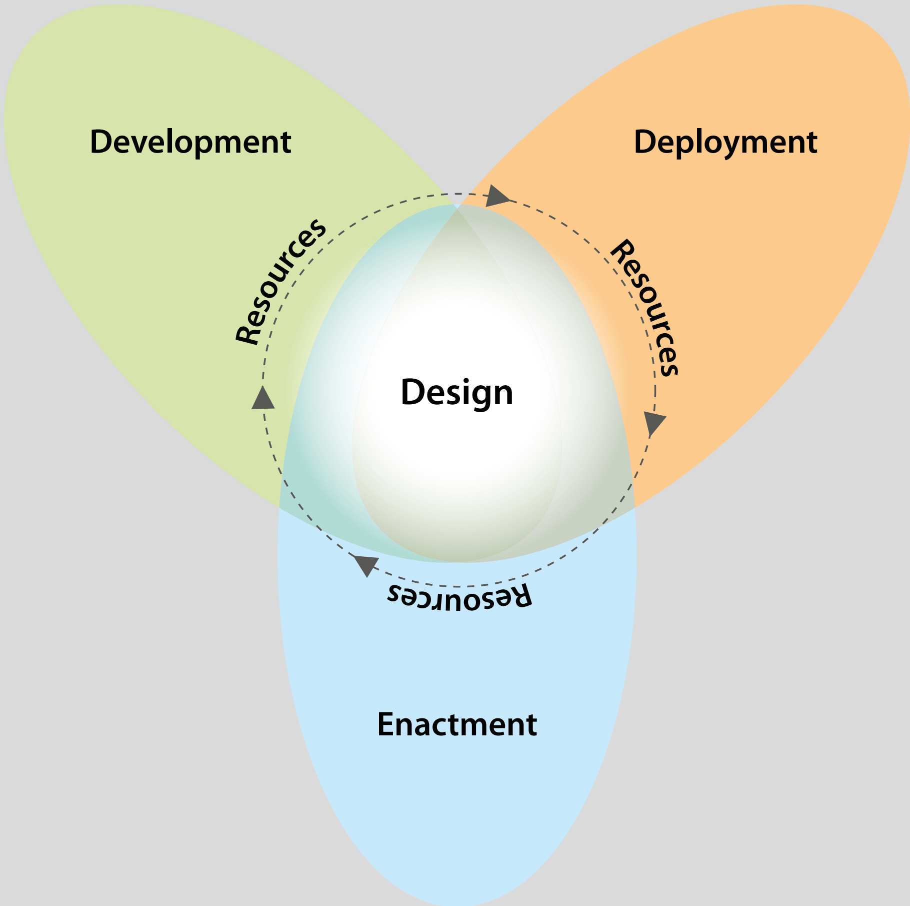

Figure 4.6: Standardization process based on the integrative design model

4.2.5 GOVERNANCE AND STRUCTURING OF AN SDO

This section explains how an SDO is typically organized, from the level of its governing entities down to its committees and sub-committees (sometimes called Working Groups, WGs). It includes a presentation of how stakeholders can become members of an SDO. In practice, each standardization organization (SDO, consortium or industry forum) has its own membership rules, works within its own environment, and defines its own set of governing policies.

The governance of an SDO is usually organized as a hierarchical structure, as shown in Figure 4.7. This ensures clear and assigned responsibilities for accountability within the system and for the consistency of the different activities. The figure and text below have been realized using terms inspired from some well-known SDOs to give meaningful examples, but equivalent terminology exists in all organizations. The different elements presented in the figure are specifically explained in the text below.

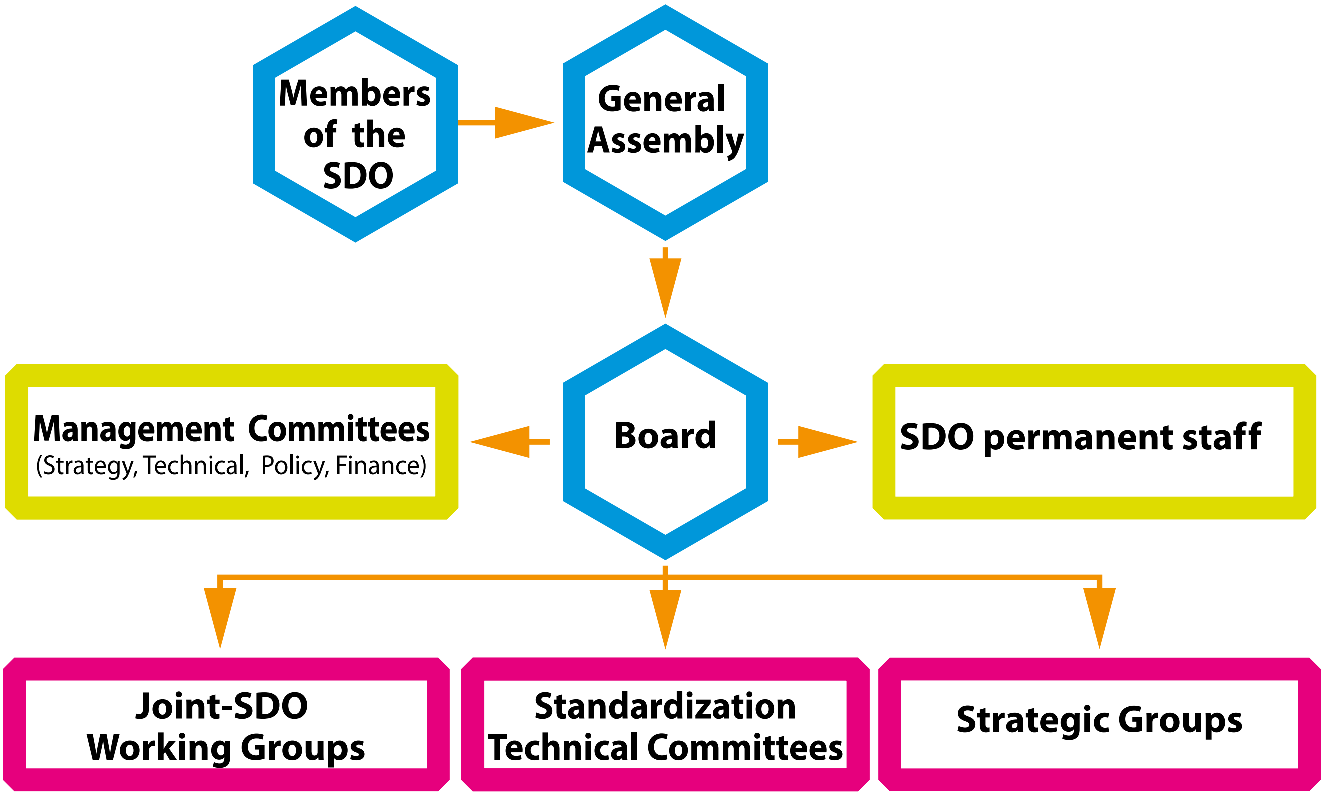

Figure 4.7: Typical organization of an SDO

The main component of any SDO is the association of its members. The types of members vary according to its internal structuring and recruiting rules. The members are represented by the General Assembly (GA), which meets periodically to make the governance decisions. The GA delegates the daily governance to a Board, which manages and coordinates the SDO's focus and strategy. The Board works in collaboration with Management Committees for finance, strategy, etc. It is supported by the SDO permanent staff. The staff enables the coordination of the committees as well as the technical and operational cooperation with other SDOs. It promotes the SDO's activities in the external environment and makes IT tools, platforms, and solutions available. It ensures that the established process and procedures are respected and that legal requirements are fulfilled.

The Board controls the standards development programme and supervises the implementation work of the different technical bodies such as committees, strategic groups or joint-SDO working groups (WG), which are the sub-entities that perform the standard preparation work (see Figure 4.12 and Section 4.3.2 for more details). The committees are usually quite autonomous. When needed, they create sub-committees to address specific tasks or topics. They are responsible for preparing and disseminating the draft documents for comment, voting, appeals and delivering the approved standardization documents. They maintain a work programme, which is reviewed periodically. When a sub-committee or WG inside a committee has fulfilled all its tasks, it may cease its operations. Committees and sub-committees are mainly responsible for the quality of their output. The SDO permanent staff provides administrative and logistical support to committees for standardization activities. It also provides capacity for the editing, printing, publishing, sale and distribution of standards.

FINANCING OF SDOs AND STANDARDIZATION

Financial options related to the development of standards, including both financial support for SDOs and the self-funded participation of the industry sector, are important to guarantee the impartiality of the standards development process. The financing of standardization activities should be capable of covering all activities related to the production of standardization deliverables for products and services. It may also cover the administrative expenses incurred by the preparation, monitoring, inspection, auditing and evaluation necessary for the purposes of implementation.

Funding may come from different sources, such as direct financing from governing authorities, membership fees, income from the sales of standards, and income from certification activities and their operations.

Below are a few examples of well-known SDOs' governance and structure.

EXAMPLES

ISO Structure and governance (ISO 2018; ISO 2019)

The ISO General Assembly is attended by ISO's Principal Officers and delegates nominated by the member bodies or national representatives. Correspondent members and subscriber members may attend as observers. The ISO Council governs the operations of ISO. The President's Committee is composed of the Principal Officers. It advises the Council on the implementation of its decisions. It also ensures effective communication and coordination among the ISO Council, the Technical Management Board and the two Council Standing Committees: the Strategy and Policy Committee (CSC/SPC) and the Committee on Finance (CSC/FIN). The Technical Management Board reports to the Council and is responsible for the overall management of the technical work. It decides on the establishment of technical committees and appoints their secretariats and Chairs.

The ISO Central Secretariat (ISO/CS) is responsible for supporting the governance and policy, advisory structure, and the operations of ISO. It assists the development process and publishes the standards.

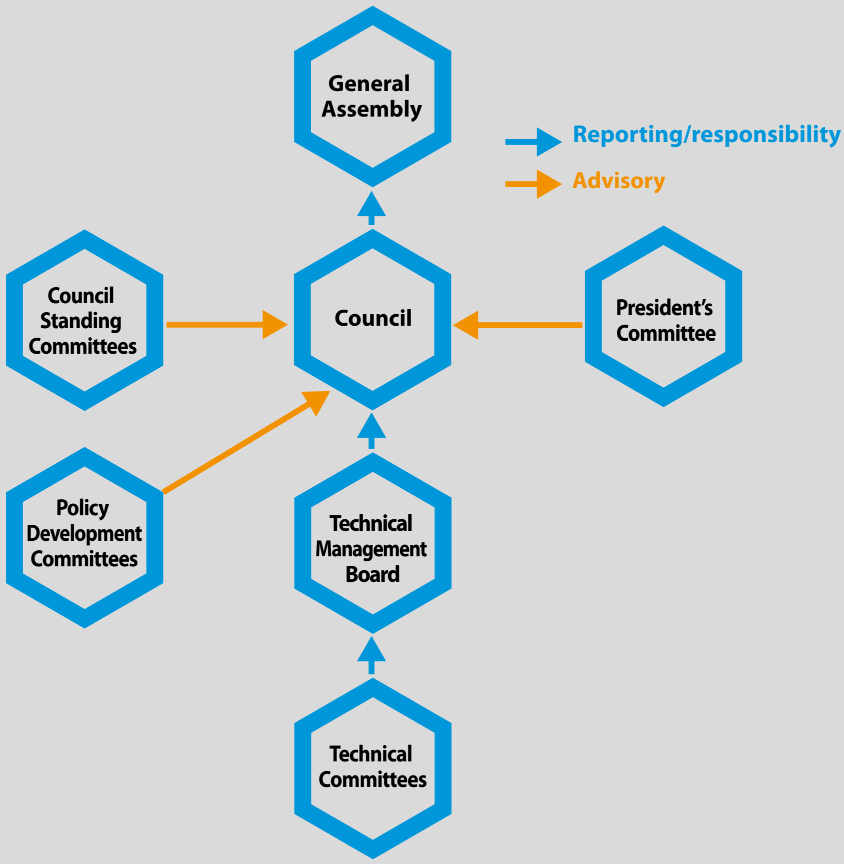

Figure 4.8: ISO governance structure (ISO 2018)

The IEC is a not-for-profit organization that develops International Standards and operates conformity assessment systems in the field of electrotechnology (IEC 2021). The IEC comprises one National Committee member per country, they each pay membership fees and in exchange can participate fully in IEC work. The IEC works closely with ISO and adopts a similar hierarchical governance.

CENELEC cooperation model (CEN 2015)

The case of the CEN and CENELEC ESOs shows how the two SDOs cooperate to avoid duplication of standards and the correlated issues (CEN 2015). CEN and CENELEC are two ESOs that complement each other. They have implemented a close cooperation agreement to clearly distribute the tasks between the two organizations: electrical and electronic engineering fields for CENELEC, all other subjects for CEN. In parallel, each organization remains independent, with its own governance structure built according to the hierarchical model. Figure 4.9 shows how the two structures collaborate for membership evaluation, with one common committee reporting to the governance structure of each of the SDOs.

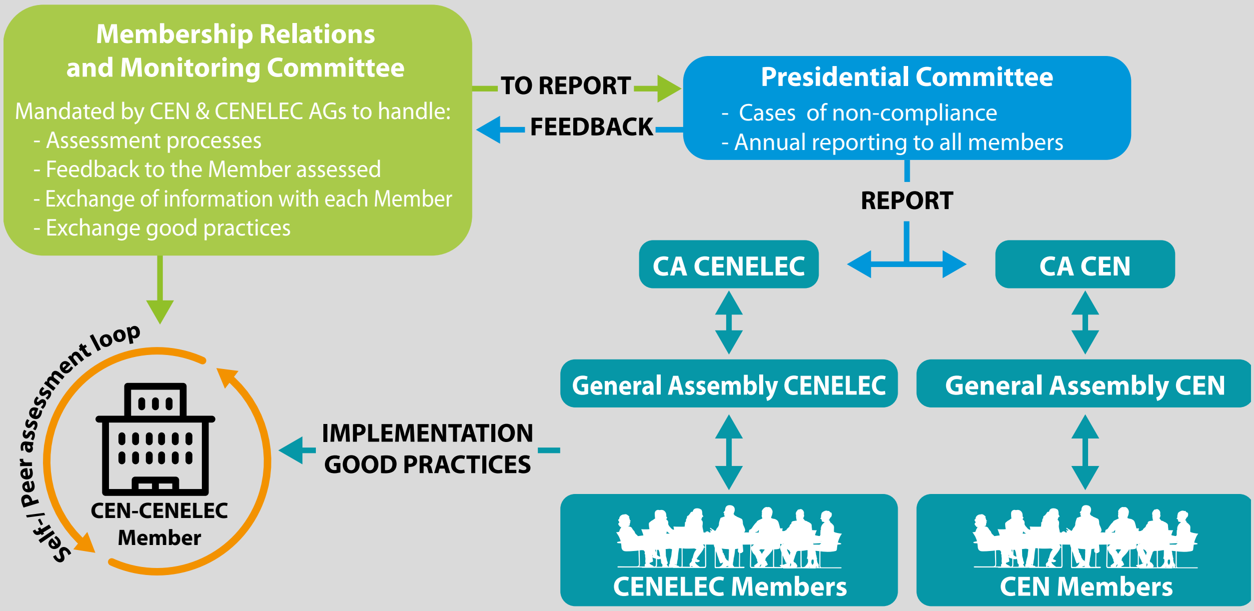

Figure 4.9: CEN-CENELEC governance and collaboration

IETF Structure and governance (IETF 2012)

The IETF is not a recognized SDO, although many specifications that are produced are used globally and even sometimes referenced by regulations. It is not a corporation and has no board of directors, no members, and no fees. The ISOC (Internet Society) is an international membership organization that fosters the expansion of the Internet. The ISOC supports the administrative staff directly employed by the IETF Administrative Support Activity (IASA). The IESG (Internet Engineering Steering Group) is responsible for the technical management of IETF activities and the Internet standards process. An important task of the IESG is to monitor the output of all the WGs to help prevent the specification of IETF protocols that are inconsistent with one another. The IAB (Internet Architecture Board) focuses on long-range planning and coordination among the various areas of IETF activity. It stays informed about important long-term issues in the Internet, through the IRSG (Internet Research Steering Group). The core registrar for the IETF's activities is the IANA (Internet Assigned Numbers Authority). The IETF depends on a volunteer group of active participants.

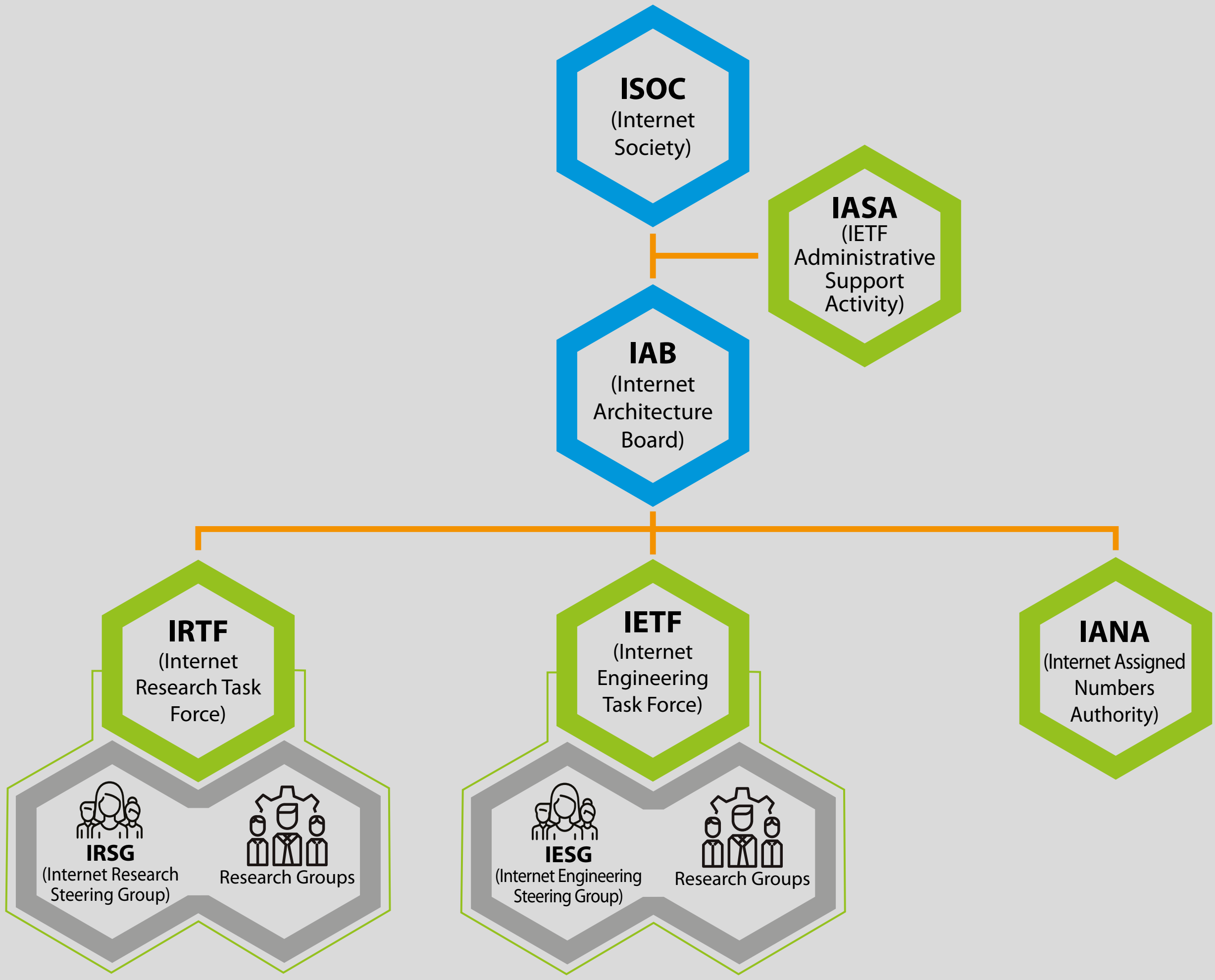

Figure 4.10: IETF governance structure

PARTICIPATING TO THE ACTIVITIES OF AN SDO

Let's now understand who are the members of an SDO. The entities participating to the activities of an SDO are all stakeholders interested in the development of standards, with an objective of inclusiveness, as shown in Figure 4.11. Standardization Professionals from interested parties can participate in the development of standards that affect them. The members of the standardization committees are a diverse selection of qualified professionals.

The typical stakeholders that send delegates to ICT standardization are corporate organizations such as industrial companies and Small Medium Enterprises (SME), ICT equipment manufacturers, service providers, and network operators. Another important group of contributors comes from research centres, academia and university staff, such as faculty and students from engineering, business, public policy, and law departments. Consultancy companies, testing laboratories and certification bodies are involved as well. Standards are also partly created by people who will use and be impacted by them: users, pressure groups, societal organizations (consumer, environmental and social), trade unions, civil society, and non-governmental organizations. Finally, administrations and public authorities, national organizations and government agencies are recommended to follow the standardization work. It allows them to stay informed of technological developments in the field and evolutions around the standards relevant for them, especially those referenced by regulations, or to give their input during the development of a standard to ensure its consistency with the regulatory objectives pursued.

Final users hardly ever participate in standards development, even if they are the consumers and beneficiaries of the products and processes standardized. In addition to financing issues, they suffer from a lack of technical background, as well as a lack of sufficient interest due to the complexity of the process. So, most often, they are represented by corporate users or societal organizations. This is also often the case for small companies (SMEs). SDOs now develop policies to promote their participation in standardization activities and dissemination of knowledge of standardization. Inter-disciplinary collaboration (vertical domains associated with IT specialists) is important at this time of digitalization of society and industry.

Depending on the SDO, becoming a member may be performed as national representations or through business interest. In the case of national representation, membership may also vary depending on the region. In Europe, membership in a national SDO requires the member to be European or to have a business interest or manufacturing presence in Europe. In India, it is based on the Public-Private Partnership model (PPP). In the US, membership is usually unrestricted and very often has an international scope.

Figure 4.11: Stakeholders involved in the activities of an SDO

Similar to the SDO governance, technical committees adopt a hierarchical structure when they are responsible for a wide work programme requiring expertise in different topics. A committee gathers the officials that were appointed by the committee, the member representatives, also called delegates, and potentially the representatives of external organizations, which have established a liaison with the committee because they share a similar interest in the topic.

Sufficiently large committees establish sub-committees (SC) or working groups (WG) to focus on specific tasks. WGs and SCs work to create, write, and make technical decisions in the process of developing standards. The number of WGs depends on the size of the committee. It often happens that small committees do not have sufficient matters to create WGs. In this case, the committee adopts a flat structure, which means that there is no sub-group created, and the entirety of the work is performed by the committee as a whole. Each committee or sub-group is managed by a chair elected by the group members or appointed by the SDO board. When established, the WG chair is responsible for reporting WG activity to the parent committee.

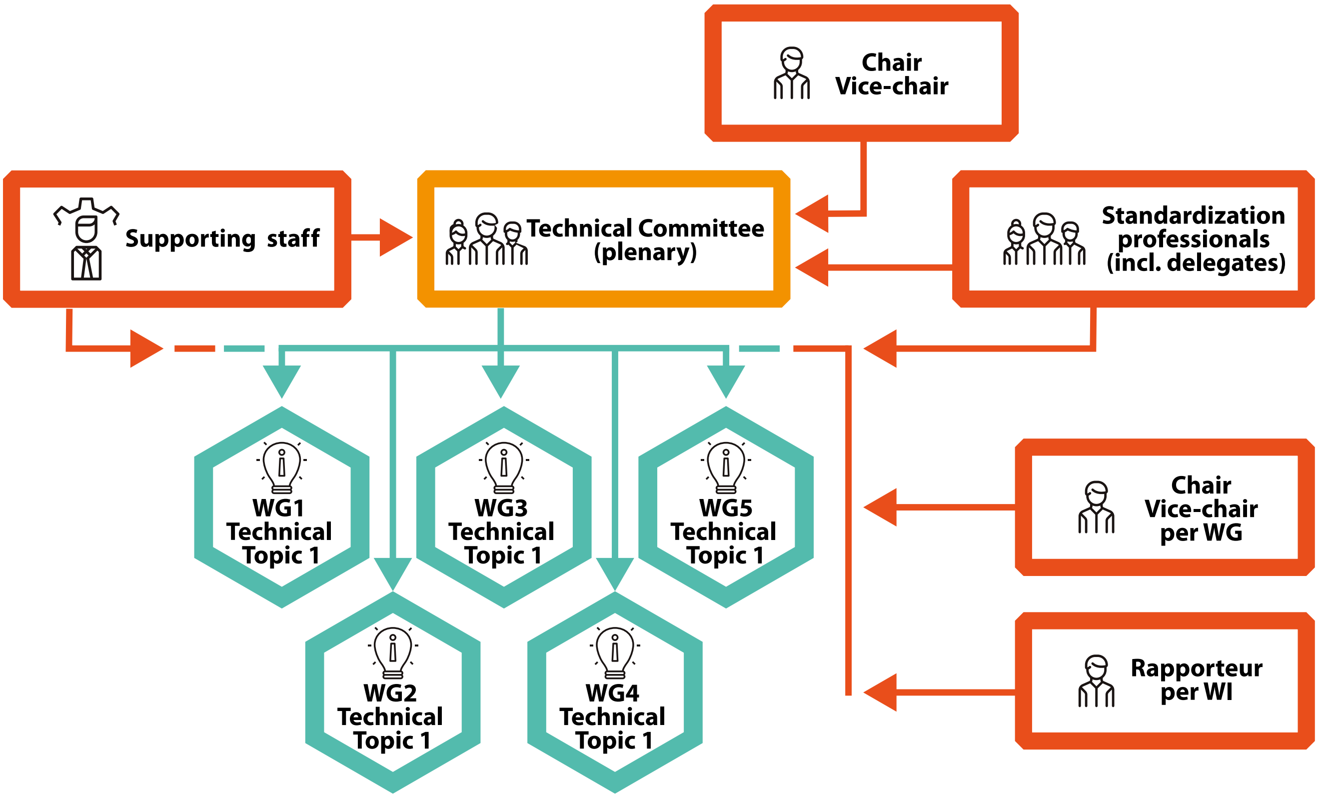

Figure 4.12: Typical organization of a Technical Committee

EXAMPLE

Organization of an IEC Committee (IEC 2021b)

The chair of an IEC technical committee (TC) is responsible for the overall management of that technical committee, including any sub-committees and working groups. The secretary is responsible for preparing the committee working documents and assisting with project management. In each working group, a convenor is named who is responsible for arranging and organizing the meetings and activities of the working group. For the development of each project, a project leader (the WG/PT convenor, a designated expert or, if appropriate, the secretary) is appointed by the TC or SC. In the case of a project team, the project leader reports to the parent committee. Experts in relevant technical fields for each committee are individuals appointed by their National Committees, via an Expert Management System, and designated to one or more working groups, maintenance teams or project teams. Experts take part in the drafting of working documents. They are capable of advising on technical issues in the field of the committee to which they have been appointed.

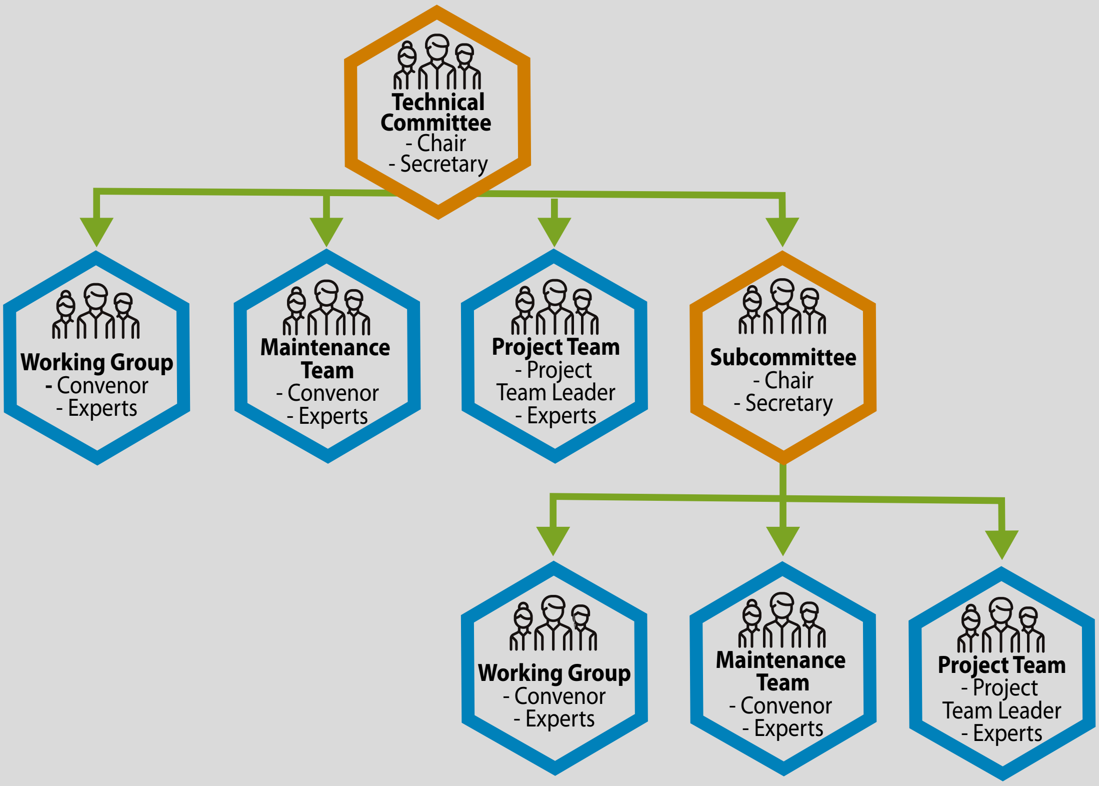

Figure 4.13: Typical organization of an IEC Technical Committee (IEC 2021b)

Another example of a committee structure can be found in ISO documentation (ISO 2018).

4.3 ROLES AND COMPETENCIES OF A STANDARDIZATION PROFESSIONAL

4.3.1 INTRODUCTION

This section explains the roles and competencies of standardization professionals and experts.

DEFINITION

In this book, we call a standardization professional (SP) a professional who works in a corporate organization, often in industry, national administration, research or an academic organization, consumer or professional association, or as a staff member of an SDO and is involved in standardization activities. S/he is often nominated by her/his organization (e.g. company, national committee) to represent it in an SDO committee. S/he does not need to have an engineering degree but does need to be knowledgeable about the technical matters to be standardized. S/he carries out, but also often coordinates, most of the tasks and activities to be performed in the standardization process with the help of the peer SP and her/his company's staff. We also call a standardization expert (SE) an SP who contributes to the content of standards. Indeed, there is no well-defined and agreed term for this position. Some actors also often name it "standardization engineer" or "standardization scientist".

Usually, the production of a standard involves different types of SPs and functions. These functions can be classified into two groups, depending on whether the SP is active: a) in the standardization committees or b) in the SDO's permanent staff. The SP's main responsibilities are described in the first part of this section. Two types of capabilities serve the SP in her/his daily activities, which are presented in the next part of this section. An SP has to demonstrate a mix of hard, or technical, skills and soft, or personal, competencies. Indeed, the set of capabilities actually required depend on the role of the SP in the standardization process. The SP should possess some of these technical and personal capabilities. The more of these capabilities the SP has, the more likely s/he is to succeed in the standardization activities. The very specific case of national representatives, which occur mainly in recognized SDOs, is presented in Section 4.4.5.

4.3.2 ROLES OF PROFESSIONALS INVOLVED IN THE STANDARDS DEVELOPMENT PROCESS

The professionals who participate in the standardization process perform different types of activities or roles. A committee or Working Group (WG) consists of SP appointed by their respective organizations. The SE have as main role to contribute to their subject matter expertise to the standard. SPs may also play specific roles by acting as chair (or vice-chair) of the committee, standards proposer, rapporteur, or liaison representative. The work of a committee also depends on the permanent staff of the SDO who take care of the administrative and technical structure of the SDO. Some professionals from the permanent staff, e.g. technical officers and final editors, may be directly involved in the development of the standards.

The tasks and responsibilities of the SP depend on the role they play in the committee.

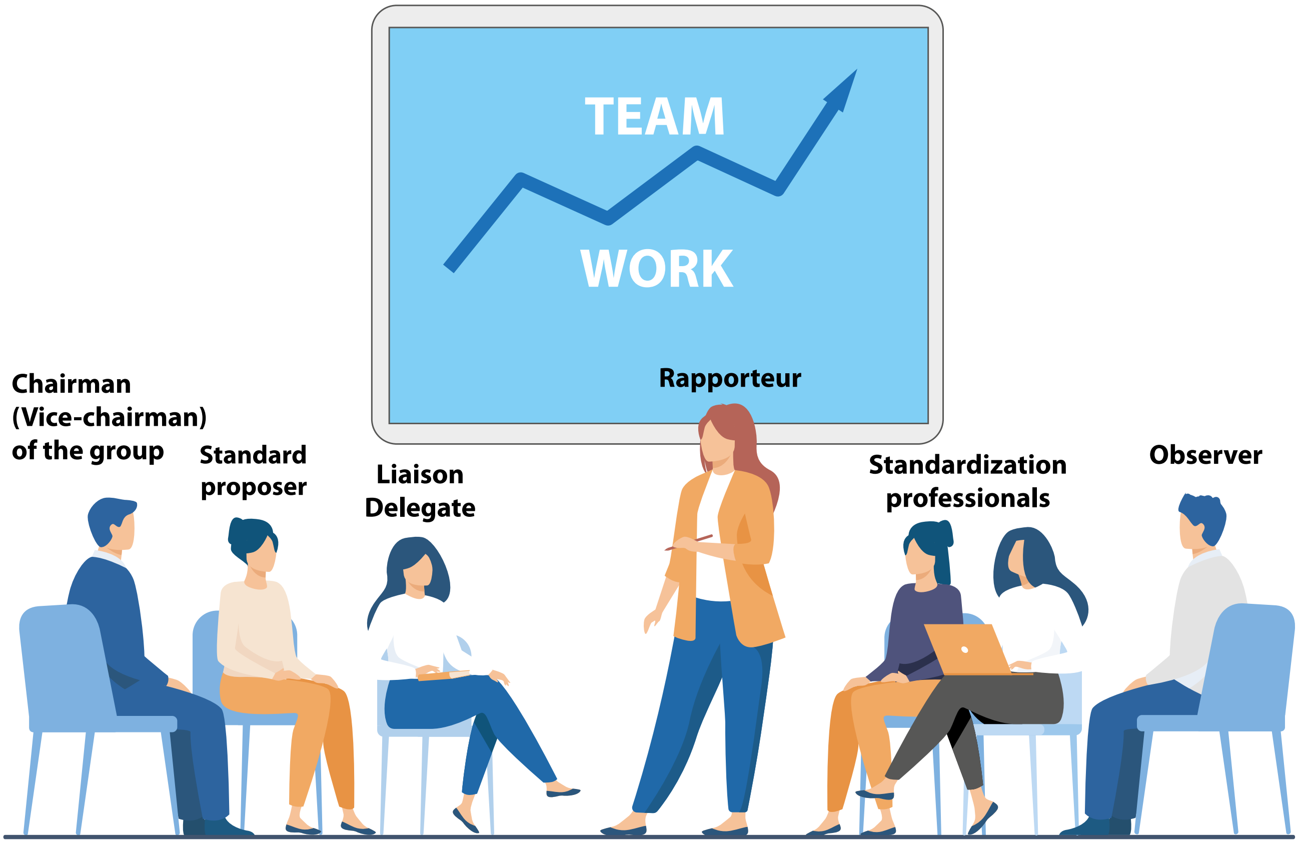

Figure 4.14: Roles of standardization experts involved in a technical committee

The chair and the vice-chair lead the activities of the SP in the committee. Together, they manage committee meetings by taking appropriate actions and decisions. They steer the discussions towards consensus, by trying to avoid sustained opposition to the content of the standard. They ensure that the work programme is completed in due time, that milestones are achieved, and that the strategy of the SDO is followed. They provide guidance to the SDO permanent staff and validate the start of the approval process for the draft standards, which are nearing publication. They are responsible for the technical and non-technical outputs from the committee, for example sending liaison statements to peer committees and keeping them informed of the ongoing activities. Sometimes, they represent the committee at external meetings to provide activity reports to the board or council, present the work programme in workshops, or give technical advice on topics addressed by the committee to other groups and committees.

The SE participates in committees, where they provide technical expertise, knowledge, and a dedicated interest in the technology that is being standardized. They write the standards by submitting contributions and change requests, while sticking to the planned schedule.

Figure 4.15: Informal collaboration structure of SP around the rapporteur

They are often informally divided by nature into two virtual circles around the rapporteur, as shown in Figure 4.15: the inner circle made of the SE who are active in the drafting of a standard and the wider sub-committee that conducts monitoring activities due to its interest in the development of the standard (de Vries 2006). Their level of activity may also change over time. The drafting work is made by and for three types of stakeholders: a) the standards developers, who write the specifications and ensure their quality; b) the implementers, who use the standard to develop their products and are dependent on its content; and c) the customers, who buy the derived products and expect them to work appropriately. The SE discuss the content of the drafts and make technical decisions. The SPs accept or reject the approval of final drafts when they are ready. They base their decisions on the position of the party they are representing. When attending as observers, the SPs follow the activities of the committee, but do not take an active part and are not allowed to participate in the decision-making process.

Among the SE, one or a group of standard proposers may detect a market need for a new standard, usually based on information received from her/his own company or organization. This is described as the inception phase in Section 4.2. Each standard development is organized as a specific short-term task with a clear scope and schedule. If interest can be raised for a specific development, a standard proposer submits a proposal to the members of the committee and triggers discussion about it during a committee meeting. S/he must receive support and interest from other members, as obtaining approval for the proposal is often a criterion to start a new standard in SDOs. This is described as the conception phase in Section 4.2.

The rapporteur takes responsibility for a standard under development. During the drafting phase, s/he serves as editor of the standardization document, following the guidance of the project team in accordance with the work specifications, guidelines, delivery schedule, and the SDO internal rules that steer its technical quality. S/he leads drafting and comment resolution meetings, collects contributions from other SE and organizations involved in the committee, and maintains the draft versions of the standard. S/he provides input for the assessment and resolution of comments during the approval process and, when necessary, updates the draft. S/he provides technical advice to the technical body on the subject/topic. Her/his objective is to obtain the largest consensus possible on the content of the standard and resolve potential conflicts during the standard approval phase. S/he delivers the final draft to the final editor and contributes to its editorial clean-up, which leads to the publication by the final editor. Additionally, s/he may serve as a focal point for technical questions related to the topic under standardization.

The liaison delegates serve as a link between two committees or WGs. They are appointed by both groups after a liaison agreement has been established. They attend WG meetings as observers. Their role is to report to each WG on the activities and standards of the other group. Documents may also be exchanged in the liaison process if deemed necessary by the liaison delegate.

EXAMPLE

Figure 4.16 gives an example of the roles held by standardization professionals in an ISO committee (ISO 2018). More specifically, it shows the roles of chairs, secretaries, committee members and liaison officers. ISO classifies its members into active participating members (P-members) and observers (O-members).

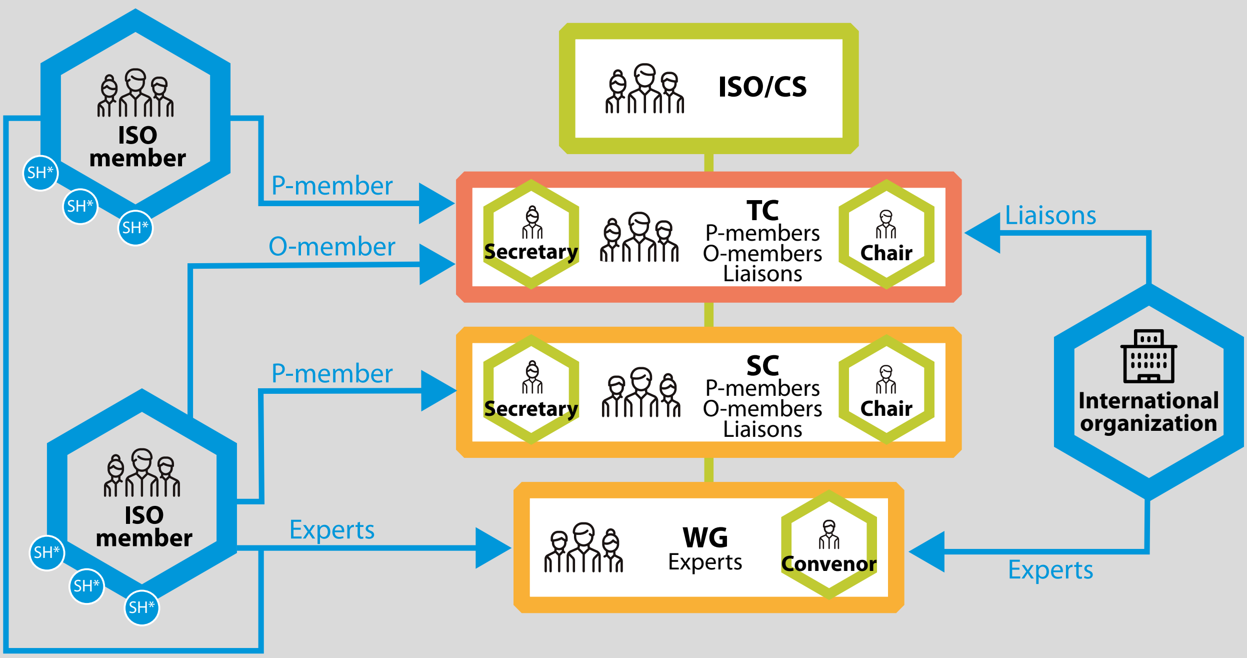

Figure 4.16: Example of the roles held by professionals involved in the standardization process in an ISO committee (ISO 2018)

The tasks and responsibilities of the permanent staff of the SDO are to facilitate the work of SP in the different committees. From a general perspective, SDO staff monitor the standardization work, from incubation to delivery to SDO members. They coordinate the standardization process and publish the standard after its approval and final editing. Where relevant, they provide guidance on the testability of the requirements and the production of test specifications. They promote the SDO's activities by participating in workshops, seminars and conferences, while maintaining collaboration relationships with external organizations, including governing authorities where applicable. They support the referencing of standards in regulations and the correct application of SDO governing policies. Within SDO staff, the technical officer and the final editor are more closely involved in standard production and publication.

More specifically, the technical officer provides administrative support to the committee chair, rapporteur and SP concerning the standardization technical process, its procedure, and the work programme content (maintenance phase) and schedule. S/he organizes the approval of the standard and enforces compliance with SDO standardization policies. S/he performs an ongoing check of the standard on matters such as editorial quality and project consistency during its drafting. S/he is aware of the technology being standardized but works in strict impartiality and has no decision-making rights.

Once the standard has been approved, the final editor performs a final check of the text, including editorial, language and terms validation and conformity with the SDO's drafting rules. If required, the text is corrected in collaboration with the authors/rapporteurs. The final editor is responsible for the official publication of the standard.

4.3.3 COMPETENCIES AND SKILLS OF A STANDARDIZATION PROFESSIONAL

To explore and promote standardization as an element of academic as well as vocational training, an EC report (Blind and Drechsler 2017) developed a comprehensive assessment of what market demand is needed. The approach was to identify "Job profiles" for which the present European employment market demands standardization-related competences. This section approaches the matter from the opposite direction of an ICT professional's perspective. It describes in a tabular format which skills and competencies the future SP should develop and demonstrate to be more comfortable and efficient to work in standardization activities. In this section, the approach is to call "skills" the technical knowledge (also often called hard skills) and "competencies" the soft capabilities of the standardization expert. The different skills and competencies are presented in the next two tables, which are organized according to the findings of the EC report (Blind and Drechsler 2017).

From a technical perspective, a standardization expert provides knowledge and technical expertise in the ICT technologies related to the topic to be standardized (e.g. radio systems, short-range communication protocols, etc.) and to the market. The reader is also referred to Table 26 "Overview about necessary knowledge and skills (companies' perspective)" of the EC report (Blind and Drechsler 2017) for a list of skills applicable to the job market perspective.

Table 4.1: Examples of Hard/Technical skills

GROUP OF SKILLS	SPECIFIC SKILLS
UNDERSTANDING AND MANAGEMENT OF TECHNICAL CONTENT (ICT OR DOMAIN-SPECIFIC)	knowledge in mathematics, sciences and engineering (technical team professionals)
	learning skills to follow the rapid evolution of the technology
	focus on architecture, influence the conception, development and implementation of technical innovations
	understand its impact, with professional and ethical responsibility
	understand and structure complex systems, respecting all sorts of technical and non- technical constraints
	manage the relationships and interactions between the designed systems
	problem-solving skills, identify and formulate technical problems, generalize across problems
	able to find innovative approaches to resolve an issue
	design and conduct experimental proofs of concept
	able to analyse and interpret the resulting data
UNDERSTANDING AND MANAGEMENT OF ICT STANDARDIZATION	experience in the field of ICT standardization
	understand the interactions and relationships between the different SDOs and their standards
	understand the international standardization strategy
	understand the process, rules and good practices applied by the SDO regarding the approval of a standard
	understand the context of committee activities
	able to identify gaps and visualize innovative trends and solutions
	able to keep up with the pace of the work and not slow down the progress of standardization work
UNDERSTANDING AND MANAGEMENT OF ORGANIZATION STRATEGY	experience of her/his organization and its technologies, products, business fields
	apply the organization’s process management
	work towards achieving strategic and operational goals by taking critical success factors into account
	understand customer/user needs
	able to commit to the organization goals

Technical skills are of high importance, but standardization also requires personal competencies often not taught in Higher Education curricula. A SP will be more efficient, if s/he possesses certain soft/personal competencies.

Table 4.2: Soft/Personal competencies

GROUP OF COMPETENCIES	SPECIFIC CAPABILITIES
COMMUNICATION COMPETENCES	communicate, listen, articulate and clearly express her/his views
	write clear, concise and user-friendly standards and technical documents
	raise issues on drafts and suggest changes
	design appropriate visual aids to prepare presentations and reports
	understand and work in the language used by the SDO, i.e. the national official languages for national bodies, which are often English, French or German in European and International organizations
SOCIAL COMPETENCES	cooperate easily with her/his organization teams and fellow SP
	persuade others with her/his own opinions and views, but at the same time, is able to listen to peer SP and respect others' opinions
	manage negotiation and cooperation, in other words how to influence people and organizations
	re-evaluate her/his own standpoint if required, in response to external conditions and internal needs
	leadership capabilities to steer the group towards a satisfactory technical solution and consensus
	inspire trust in her/his decisions
	coordinate the many skillsets in her/his business organization
PERSONAL COMPETENCES	willing to keep learning and transfer her/his skills to peer experts
	firm when necessary and confident in conflict management
	flexible and able to decide whether a compromise is acceptable
	remain open-minded when receiving criticism
	network and collaborate easily with peer delegates
METHODOLOGY COMPETENCES	read a large number of documents, essentially the committee documents and draft standards
	organize and prioritize her/his work, project management capabilities
	deliver tasks and documents within the planned deadlines
	take initiative and work autonomously
	use recent electronic and collaborative tools such as mailing lists, word processors, web and FTP services, wikis, phone and web conferencing
	willing to travel to attend meetings to discuss specific matters more directly with peer experts

4.4 PROFESSIONAL ACTIVITIES OF A STANDARDIZATION EXPERT

4.4.1 INTRODUCTION

Section 4.3 explained what are the different roles of the SPs in the standardization process, including those of the standardization experts (SE) who actually prepare and contribute to the draft standards. This section explains the main professional activities of a SE to meet her/his commitments. The expert's tasks are split over three types and periods of activities. The main activities related to standardization take place at the SDO premises when participating in standardization meetings, including interim periods such as networking breaks. Between meetings, the standardization expert writes or reviews standardization documents and collaborates with his colleagues inside her/his own company.

The section also explains how the standardization expert has an impact and collaborates inside her/his corporate organization. S/he interacts with her/his colleagues on company premises to discuss the standards with relevant technical teams, as well as with marketing and management teams. The activities to be performed by the standardization experts from other types of organizations, e.g. consulting, academia, etc. are usually more limited, yet still very similar to the activities performed by industry experts.

Finally, the last part of this section introduces the specific duties of the standardization expert when s/he represents her/his country's interests as a national delegate.

Figure 4.17: Standardization expert working at the SDO and then at the office

4.4.2 DURING COMMITTEE MEETINGS

Standardization meetings involve the appointed experts and, where relevant, external observers and liaison officers. This is the place where ideas are discussed and the committee can cooperate and progress on the work programme, which is carefully reviewed against deadlines. Before leaving for the meeting, the standardization expert has to read the draft documents and contributions in her/his area of expertise.

Most of the meeting is spent reviewing the status of the committee documents: draft standards, contributions, and proposals for new standards. When s/he attends standardization or committee meetings and attends as a committee member, the SE gets involved in the discussions, while bringing in her/his own knowledge on the topics discussed, and trying to find compromise solutions where necessary. If a draft standard is ready for approval, the SE participates in the decision-making process. If the SE has been selected as liaison officer between two committees or two SDOs, s/he presents the activities that are taking place at the other WGs/SDOs. Learning from these reports enables cooperation between SDOs and the coherence of the standardization as a whole for a given market.

As a rapporteur, the SE presents the latest version of the draft standard to her/his peers to enable the progress and tracking of the standard project. The rapporteur explains what changes have been made since the previous version. A few slides can be helpful to present a status report and the main ideas to be discussed.

Depending on the committee, meetings may include drafting sessions, where draft standards are written and updated, or only reviewing sessions, where changes and open issues are discussed. The rapporteur collects questions, while triggering discussions and trying to provide answers to clarify the topic. When competing ideas block the progression of the work, the SE suggests compromises to obtain consensus on a possible solution that will be recorded in a status report and integrated in the revision of the draft standard.

Figure 4.18: Rapporteur presenting the draft standard to the committee members

A large part of the work is also performed by people talking to one another during the standardization meetings or during breaks or networking time such as lunches and dinners. Unofficial get-together sessions can also be organized on the fly between peers to progress on a draft, try to resolve blocking issues or build compromises. Working in smaller groups allows faster progress on issues. Networking time is also a good opportunity for the SE to raise awareness about new concepts or processes that may need to be standardized and to find supporters for triggering a new standard. However, official decisions are always taken and reported during the formal meetings.

4.4.3 INTERVAL BETWEEN STANDARDIZATION MEETINGS

When in her/his office, the SE has more time to reflect on the content of the standards and think about new proposals.

When acting as rapporteur, s/he updates the current draft to prepare the next version of the standard. S/he organizes drafting (or working) meetings where peer SE discuss more specifically the content of the draft. Working and editing meetings can be organized as virtual interim meetings, where interested parties discuss the document in more detail. Virtual meetings may allow some SEs to get involved in the process without having to support the cost of in-person meetings. Drafting sessions can be launched as an email discussion or as an informal phone call among a few SEs as well.

As the main editor of a draft standard, the rapporteur collects contributions and uses the interim meetings to obtain input from other SE, and to trigger and distribute writing tasks among the SEs who are willing to contribute. At her/his office, the rapporteur has more resources to investigate the IPRs related to the topic under standardization owned by her/his company and ensure that the SDO rules on the matter are respected. Furthermore, before the next WG meeting, the rapporteur prepares a status report of the draft standard under her/his responsibility.

If s/he is not the rapporteur, the SE prepares contributions and change requests to draft standards. S/he uses traditional and digital working tools: word processor, Instant Messaging (IM), phone, collaborative/shared workspace and conference tools to get access to committee documents or attend interim drafting meetings. The SE can also use this period to implement the standard in collaboration with in-house technical teams and prepare a report of inconsistencies that were found during implementation and testing. An important part of the work related to standardization activities is done before each committee meeting. The SE reads the latest versions of the drafts and other documents that have been submitted, while making sure that s/he understands their contents. The SE also tries to identify open points and issues to be discussed at the meeting.

4.4.4 ACTIVITY INSIDE HER/HIS OWN ORGANIZATION

Developing and standardizing a new or an evolved technology requires the collaborative work of technical, marketing and managerial teams, when available in a corporation. Back at the office, the SE is asked to interact with these teams. The following paragraphs describe a generic view of these activities and responsibilities, even though they are often only partially relevant for specific SE.

Inside the company, the SE exchanges with the relevant technical teams and reports on recent standardization activities and trends, especially with respect to the latest standards approved, and the liaison reports from other SDOs. Usually, s/he provides it as a complete meeting report. The report also gives feedback on the interest received from other delegates about the proposed developments and about copyright or IPR issues that may be associated with the information included in the report.

When collaborating with the development teams, the SE explains the standards and how to use them to accelerate the product-to-market process, ensuring that changes to protocols, entities or interfaces decided by the committee on proposed technologies are retro-fitted into local prototypes and products. In this way, the SE tries to prevent the technical teams from creating proprietary solutions when not appropriate. If needed, the terminology for a common understanding of the in-house projects is defined or updated according to the terms used in the standards.

The SE leads or participates in the activity of building prototypes that demonstrate the effectiveness of the new technologies to be standardized and the correctness of the standards requirements. S/he also show her/his colleagues how existing systems must be tweaked. Implementing standards is an important activity that helps potential problems be discovered early.

The SE should also use part of the office time to extend her/his knowledge about existing and future technologies, concepts and developments, such as ongoing research or expertise handled by other organizations. Contributing to knowledge management and dissemination is an essential activity to achieve innovation in the company.

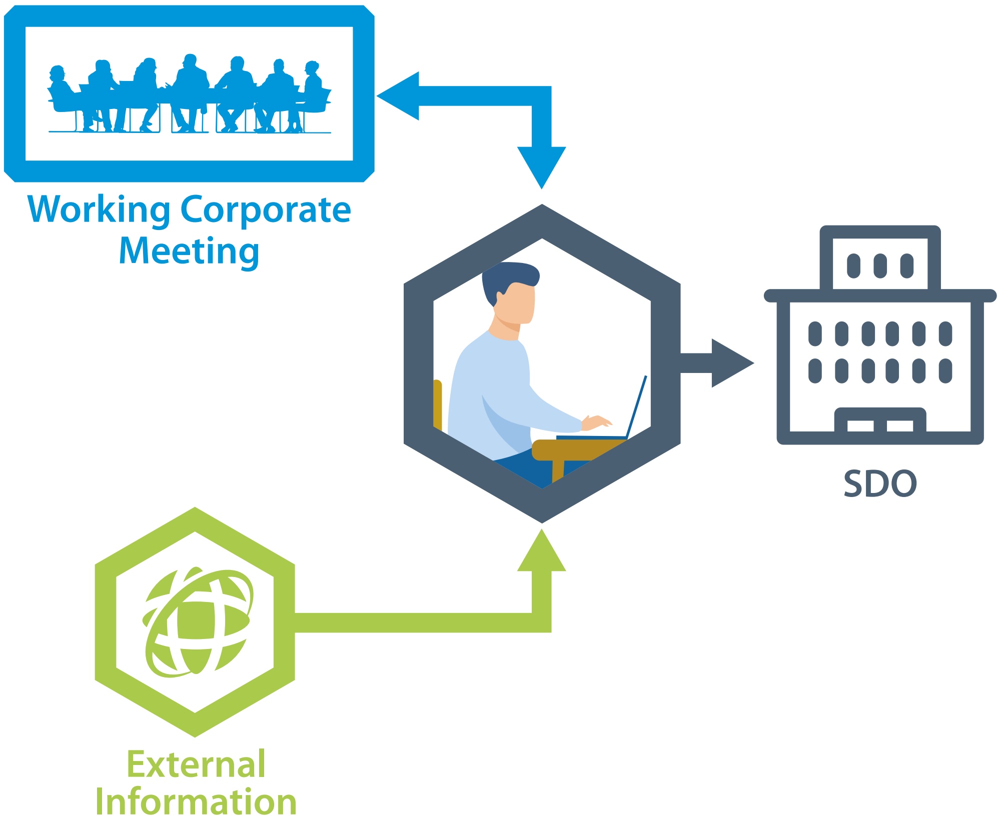

Figure 4.19: Standardization expert involved in the technical activities of a corporate company

Inside the company, the SE interacts with the marketing team. As the ICT market is evolving at a fast pace, it is important to evaluate how companies can enhance existing products or introduce new ones. Standards play an important role here, as they can foster the company's innovation or, on the contrary, exclude it from the market (see Chapter 5).

The SE must know and understand the development strategy of the business units and trigger the relevant standards that will facilitate and establish this strategy. S/he acts as a link between the marketing teams and the standardization committee: the SE understands and analyses with the marketing team the customer's feedback and expectations and identifies potential standardization gaps. S/he can envision the new standards required to address these customers' needs and prepares proposals to start their development. Thus, it is crucial for corporate organizations to actively participate in the standardization process related to their market in parallel to their marketing activities.

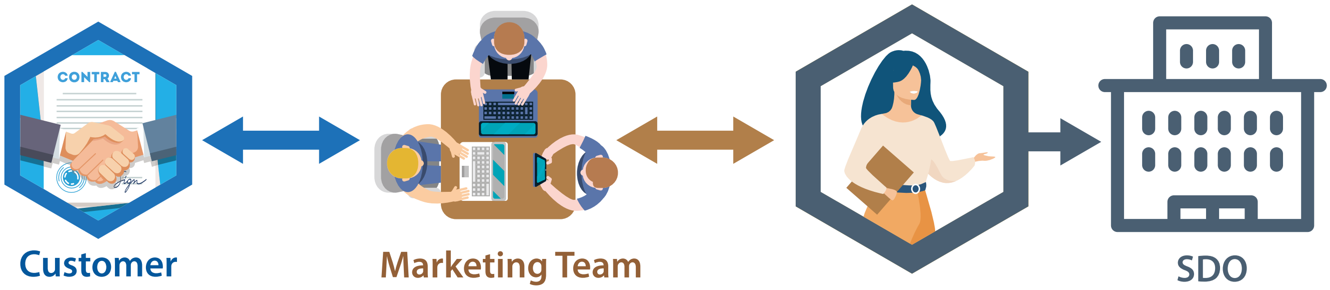

Figure 4.20: Standardization expert involved in the marketing activities of the company

Inside the company, the SE interacts with the management team, together with the technical and marketing teams, to understand the company's strategy with respect to its standards portfolio. It is important for ICT companies to maintain internal coordination efforts and develop and implement a standardization strategy. Except for very large companies, the high number of consortia and SDOs working in the various ICT domains would need too many resources if the SE had to attend all of their meetings. A careful selection needs to be made by ICT manufacturers and vendors to ensure that the company is active at the relevant standardization groups that can help develop its own innovation.

The SE together with the management team should analyse which SDO memberships are of interest and how to organize and maintain the contributions to the company's standard portfolio. It may happen that the motives for this strategy are not technical, thus requiring the understanding and support from the SE.

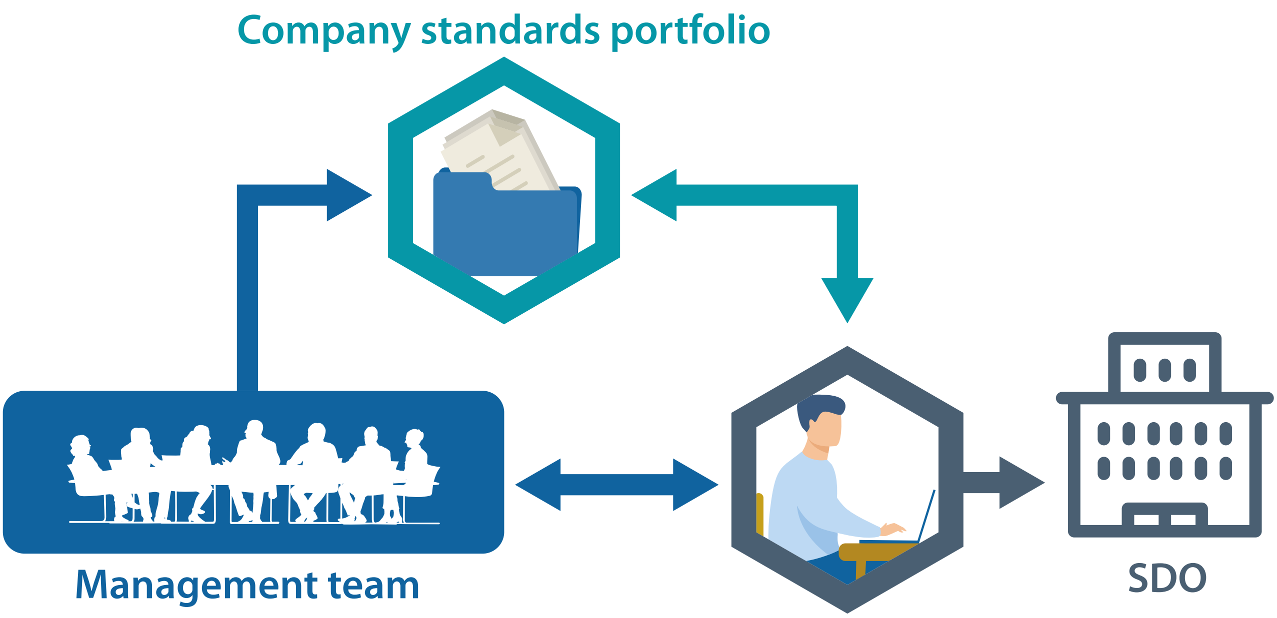

Figure 4.21: Standardization expert involved in the management activities of the company

4.4.5 FURTHER ACTIVITIES AS A NATIONAL DELEGATE

As has been stated before, SDO governance defines rules for membership application. SEs can contribute to the SDO in their own capacity, for example at the IETF and IEEE, even if their activities are actually funded by their own organizations. In other cases, membership is obtained directly by the SE's organization and s/he is appointed by the organization to represent its interests. This is the case at ETSI and ANSI for example. It applies as well in the majority of industrial alliances. SDO governance may require members to be representatives of an organization recognized as the official standards body in the country, or as an organization competent in the domain of the SDO in its country. CEN, CENELEC, ITU, IEC and ISO belong to this category of SDOs. In this case, a national delegate is an individual expert appointed by the national member of an SDO in which membership is attributed on a per-country basis.

An SE who serves as a national delegate represents the point of view of her/his country in the standardization group as a member of her/his National Standards Body (NSB). The SE has the following additional duties in the NSB. S/he triggers at national level the adoption, promotion, and dissemination of international or regional (for example, European) standards, and the withdrawal of conflicting national standards. S/he organizes meetings of national stakeholders, for instance in national technical mirror committees, to collect their positions, thus acting as a facilitator and coordinator of local involvement in the standards by all types of national players: providers, academia, societal stakeholders, and national authorities.

4.5 CASE STUDY: THE 3RD GENERATION PARTNERSHIP PROJECT (3GPP)

This case study analyses the standardization process at the 3GPP (see also a short description of this project in Chapters 2 and 3). Even if it is not an SDO per se, 3GPP is one of the most important standardization projects ever in the ICT domain, as it enabled the development of mobile telephony and connectivity. Since the specifications it prepares are set to be adopted by recognized SDOs, it follows a very well-defined process. This section presents the 3GPP process as an example of application of the concepts introduced in Chapter 4.

The 3rd Generation Partnership Project (3GPP) covers cellular telecommunications network technologies. 3GPP began its activities in 1998, when several ICT SDOs, including ETSI and ARIB, came together to develop a single standard for "third-generation" mobile telecommunications, in application of the fundamental coherence principle (3GPP 1998). A similar organization, the 3GPP2, was founded in parallel in the US to develop a competitive technology. Mobile standards converged to 3GPP when the evolution of the market required an evolution for faster mobile networks, as well as a global solution. It was named the Long-Term Evolution (LTE) cellular system, also known as 4G.

The 3GPP brings together telecommunications SDOs, known as "Organizational Partners" (3GPP 1998). An Organizational Partner is an SDO that has signed the Partnership Project Agreement and that has an officially recognized status with the capability and authority to publish standards nationally or regionally. The 3GPP makes all approved versions of its specifications available as soon as possible after their approval on a file server (3GPP 2017), while the Organizational Partners transpose and adopt the relevant Technical Specifications (TS) as their own deliverables through their normal procedures.

The 3GPP committee structure is made up of three Technical Specification Groups (TSGs), each addressing a sub-system of the cellular communications system (System and Services, Radio, Core Network and Terminals). Each TSG has established working groups (WGs) to address dedicated working topics. Meetings are organized periodically to measure the progress of the work and make decisions. They take place in locations where partners are active, which means that delegates travel all over the world. The size of the different WGs vary, and sometimes prevent the discussion of technical topics during meetings. The large number of documents to be reviewed requires that delegates discuss the technical issues during offline discussions, leaving room only for approval or rejection of decisions during the meetings. 3GPP specifications and studies are contribution-driven by member companies in WGs and at the Technical Specification Group level.

3GPP follows a three-stage methodology mapped to ITU Recommendation I.130 (ITU-T 1988). Its own methodology is defined in 3GPP TR 21.900 (3GPP 2017), clause 4.1.

At 3GPP, stage 1 (Service requirements) consists in describing the aim of the system, as seen by those for which the service is provided, such as end users, operators, service providers, etc. Stage 2 is an overall architectural description of the structuring of the network functions to map service requirements onto network capabilities. In stage 3, the technical implementation covers the detailed interface specifications that are needed to support the services defined in stage 1. The architectural implications and requirements need to be identified at a very early stage in the process.

In 3GPP, it is often seen as appropriate to start with the production of a feasibility report prior to the specification work. A feasibility study may include commercial as well as technical considerations. This analysis leads to the definition of candidate new features to be added to the existing system. This is sometimes referred to as "stage 0". Furthermore, it is also appropriate to follow stage 3 with the production of test and certification specifications. This is referred to as stage 4.

Delegates thus represent a very wide variety of technical skills, from system architects to specialists such as radio or security experts. Decisions may have a very real impact on the market, given the wide range of interests involved in standardization work; as such, delegates often have well-proven negotiation competencies.

The progress of 3GPP standards is measured by the milestones set when the standardisation project, called Work Item (WI) is approved (3GPP 2017). The progress of the entire collection of 3GPP specifications is also measured as a whole, in releases. When a release is completed, new features are "functionality frozen" and are ready for implementation. 3GPP works on a number of releases in parallel, starting future work well in advance of the completion of the current release.

4.6 SUMMARY

Standards production is a complex process that involves technical resources, but also a strong operational structure and interactions between standardization professionals. Standards enabling competition and fair trade implies compliance with a set of fundamental principles, based on the WTO's TBT report (WTO 2000). A systematic development methodology for ICT systems as well as for individual standards has been described. SDOs and technical committees generally adopt a hierarchical structure for their governance which is also depicted in its general structure.

The roles of standardization professionals in SDOs and standardization committees are described, even if they may vary slightly among the different SDOs. Technical skills are of prime importance, but a variety of soft/personal competencies, often not taught during Higher Education, help make a successful standardization professional.

Finally, the chapter addresses the fact that standardization experts work for the production of standards not only during committee meetings, but also during breaks and between meetings when they are back in their companies. They also closely collaborate with their colleagues from development, marketing and management teams from their own organizations.

4.7 QUIZ

1 - WHICH PRINCIPLE BELOW IS NOT A FUNDAMENTAL PRINCIPLE OF THE STANDARDIZATION PROCESS?

(See Section 4.2 for hints)

a) *Openness*

b) *Abstraction*

c) *Transparency*

d) *Impartiality*

2 - WHAT IS THE NAME OF THE DEVELOPMENT PHASE TAKING PLACE AFTER CONCEPTION?

(See Section 4.2 for hints)

a) *Inception*

b) *Approval*

c) *Drafting*

d) *Maintenance*

3 - WHICH GROUP OF STAKEHOLDERS DOES NOT TAKE PART IN THE PROCESS OF DEVELOPING ICT STANDARDS?

(See Section 4.2 for hints)

a) *Biology faculty members*

b) *Consulting company staff*

c) *Certification laboratory engineers*

d) *Users involved in environmental organizations*

4 - DOES THE CHAIRMAN OF A TECHNICAL COMMITTEE BELONG TO THE SECRETARIAT OF THE SDO?

(See Section 4.3 for hints)

a) *Yes*

b) *No*

5 - WHICH OF THE FOLLOWING IS NOT A SOFT COMPETENCY?

(See Section 4.3 for hints)

a) *Active listening*

b) *Fluency in English*

c) *Problem solving*

d) *Word processing proficiency*

6 - IS MATHEMATICAL EXPERTISE REQUIRED TO BECOME A STANDARDIZATION EXPERT?

(See Section 4.3 for hints)

a) *Yes*

b) *No*

7 - THE STANDARDIZATION EXPERT ESTABLISHES THE COMPANY STANDARDS STRATEGY WITH:

(See Section 4.4 for hints)

a) *the marketing team*

b) *management*

c) *the product development leader*

8 - THE STANDARDIZATION PROFESSIONAL HAS TO TRAVEL TO ATTEND ALL HIS MEETINGS

(See Section 4.4 for hints)

a) *True*

b) *False*

9 - NATIONAL DELEGATES REPRESENT THE POINTS OF VIEW OF THEIR COUNTRIES AS PRESCRIBED BY:

(See Section 4.4 for hints)

a) *the company CEO*

b) *the network operators*

c) *the national administration*

d) *the national mirror committee*

10 - THE IETF RFC PROCESS IS:

(See Section 4.2 for hints)

a) *a top-down process*

b) *a bottom-up process*

c) *an integrative design process*

d) *a standardization technical committee*

11 - A TYPICAL SDO IS GOVERNED ACCORDING TO:

(See Section 4.2 for hints)

a) *a cooperation agreement*

b) *a hierarchical structure*

c) *a horizontal model*

12 - 3GPP IS:

(See Section 4.5 for hints)

a) *a national SDO*

b) *a European SDO*

c) *an international SDO*

d) *a partnership project among telecommunications SDOs*

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4.8 GLOSSARY

- Committee: Set of standardization professionals working on a specific topic. It can be a full organization (for example CEN) or a sub-group of an organization.
- Conformance test suites: test suites that verify that a product or function complies with a standard.
- Drafting: Iterative writing of the different clauses of a draft standard.
- Rapporteur: Standardization professional responsible for the drafting of a specific standard.
- Semantic: Set of data helping to define the meaning of a concept.
- Specification: Set of rules that competing products must comply with to enable their interoperability.
- Standardization expert: Standardization professional who contributes to the content of standards.
- Standardization professional: Professional working in a corporate organization, often industry, in a national organization, in a research or academic organization, or in a consumer or professional association and involved in standardization.
- Standardization stakeholder: Party impacted by the publication of standards, e.g., corporate organizations, user groups, or national authorities.
- Standards strategy: Plan of action designed to obtain a standards portfolio in line with corporate business goals.
- Technical body: Generic term designating technical committees, sub-committees and working groups that bring together delegates to produce standards.

4.9 LIST OF ABBREVIATIONS

- 3GPP: Third Generation Partnership Project
- ANSI: American National Standards Institute
- ARIB: Association of Radio Industries and Businesses
- CA: Conseil d'Administration (Administrative Board)
- CEN: Comité Européen de Normalisation (European Committee for Standardization)
- CENELEC: European Committee for Electrotechnical Standardization
- CSC: Council Standing Committee
- EC: European Commission
- ETFA: European Free Trade Association
- ESO: European Standards Organization
- ETSI: European Telecommunication Standards Institute
- FIN: Finance
- FTC: Federal Trade Commission
- FTP: File Transfer Protocol
- GA: General Assembly
- GSC: Global Standards Collaboration
- HL7: Health Level Seven
- HTML: HyperText Markup Language
- IAB: Internet Architecture Board
- IANA: Internet Assigned Numbers Authority
- IASA: IETF Administrative Support Activity
- ICT: Information and Communication Technology
- I-D: Internet-Draft
- IEC: International Electrotechnical Commission
- IEEE: Institute of Electrical and Electronics Engineers
- IESG: Internet Engineering Steering Group
- IETF: Internet Engineering Task Force
- IM: Instant Messaging
- WTO: World Trade Organization
- IPR: Intellectual Property Rights
- IRTF: Internet Research Task Force
- IRSG: Internet Research Steering Group
- ISDN: Integrated Services Digital Network
- ISO: International Organization for Standardization
- ISOC: Internet Society
- ISO/CS: ISO Central Secretariat
- IT: Information Technology
- ITU: International Telecommunication Union
- ITU-T: International Telecommunication Union—Telecommunication Sector
- LTE: Long Term Evolution
- MoU: Memorandum of Understanding
- NIST: National Institute of Standards and Technology
- NSB: National Standards Body
- PPP: Public-Private Partnership
- PT: Project Team
- RFC: Request for Comments
- SC: Sub-Committee
- SDO: Standards Development Organization
- SE: Standardization Expert
- SME: Small or Medium-sized Enterprise
- SP: Standardization Professional
- SPC: Strategy and Policy Committee
- TBT: Technical Barriers to Trade
- TC: Technical Committee
- TCP/IP: Transmission Control Protocol/ Internet Protocol
- TR: Technical Report
- TS: Technical Specification
- TSG: Technical Specification Group
- US: United States
- W3C: World Wide Web Consortium
- WG: Working Group
- WI: Work Item

4.10 REFERENCES

- 3GPP (1998). Third Generation Partnership Project (3GPP) Partnership Project Description, December 1998.
http://www.3gpp.org/ftp/Inbox/2008_web_files/3GPP.ppt. Accessed 12 August 2021.
- 3GPP (2017). Technical Specification Group working methods. Technical Report. TR 21.900.
- Abernathy, W. J., & Utterback, J. M. (1978). Patterns of innovation in technology. Technology Review, 80(7), 1–47.
- ANSI (2020). ANSI Essential Requirements: Due process requirements for American National Standards, January 2020.
- Beeler GW. (1998). HL7 version 3--An object-oriented methodology for collaborative standards development. International Journal of Medical Informatics. February 1998 (pp. 151–161).
- Blind, K. & Drechsler, S. (2017). European market needs for education in standardisation/ standardisation- related competence. Luxembourg: Publications Office
- Breitenberg, M. (2009). The ABC's of Standards Activities. Report NISTIR 7614, NIST, August 2009. https://www.nist.gov/document/abcs-standards-activities. Accessed 12 August 2021.
- Carnahan L. & Phelps A. (2018). ABC's of Conformity Assessment. NIST Special Publication 2000-01, NIST.
https://doi.org/10.6028/NIST.SP.2000-01. Accessed 12 August 2021.
- CEN-CENELEC (2009). CEN and CENELEC cooperation agreement. Guide 3, Edition 2, August 2009.
- CEN-CENELEC (2015). Guide on the organisational structure and processes for the assessment of the membership criteria of CEN and CENELEC. Guide 22, Edition 3, February 2015.
- CEN-CENELEC (2015). Guide on membership criteria of CEN and CENELEC. Guide 20, Edition 4, February 2015.
- CEN-CENELEC (2016) Development Shaping European Standards. StandarDays, September 2016.
- CEN-CENELEC (2017). Roles and Responsibilities for National Standards Bodies, the National Electrotechnical Committees, and CEN-CENELEC Management Centre. CEN/AG Resolution 21/2017 and CLC/AG Decision AG 57/11, Edition 1, July 2017.
- CEN-CENELEC (2017). Common Rules for Standardisation Work. Internal Regulations, Part 2, February 2017.
- Cerri, D., & Fuggetta, A. (2007). Open standards, open formats, and open source. Journal of systems and software, 80(11), 1930–1937.
- Delaney, H. & van de Zande, R. (2000). A Guide to EU Standards and Conformity Assessment. Global Standards Program, Office of Standards Services, National Institute of Standards and Technology, Order No. 43 NANB912297, May 2000.
- Direction Generale des Entreprises (2016). Guide relatif au bon usage de la normalisation dans la réglementation. June 2016.
https://www.entreprises.gouv.fr/fr/normes/bon-usage-des-normes-dans-la-reglementation-2016. Accessed 12 August 2021.

- European Commission. (2013). COM(2013) 455 final. Against lock-in: building open ICT systems by making better use of standards in public procurement. http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=2327. Accessed 12 August 2021
- Egyedi, T. M. & Sherif, M. H. (2010). Standards Dynamics through an Innovation Lens: Next-Generation Ethernet Networks. IEEE Communications Magazine, vol. 48, no. 10, October 2010 (pp. 166-171).
- ETSI (2020). A Guide to Writing World Class Standards. https://www.etsi.org/images/files/Brochures/AGuideToWritingWorldClassStandards.pdf. Accessed 12 August 2021.
- ETSI (2020). ETSI Standards Making Process, https://portal.etsi.org/Resources/Standards-Making-Process/Process. Accessed 12 August 2021.
- European Union (2012). Regulation (EU) No 1025/2012 of the European Parliament and of the council of October 25, 2012 on European standardisation, November 2012. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R1025&from=EN. Accessed 12 August 2021.
- Galasso, G. (2015). Open standards for ICT procurement: evidences from the ICT Procurement survey. PWC, June 12, 2015. https://joinup.ec.europa.eu/sites/default/files/inline-files/07_Giovanna_Galasso.pdf. Accessed 12 August 2021.
- R. Hovey and S. Bradner (1996). The Organisations Involved in the IETF Standards Process. IETF, RFC 2028, October 1996.
- IEC (2021). IEC Management structure. https://www.iec.ch/management-structure. Accessed 12 August 2021.
- IEC (2021). Roles & responsibilities: TC/SC officers, WG/MT convenors and PT leaders and experts. https://www.iec.ch/standards-development/roles-and-responsibilities. Accessed 12 August 2021.
- IEEE (2017) Develop Standards - How are standards made? https://standards.ieee.org/develop/process.html. Accessed 12 August 2021.
- IETF (2012). The Tao of IETF: A Novice's Guide to the Internet Engineering Task Force. https://www.ietf.org/tao.html. Accessed 12 August 2021.
- Government of India (2016). Discussion paper on standard essential patents and their availability on FRAND terms. Department of Industrial Policy and Promotion, Ministry of Commerce & Industry, March 2016.
- IETF (2015). The IETF Process: an Informal Guide. https://www.ietf.org/about/process-docs.html. Accessed 12 August 2021.
- ISO/IEC (1994). Code of good practice for standardization, Guide 59:1994. Revised by ISO/IEC Guide 59:2019.
- ISO (2016). How to write standards - Tips for standards writers. Brochure, November 2016.
- ISO (2018). My ISO job - What delegates and experts need to know. 2016 edition, http://www.iso.org/iso/my_iso_job.pdf. Accessed 12 August 2021.
- ISO (2019). ISO in brief. https://www.iso.org/publication/PUB100007.html. Accessed 12 August 2021.

- ISO (2021). Developing standards. https://www.iso.org/developing-standards.html. Accessed 12 August 2021.
- ITU-T (1988). Method for the characterisation of telecommunication services supported by an ISDN and network capabilities of an ISDN. Recommendation I.130, November 1988.
- ITU-T (2017). Global Standards Collaboration web site, http://www.itu.int/en/ITU-T/gsc/Pages/default.aspx. Accessed 12 August 2021.
- Jakobs, K. (2008). ICT standardisation - coordinating the diversity. In 2008 First ITU-T Kaleidoscope Academic Conference - Innovations in NGN: Future Network and Services (pp. 119–126). doi:10.1109/ KINGN.2008.4542257.
- JISC (2013). Japan's Standardization Policy 2013. Japanese Industrial Standards Committee Secretariat, Ministry of Economy, Trade and Industry, March 2013.
- Krassadaki, E. (2017). Engineering students' skills: What – Why and How? Events on Education (EoE), organized by BEST, Technical University of Crete, Chania, Crete. July 2017.
- Maxwell, E. (2006). Open Standards, Open Source, and Open Innovation: Harnessing the Benefits of Openness. Innovations: Technology, Governance, Globalization, 1(3), 119–176. doi:10.1162/ itgg.2006.1.3.119.
- Millerand, F. & Baker, K.S. (2010). Who are the users? Who are the developers? Webs of users and developers in the development process of a technical standard. Information Systems Journal, 2010 (pp. 137-161).
- OpenStand (2012). Core Principles for open standards development. 29 August 2012. https://open-stand.org/about-us/principles/. Accessed 12 August 2021.
- SPF (Service public fédéral) Economie belge (2017). Référer aux normes dans les réglementations techniques - Découvrez les avantages! May 2017. https://economie.fgov.be/fr/file/696/download?token=GYWOJc5N. Accessed 12 August 2021.
- Tarafdar, M. & Gordon, S. R. (2007). Understanding the Influence of Information Systems Competencies on Process Innovation: A Resource-Based View. Journal of Strategic Information Systems, Volume 16, Issue 4, December 2007 (pp. 353-392).
- de Vries, H. (2006). Advanced Topics in Information Technology Standards and Standardisation Research, Volume 1. Hershey, PA: IGI Global. IT Standards Typology (pp. 1-26). DOI: 10.4018/978-1-59140-938-0. ch001.
- Wiley - IEEE (2017). What makes a successful engineer? Wiley and IEEE survey results. March 2017.
- World Trade Organisation (1995). Committee on Technical Barriers to Trade - Decisions and recommendations adopted by the committee since 1 January 1995. G/TBT/1, Doc #95-1682, June 22, 1995.
- World Trade Organisation (2000). Committee on Technical Barriers to Trade - Second Triennial Review of the Operation and Implementation of the Agreement on Technical Barriers to Trade. G/TBT/9 Annex 4, Doc #00-4811, November 13, 2000.
- World Trade Organisation (2011). Committee on Technical Barriers to Trade - Principles of international standard setting, communication from India. G/TBT/W/345, November 10, 2011.
- World Trade Organisation (2019). Committee on Technical Barriers to Trade - Decisions and recommendations adopted by the committee since 1 January 1995. G/TBT/1/Rev.14, Doc #19-6148, September 24, 2019.

5 STANDARDIZATION AND INNOVATION

LEARNING OBJECTIVES

- Students should get insights into the interdependencies between innovation and standards/standardization.
- Students should understand how standardization and innovation can benefit each other.
- Students will learn some concrete examples how standardization and standards can boost innovation.
- Students will understand the relationships between research and standardization, in particular, how standards and standardization can be leveraged during the research process.
- Students will learn about the ways, in which standards and standardization can support innovation, both as a process and as an output in the sense of a technology or product, in particular, so-called innovation potential in standardization:
  - Efficient target-oriented innovation
  - Differentiation
  - Exceeding the requirements of standards
  - Business model innovation
  - Innovation impulses
  - Innovation communication
  - Absorption of innovation

5.1 INTRODUCTION

Companies need to be innovative in order to succeed in a competitive marketplace. They must constantly look for new opportunities for innovation. So far, scientific literature has identified many innovation drivers, such as innovation teams (e.g., interdisciplinary teams that work on a specific innovation task), innovation cultures (e.g., company cultures that do not sanction failures and encourage learning), creative techniques (e.g., bionics and the Theory of inventive Problem Solving TRIZ), and innovation competitions (also called innovation contests that give individuals from inside or outside the organization the opportunity to work on an innovative task). Whereas innovation is understood as the result of a creative process, standards represent stability and identification of common grounds. Both aspects are — at first glance — not necessarily conducive to innovation. In the literature, innovation has been mainly described as the output of out-of-the-box thinking, which is rather unstructured and out of the ordinary. As such, the interactions between innovation and standards are not self-explanatory.

Standards are the result of many years of knowledge gathering and structuring. They are an important source of codified knowledge. There is no doubt that knowledge is crucial to innovation. Still many companies do not clearly see the relationships between standards/standardization and innovation.

More in-depth consideration can reveal how the innovation and standardization processes are, or at least should be, strictly and effectively correlated. First, because standards are a relevant source of codified knowledge, we could think of them as a "box" that delimits and consolidates state-of-the-art approaches. In this respect, innovative companies (to really be innovative) need to understand the contents of the box and then deliberately place themselves outside of this box. Second, modern standards are flexible by design and do not have to be solution oriented, i.e., describing a particular solution to be implemented. Standards can be requirements oriented, thus only defining a general framework, but still allowing freedom of design and interpretation. Third, current research, especially in the industry related to information and communications technology, suggests that standardization plays a crucial role in the emergence and diffusion of innovation.

The next Section, 5.2, provides a general overview of the interdependencies among standards, standardization and innovation. Section 5.3 deals with the relationship between standardization and research, as research can be a fundamental component in the quest for innovation. We will demonstrate how standards and standardization can support the research process in an effective way. Section 5.4 shows that formal standardization can be a useful aid to innovation and introduces the so-called innovation potential in standardization. It shows how companies can leverage SDO standards and formal standardization to promote innovation. Finally, Section 5.5 summarizes the contents of the chapter as well as the key insights.

5.2 INTERDEPENDENCIES BETWEEN STANDARDIZATION AND INNOVATION

5.2.1 INTRODUCTION TO INNOVATION

Schumpeter (1934) defines innovation as the "commercialization of all new combinations based upon the application of new materials and components, the introduction of new processes, the opening of new markets, and/or the introduction of new organizational forms". Innovation is more than an invention and includes the commercialization of inventions. Furthermore, innovation is not limited to final products sold to customers. It can happen at different levels, such as materials, processes, services, components, markets and/or organizational forms.

The degree of novelty is an important property of innovation. Innovation can be incremental or radical. Incremental innovation (also called evolutionary) happens when the performance of an existing technology improves in small steps over time. In the case where the technology achieves a jump in the level of performance over a very short time, the innovation is referred to as radical or revolutionary. For example, the improvement of processing power and storage capacity of computers is an incremental innovation. Whereas the underlying computer technology does not change, the ability to integrate a larger number of transistors on a same or even smaller surface improves. Radical innovation happens when this underlying technology changes, e.g., because of a transition to quantum computers.

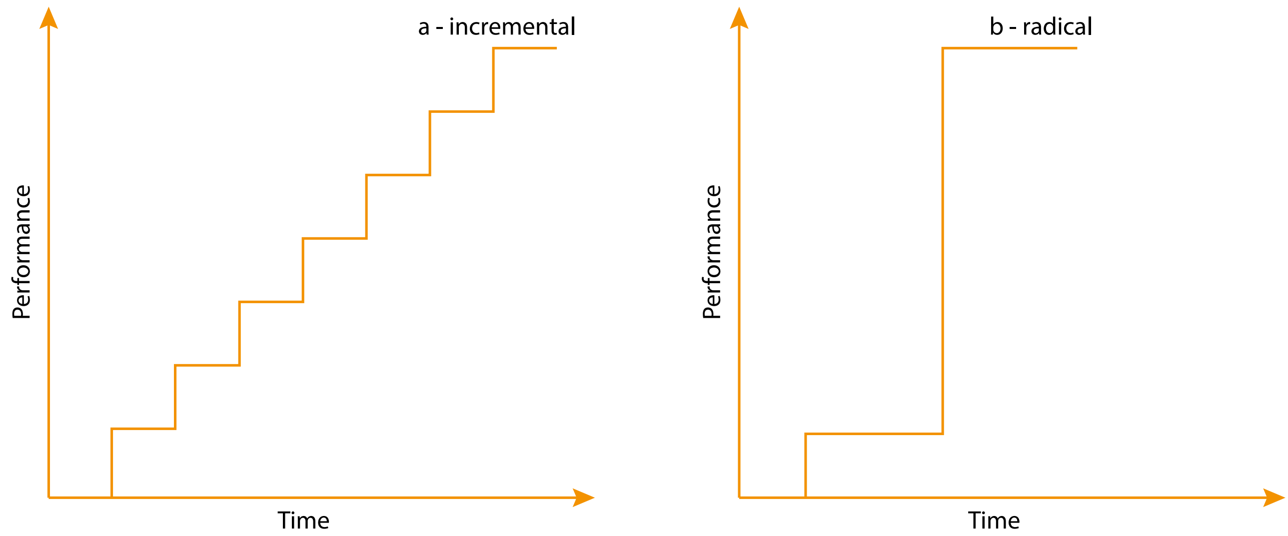


Figure 5.1: Incremental and radical innovation

According to OECD (2005), depending on the novelty level, there are four types of innovation: New-To-the-Firm (NTF), New-To-the-Market (NTM), New-To-the World (NTW) and disruptive innovation. NTF innovation means that a company adopts an existing technology. For instance, an Enterprise Resource Planning (ERP) system that has been used for a while by other companies in a specific industry but is implemented for the first time by a particular company is an NTF innovation. Hence, even the adoption of an existing technology can be understood as innovation activity, as long as it is new to the firm. The ability of companies to accommodate existing innovation is called absorption capacity (Cohen and Levinthal 1990). Absorption capacity is understood as a firm's “ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, p. 128). NTM innovation happens when known technologies are being transferred into a new market, whereas NTW innovation is ground-breaking and did not exist before. Disruptive innovation represents a new technology that originally (Bower and Christensen 1996) offers less performance than an established technology with respect to a relevant feature, around which competition has taken place thus far (e.g., the storage capacity of a floppy disc). Because the performance of the new technology regarding that feature is lower, it can be produced at lower costs than the established technology. As such, it addresses potential users that are currently non-consumers since they did not buy the established technology before. Also, because of its lower performance, the companies producing the established technology do not react to the new technology, since they do not perceive its potential danger. Over time, the new technology can improve, in such a way that its performance becomes attractive to consumers, whose needs are overshot by the established technology. Now, because the new technology is lower priced and its performance is sufficiently good, consumers in the established market start switching to the new technology, leaving the companies offering the established technology in trouble. This new technology is called disruptive because it disrupts the established market and can lead to the bankruptcy of companies that have served that market.

5.2.2 STANDARDS AS AN ENABLER FOR INNOVATION-DRIVEN GROWTH

"Standardization and innovation give the impression of being opposites" (Perera 2010). Standardization appears to be about keeping things the same, whereas innovation is about the development of new things. According to David (1995) however, standards are "the flux between freedom and order".

There are many reasons why standards may have been perceived as innovation hampering. For instance, standards contain solutions that are intended to be used repeatedly. This is often perceived as "static", as the solution seems to be "frozen" for a certain time. Only when there is the necessity to develop another solution does the old one make place for the new one (de Vries 2006b).

But standards can also promote innovation. They allow critical mass to be achieved. Standards also ensure compatibility, allowing for innovation to take place based on other innovations. Furthermore, standards support the diffusion of research results, thus allowing for technology transfer (de Vries 2006b). We reuse an example from Chapter 2 about the QWERTY and DVORAK keyboards for another purpose, in particular to illustrate the idea how a standard can support and hamper innovation at the same time.

EXAMPLE

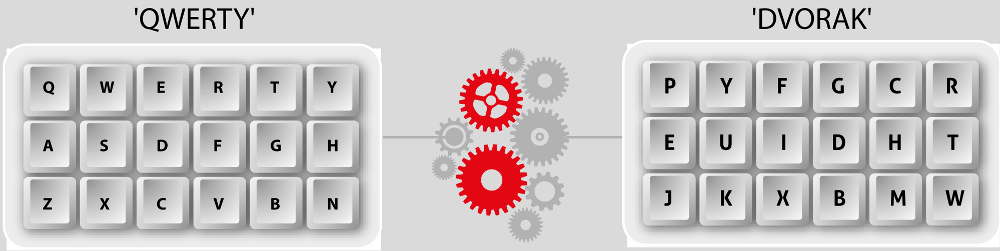


Figure 5.2: QWERTY vs. DVORAK

The QWERTY, as a de facto standard, vs. DVORAK story is interesting and has led to inspiring debates in the academic literature because of two reasons. First, it illustrates that standards can hamper or support innovation. Second, there are two versions to the story itself. The first version of the story was popularized in David (1985) and acknowledges the superiority of DVORAK, whereas the second version of the story published by Liebowitz and Margolis (1990) questions the validity of David's argument and rejects the idea that QWERTY could establish itself as a universal standard in spite of its inferiority.

The first version of the story:

Developed in 1879, the QWERTY keyboard was created to slow down the typist. The layout of the typewriter keyboard was designed in a way that makes the keys less likely to jam. In the meantime, the computer has replaced the mechanical typewriting machine. As such, the QWERTY keyboard does not provide any benefit. Though the Dvorak layout—named after its inventor Dr August Dvorak—is superior, this design with improved ergonomics could not establish itself in the market.

Indeed, the QWERTY standard had many innovation-hampering aspects, in particular the lock-in effect. The lock-in-effect means that when users adopt and spend time, effort, and money to learn a specific technology, they are less likely to switch to another one (The Independent 2010). Hardware replacement incurs high costs for users. Learning how to use a new standard, such as the DVORAK keyboard, generates costs for users. In addition, the old standard drives network effect. The network effect means that the larger the user basis of a technology, the higher its value. More users would be willing to switch to the new technology, only if others do so. This is the penguin effect, which means that everyone is waiting for the other to go for the new technology. Note that although related, the network effect and penguin effect do not represent the same concept. The penguin effect deals with the switching barrier to another technology, whereas the network effect addresses the value of a product as a function of its user base.

QWERTY, however, was also innovation fostering. QWERTY is the standard for the interface between human and machine. Whereas the typewriting machines have been replaced by computer-based text-processing software, the QWERTY standard did not change. QWERTY is used worldwide and enables suppliers of hardware and software to benefit from economies of scale. Customers would not be willing to accept an improved machine without a standardized interface (de Vries 2006b).

The second version of the story:

In their article published in 1990, Liebowitz and Margolis (1990) put in question David's argument, which is essentially this: "an established standard can persist over a challenger, even where all users prefer a world dominated by the challenger, if users are unable to coordinate their choices" (Liebowitz and Margolis 1990, p. 1). In other words, although DVORAK is the better keyboard arrangement as it is faster to learn and improves the typist productivity, because users are waiting for others to switch and nobody does so, QWERTY will persist as the dominant standard, thus leading to market failure with respect to the superior technology, DVORAK. In their article, Liebowitz and Margolis (1990) provide a series of arguments against the claim for the superiority of the DVORAK standard. For example, the authors question the validity of the experiments conducted with respect to the superiority of DVORAK in terms of faster learning and improving typist productivity. They also cite experiments that do not necessarily confirm that DVORAK is better than QWERTY. In addition, from an ergonomic perspective, DVORAK is not very advantageous as claimed by its proponents. More importantly, if DVORAK was truly superior, then there would have been innovative entrepreneurial activity that would have capitalized on the benefits of DVORAK and that would have led the users to switch to the new keyboard arrangement.

Standards support the development of new products and services and constitute the foundation upon which markets can grow. The analogy between pruning a tree to maximize its fruitfulness and the design of the standards system to maximize innovation-led growth explains the potential of standards in supporting innovation and growth. So, why does a tree need pruning? Pruning is important to remove weak, dead, and damaged branches and to promote healthy growth of wood. Pruning is also important to thin a dense canopy on a tree to increase air supply and sunlight absorption, resulting in healthy and increased flowering and fruitfulness. The trunk and branch structure plays a key role in determining the vigour of growth, leaves and fruit. It is dysfunctional to let all shoots grow, but through pruning, the tree must select a shoot and concentrate its energy into the growth of this individual shoot. Furthermore, pruning gives the tree the desired shape (Swann 2000).

By analogy, like pruning, which eliminates dead and weak branches, standardization limits variety but helps to develop a "strong tree". The tree is analogous to technology. Innovation helps to grow the tree—in other words the technology—but standardization stops messy proliferation by holding back subsequent messy growth.

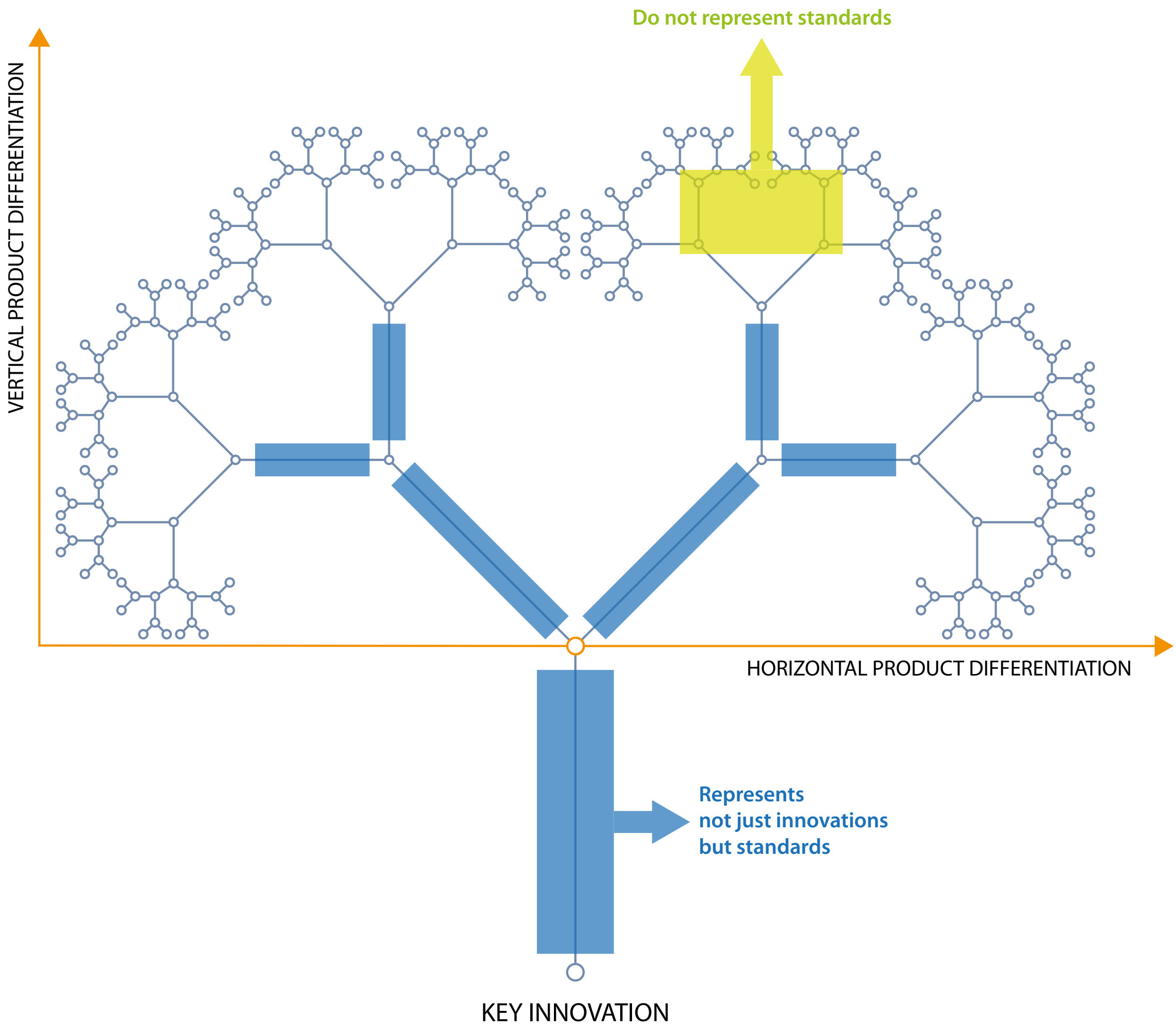
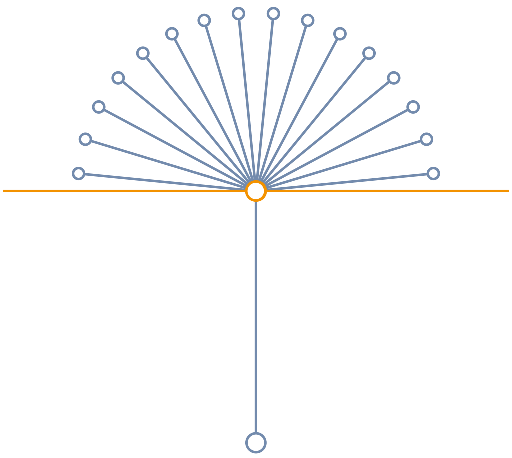


Figure 5.3: Product innovation with standardization; adapted from Swann (2000)

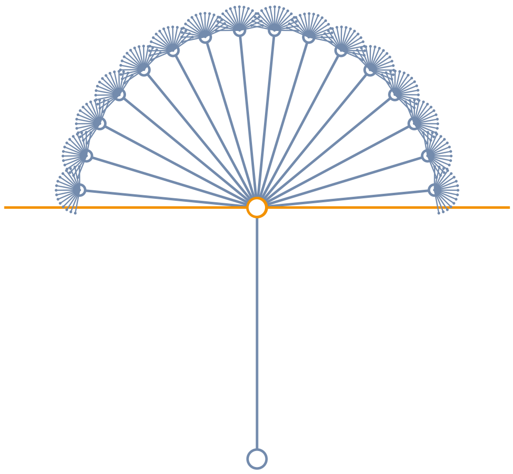
This analogy is applied to the evolution of standards and innovative products or services. The structure of the standards system can be depicted by means of a diagram (Figure 5.3) representing the technological space. Along the axes, we distinguish between vertical and horizontal product differentiation. Vertical differentiation means the further up the diagram, the greater the performance or functionality, whereas horizontal differentiation implies different designs and configurations with roughly comparable performance or functionality (Abbott 1955).

Starting from the first node, for example a key innovation, standards support the development of further innovations. The usual forces of product innovation and competition continue to build a "canopy" of competing products and services of different characteristics. Standards enable and shape this pattern of innovation. The closer the innovations are to a standard, the greater the confidence of consumers and producers.



(a) stage 01

Large number of slightly differentiated innovations follow different directions from the base point



(b) stage 02

Messy result after two rounds of innovation. "Canopy" is very well covered but does not reach as far as it was the case based on formal standardization

Figure 5.4: Product innovation without standardization; adapted from Swann (2000)

If product or service innovations are developed without standardization, the same process of innovation- led growth takes place, but many slightly differentiated innovations follow different directions from the base point. Each stage shows a substantial amount of innovation and duplicated effort. Therefore, the potential for economies of scale is unused. The "canopy" is very dense, but the vertical product differentiation does not reach as far as it does with formal standardization (Figure 5.4).

5.2.3 STANDARDIZATION AND THE TECHNOLOGY LIFE CYCLE

Standardization can be related to the Technology Life Cycle (TLC) represented by an S-curve. The TLC (Figure 5.5) describes the level of commercial return and improvement in technological performance depending on the investments in Research and Development (R&D). At the beginning of the TLC, investments in R&D generate an increasing improvement in performance and commercial return. This level of improvement grows slowly at the beginning, then accelerates until it reaches a peak (tipping point), after which the rate of growth tends to decrease. The TLC, depicted by the S-curve, consists of four phases: introduction, growth, maturity, and decline.

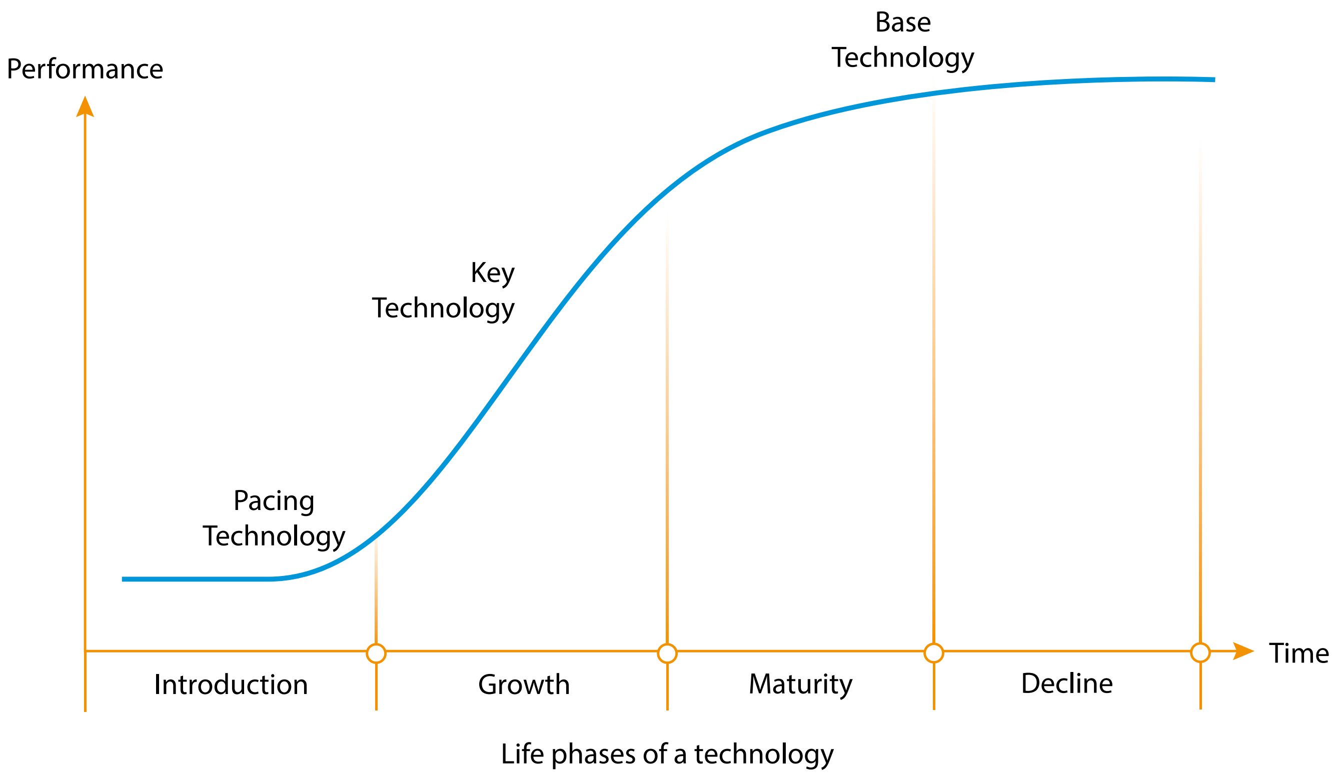


Figure 5.5: Technology Life Cycle over time; translated from Brockhoff (1999)

The Introduction phase of the TLC is characterized by a relatively slow progress of technology performance. The technology is still new, and no dominant design has been established yet. Competition on the market is high because market players aim to push through their technology to a dominant design, in other words to a de facto standard. Therefore, companies intensively invest in R&D, resulting in improved performance. In the growth phase, the dominant design emerges, and the performance of the technology improves at a higher pace. Furthermore, there are great advances in production processes and capacities, thereby lowering costs due to economies of scale and learning curve effects. As the technology improves further, it approaches its physical limitations that derive from the laws of nature. At this point, the technology reaches its Maturity phase. It is almost completely adopted by the market, and the strong competition causes the market players to spend their resources on improving production and lowering costs. After reaching market saturation, the curve starts to dip in the decline phase because of decelerated development.

At the beginning of the TLC, during the introduction phase, the technology is called a pacing technology. During its growth, it is a key technology, whereas during the maturity and decline phases, the technology is called a base technology.

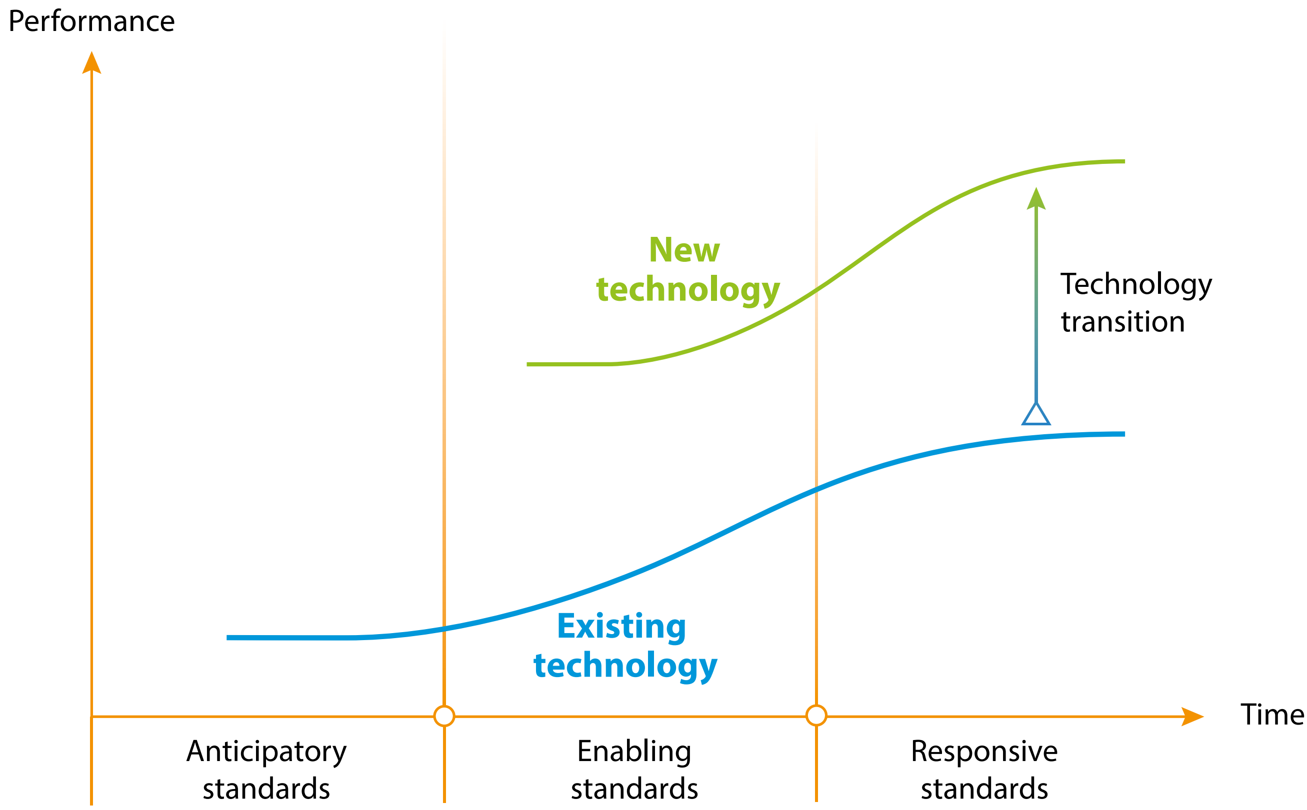


Figure 5.6: Standards related to the Technology Life Cycle (Sherif et al. 2005)

Related to the TLC, three types of standards can be defined: anticipatory standards, enabling standards and responsive standards (Figure 5.6). While this classification of the types of standards is useful, it does not rely on terminology used during the standardization process.

Anticipatory standards are "forward-looking" answers to expected technological problems. They are essential for successful network systems. The specification of anticipatory standards runs in parallel to the development of prototypes, pilots, and field trials to condense available theoretical and practical knowledge. Anticipatory standards also provide a way of sharing ideas. This is crucial when the risks of not collaborating with other competitors are high. Examples of anticipatory standards are: X.25, Integrated Services Digital Network (ISDN), Secure Sockets Layer (SSL), Bluetooth, Universal Mobile Telecommunications System (UMTS), etc. (Egyedi and Sherif 2008). Anticipatory standards are used during the introduction phase of the TLC and can lead to the acceleration of technology development as well as the reduction of redundant development.

EXAMPLE

Bluetooth has been a fast-growing innovation, with many Bluetooth products currently in use. It was very quick to gain standards status. The technology, which started in 1994 at Ericsson as alternative to RS-232 cables, went through many updates with the objective of reducing costs and enhancing feature capabilities. The Bluetooth standard (one version of it was standardized as IEEE 802.15.1), ensures interoperability of Bluetooth-enabled devices while connecting them over short distances (up to 10 meters) by operating in the frequency band ranging from 2400 to 2480 MHz. In the meantime, Bluetooth standard is managed by Bluetooth Special Interest Group (SIG) with more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics (Schneiderman 2015).

Enabling standards proceed in parallel with market growth and the improvement of technology and products to enhance the agreed-upon design by extending robustness and scale. In general, competitive forces and the need to reduce production costs influence the direction in which the standard develops. Enabling standards support the diffusion of technical knowledge and prevent market fragmentation. Enabling standards support the TLC growth phase. One example of enabling standards is the V.90 Recommendation from ITU-T for modems at 56Kbit/s, used for digital communication on traditional analogue telephone networks. At that time, proprietary designs of modems operating at that rate already existed. To avoid market fragmentation and to increase the total market size, chip manufacturers agreed to collaborate in the standardization process at ITU to develop a design that would work independently of the chipset used. Some technologies rely on a mixture of anticipatory and enabling standards. For instance, some areas of GSM (Groupe Spécial Mobile—Global System for Mobile communications) specifications were anticipatory to define a **platform** for future growth both for service operators and manufacturers, and others were enabling, defined after getting feedback from the market (Egyedi and Sherif 2008).

WHAT IS A PLATFORM?

Baldwin and Woodard (2009, p. 25) question, whether the "various platform concepts are synonymous or simply evocative uses of the same word to mean different things." They review three perspectives on platforms: product development, technology strategy, and industrial economics. They conclude that at the level of architecture all platforms are fundamentally the same and hence, propose a unified view of platform architecture. A platform architecture is "…a modularization that partitions the system into (1) a set of components whose design is stable and (2) a complementary set of components which are allowed – indeed encouraged – to vary. The combination of stability and variety is accomplished via 'stable, yet versatile' interfaces, which govern the interactions of components (Baldwin and Woodard 2009, p. 41).

A platform also denotes a group of technologies that are used as a base upon which other applications, processes or technologies are developed. In personal computing, a platform is the basic hardware (computer) and software (operating system) on which software applications can be run (www.techopedia.com/).

Responsive standards are created at the end of technology development, in other words during the maturity or decline phases. It can be distinguished between internal and external responsive standards. Internal standards are related to processes and practices inside the organization, e.g., processes used to manufacture a product whereas external responsive standards are related e.g., to the product that is seen by the customer. Internal responsive standards are defined after the dominant design has stabilized. The main objective is "…to codify best practices into daily routines" (Egyedi and Sherif 2008, p. 3). External responsive standards improve efficiency or reduce market uncertainty for auxiliary products and services. External responsive standards may also be called "business standards", because they contribute to achieving maximum return associated with an already established technology. For instance, Transport Layer Security (TLS) is a responsive standard. TLS, also known under the name of its predecessor Secure Sockets Layer (SSL) denotes a cryptographic protocol for a secure communication of data over the internet (Egyedi and Sherif 2008). TLS was first designed as another protocol upgrade of SSL 3.0 in 1999. Though the differences aren't considered dramatic, they are significant enough that SSL 3.0 and TLS 1.0 don't interoperate. SSL 3.0 is seen as less secure than TLS (https://www.digicert.com/blog/evolution-of-ssl).

5.3 RESEARCH AND STANDARDIZATION

Innovation and research are related. Research transforms money into knowledge, whereas innovation transforms that created knowledge into money. A successful transfer of research results into innovative products and processes is crucial for the economy. So far, many technology transfer instruments have been developed and implemented. Still, standardization has not been widely recognized as an instrument that enables the transfer of knowledge from research to a practical context. Germany, for example, at some point achieved a leading position in nanotechnology research globally but was not able to leverage this advantage and occupy a leading position in European and international markets due to a delay in national standardization activities (Blind 2009).

Research results should be integrated in standards for many reasons. First, companies that build upon these standards absorb the latest knowledge. Second, standardization constitutes an excellent mechanism to support the transfer of research results into innovative products/services. Standards are more likely to be broadly implemented because all interested stakeholders involved in the standardization process reached consensus. Third, publicly funded R&D results become public goods through standards, thus increasing the economic efficiency and achieving the economic objectives of research subsidies (Perera 2010).

5.3.1 TRADITIONAL VS. RECURSIVE RESEARCH EXPLOITATION

Standardization and research are mutually supportive. Research produces knowledge that can flow into standards (traditional technology transfer), and standards can serve as a knowledge source for further/new R&D projects. Consequently, there is a recursive knowledge flow from standardization back to research. This prevents the reinvention of the wheel and stimulates ideas for new research projects (Blind 2013).

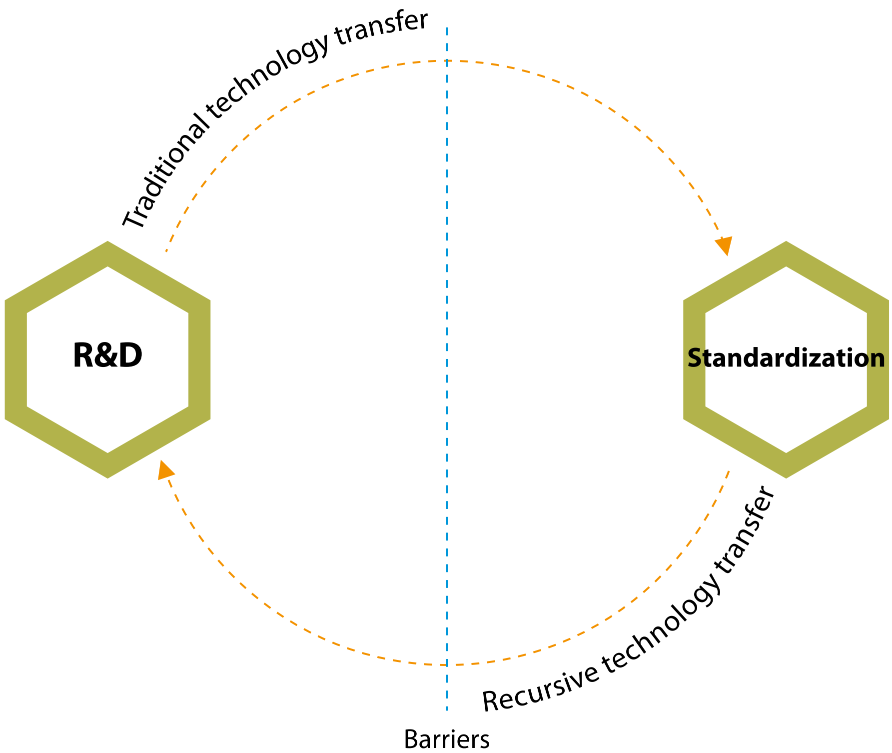


Figure 5.7: Research and standardization; adapted from Blind (2009)

5.3.2 STANDARDIZATION AS A COOPERATIVE PROCESS TO SUPPORT THE EXPLOITATION OF RESEARCH RESULTS

Standardization enables the transfer of knowledge and supports cooperation. The standardization committee meetings enable participants to work collaboratively and in a structured way. Members of the standardization committees exchange explicit and tacit knowledge during the standardization process. As such, the standard integrates knowledge from heterogeneous sources with different perspectives such as research, industry, government, Non-Profit Organizations (NPOs), and consumers (Blind 2013).

Figure 5.8 depicts the interactions between research and standardization in a simple technology transfer model. Research and development activities produce knowledge, which can be codified in publications and patents. This codified knowledge can be combined with knowledge from experts to feed the standardization process. The process of standardization as well as the coordination work (e.g., supported by an SDO) generate standards, which are then implemented in practice. The implementation of the standards feeds back to standardization (e.g., to update the standard) and research (e.g., when new research areas or insights emerge after standards have been implemented in practice).

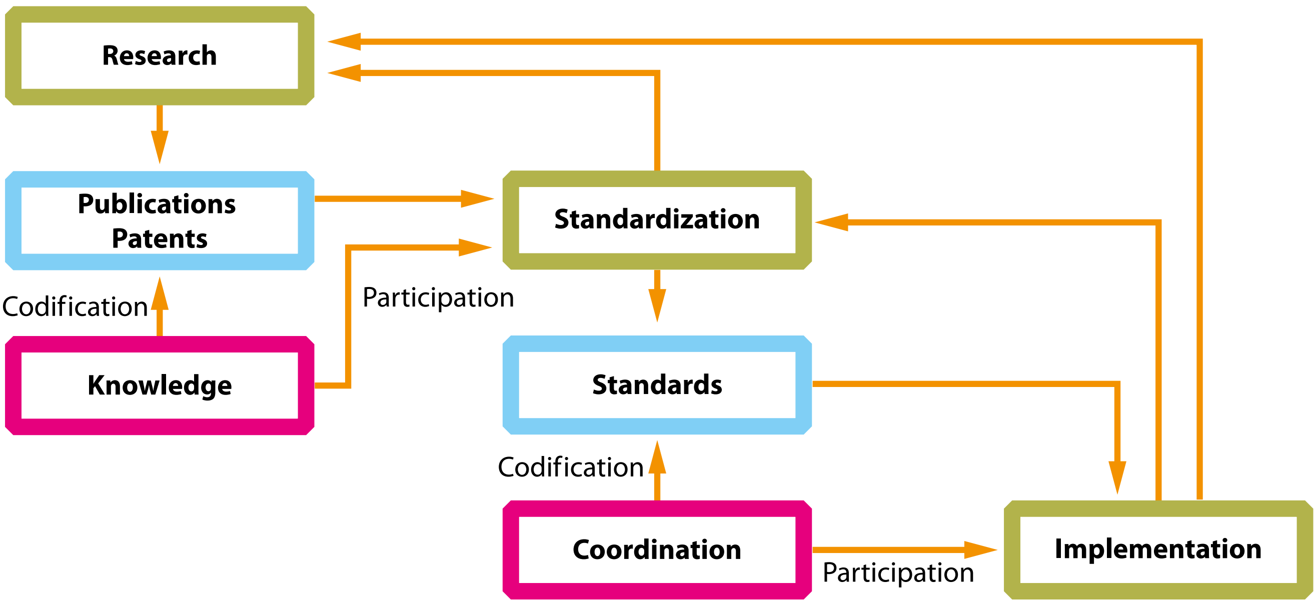


Figure 5.8: Research and standardization in a simple technology transfer model (Blind and Gauch 2009)

5.3.3 A MODEL FOR THE INTEGRATION OF STANDARDIZATION IN RESEARCH

Blind (2013) identifies five phases in the process of research and innovation: pure basic research, oriented basic research, applied research, experimental development, and diffusion (Figure 5.9). Pure basic research aims to conduct theoretical or experimental work to generate new foundational knowledge. Oriented basic research produces knowledge that is likely to provide the basis for a solution of current or future problems. Applied research constitutes an original investigation towards an aim or objective. It involves the practical application of science. Experimental development represents systematic work that leverages knowledge gained from research and practical experience, while producing complementary knowledge directed at producing new products. The diffusion process deals with spreading innovation from the first implementation to wide implementation for different consumers, countries, regions, sectors, markets and firms (OECD 2005, 2015).

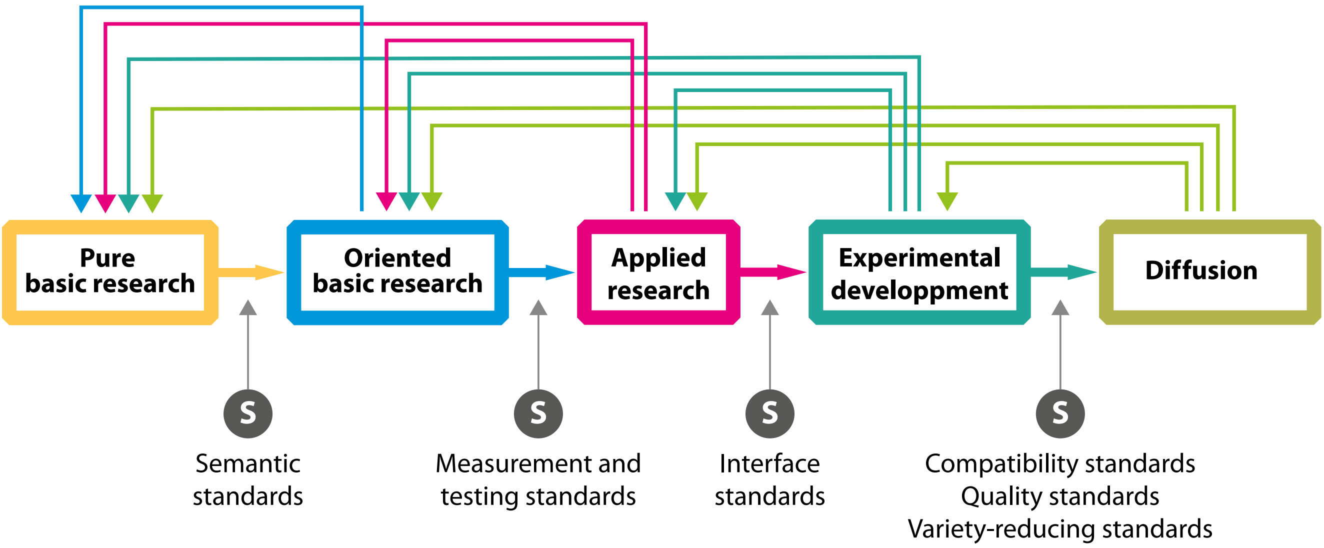


Figure 5.9: Various roles of different types of standards in the innovation process (Blind and Gauch 2009)

Different standards can play different roles, depending on the stage of the research and innovation process (Blind and Gauch 2009):

- Terminology or semantic standards facilitate efficient communication. They are required in basic research as well as in the transfer of knowledge to oriented basic research and all subsequent research activities.
- Measurement and testing standards support the shift towards product developments. They can be used to check whether specific requirements have been met (e.g., performance criteria) and to ensure comparability through agreed-upon test methods.
- Interface standards support the interoperability of components integrated into products or process technology.
- Compatibility, quality and variety-reducing standards support the transition of products into mass markets.

These types of standards will be dealt with in greater detail in Chapter 8. Semantic standards and measurement and testing standards can reduce information and transaction costs. Interface standards drive the interoperability among components and save adaption costs. Compatibility standards, quality standards and variety-reducing standards lead to increased quality as well as reduced health, privacy, and safety risks, while supporting the building of critical mass.

EXAMPLE

MP3 is an excellent example that illustrates how standardization and research can support each other. Research within the Digital Audio Broadcast (DAB) project was conducted at the University of Erlangen-Nuremberg, Germany. The first patent applications, based on the results of the project, were filed in 1987. Also in 1987, Fraunhofer Institute for Integrated Circuits (Fraunhofer IIS), also based in Nuremberg, Germany, started audio encoding research as part of the DAB project. In 1989, the Moving Picture Expert Group (MPEG) standardization committee was founded. This committee included leading companies from the industry such as Sony, Philips, and EMI. In 1992, MPEG released MPEG-1-Layer3, known as MP3, as a standard MP3-player format. In the meantime, the MP3 patent is included in an ISO standard. The MP3 standard is very successful and has led to the sale of millions of MP3 players and to more than €100 million in licensing revenue for the Fraunhofer society (Blind 2009).

Despite the importance of standardization and standards for research, there is currently limited awareness of their benefits among researchers. As standards are often driven by strongly business-oriented industries, there may be some scepticism against researchers and research in general and a tendency to not acknowledge their expertise as relevant to the standardization process. This is also because, research is sometimes not close enough to the market. In addition, standardization is a time-consuming process that can discourage researchers from working in standardization committees. Furthermore, the output of researchers is rather evaluated based on publications in scientific journals and patents than on participation in standardization (Blind 2009, 2013).

5.4 FORMAL STANDARDIZATION: A DRIVER FOR INNOVATION

"Standardization is an essential part of the microeconomic infrastructure: it enables innovation and acts as a barrier to undesirable outcomes" (Swann 2010, p. 9). Standards and standardization can support innovation, defined as a combination of invention and exploitation. This section provides details on how standards and standardization can have a positive effect on invention and exploitation. It is based on research conducted by Abdelkafi and Makhotin (2014) within the scope of a project funded by the German Institute for Standardization (DIN). It investigates how German companies, in particular SMEs, can leverage SDO standards to drive innovation.

The seats in Technical Committees may be limited, making it impossible for all SMEs to participate in standardization. Nevertheless, the current level of participation of SMEs is regarded to be still low, and there is potential for improvement. Additionally, if SMEs are not able to join a working group, they can be represented by SME associations, which can participate to preserve the interest of their member SMEs. If SMEs do not participate themselves or through association, they still can contribute by commenting on early drafts of a standard. Hence, SMEs can exhibit different participation and involvement levels in the standardization process.

The type of Innovation support by standardization and standards is classified by drawing on two dimensions (Figure 5.10). The first dimension concerns innovation, which is defined as a combination of invention and exploitation. Standards and standardization can support invention by inspiring people and triggering new ideas. They can also facilitate the exploitation process by pushing commercialization and sales of the invention. The second dimension concerns whether the support to innovation is provided thorough the participation in the process of standardization or through the application of standards. The quadrants in Figure 5.10 show the opportunities of innovation, revealing how invention and exploitation can be concretely supported. The content of these quadrants will be specifically discussed and expanded in the following sections.

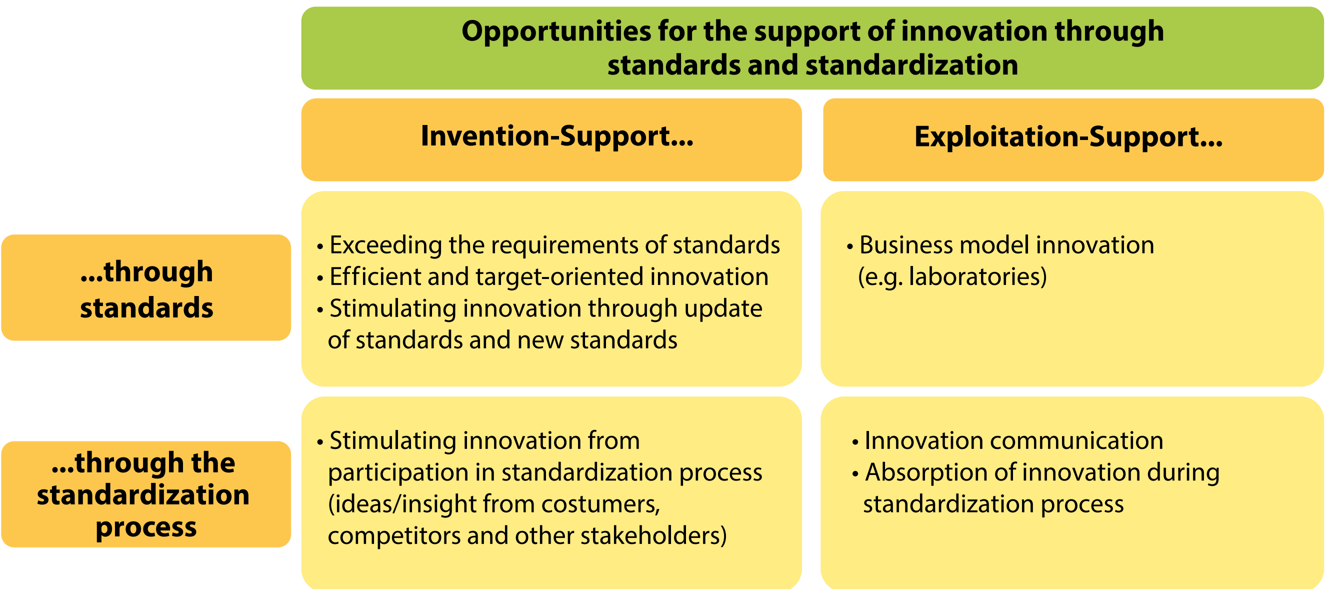


Figure 5.10: Innovation potentials in standardization; adapted from Abdelkafi and Makhotin (2014, p.46)

5.4.1 EFFICIENT AND TARGET-ORIENTED INNOVATION

SDO standards provide a useful framework for the development of new products. Standardization increases the effectiveness of R&D activities and enables the transfer of innovations from one sector to another. For instance, a security company sees the set of standards as the basic prerequisite to not develop products "for the trash".

Standards can provide a guideline for the innovation process. They enable the creation of an efficient and target-oriented innovation. The cost efficiency of innovation projects depends on resource inputs such as time, material, energy, and money (Spath et al. 2010). Standards can positively influence these factors by increasing the productivity in product development, thus decreasing the cost of innovation. In highly innovative technological fields, quality standards ensure reliable documentation and traceability, which are essential for the approval of a new product. Though the product is new, engineers can still use quality standards in order for the innovation to meet the quality targets. In less-standardized fields such as nanotechnology, setting standardized testing methods supports comparability among products, making the developers of new products aware of the requirements to be fulfilled.

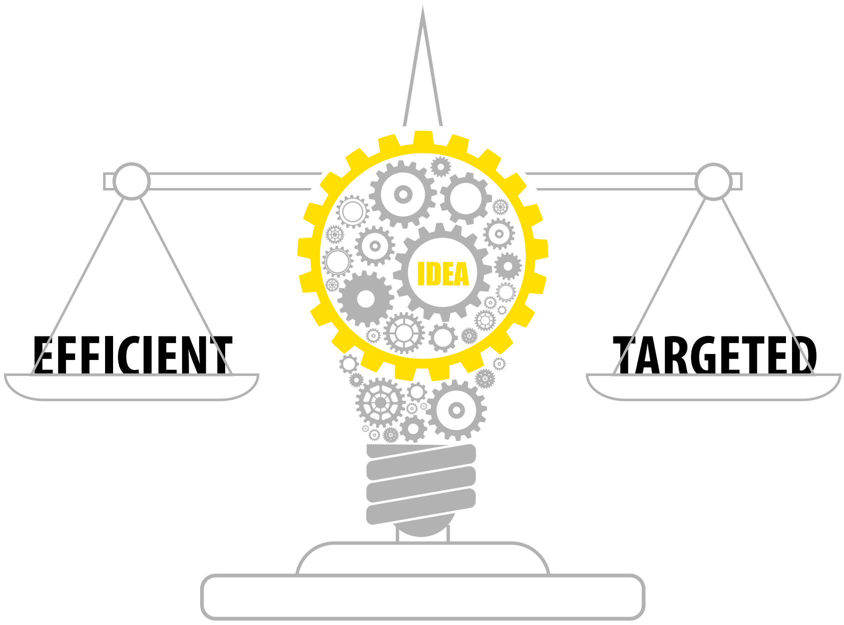


Figure 5.11: Efficient and target-oriented innovation

5.4.2 DIFFERENTIATION

Companies can achieve a competitive advantage, depending on how well and how quickly they can fulfil the requirements of a new standard. Standardization can create opportunities for the development of differentiated products. This can take place when the company synchronizes its R&D process with the standards development process and adapts faster to the requirements of the released standards.

Standards represent state-of-the-art knowledge and define the requirements that can be applied by all relevant stakeholders. Hence, it is paradoxical to consider standards as a means of differentiation. Nevertheless, the standard represents the foundation upon which companies can develop their unique selling propositions. In effect, by knowing the requirements of the standard, which can be fulfilled by virtually all competitors, the company can define the areas in which it can be different. In these areas, it can develop specific capabilities, particularly core competencies (Prahalad and Hamel 1990), thus differentiating itself from the competition.

Not only standards, but also the standardization process, can support differentiation. The information advantage that participants gain during standardization can be exploited within the R&D process to achieve product differentiation (de Vries 2006a).

Figure 5.12: Synchronizing the product development and standardization activities with the objectve of differentiating own products

5.4.3 EXCEEDING THE REQUIREMENTS OF STANDARDS

Standardization and standards can drive innovation if the company sets the standard as the minimum requirements to be achieved and then tries to do better than what the standard recommends. Standards specify requirements and leave some degree of freedom to the design or solution. Knowing the basic requirements of standards, companies can develop different solutions to meet the standard. For instance, one company producing equipment for security gates at airports uses the related standards as a starting point. Let us assume that the standard requires that people traversing security gates should not be radiated with more than five radiation units. The company sets a target to produce equipment with much lower radiation units, whereas most of the competitors produce equipment with five radiation units. Thus, knowing the basic requirements, which are documented in the standards, companies can develop "out-of-the box" solutions. Besides the general need of increasing competitiveness, going beyond standards may be justified by other reasons like special-purpose customer requests, marketing reasons, previous experience or hedging against uncertainties.

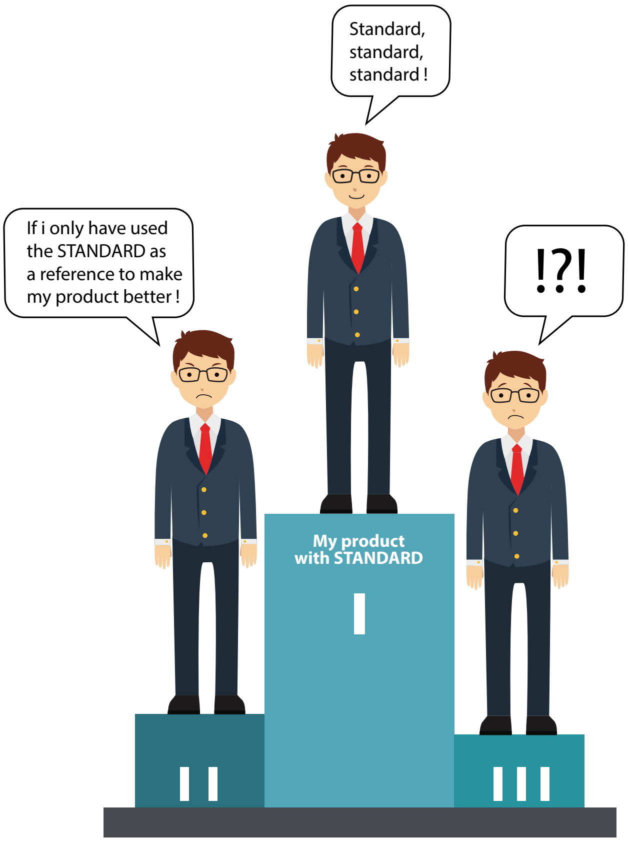


Figure 5.13: Exceeding the requirements of standards

5.4.4 BUSINESS MODEL INNOVATION

Standards can lead to new business models, such as test labs, consulting firms and certification organizations. Business models describe how an organization creates value (Linder and Cantrell 2000). Business model innovation refers to the process of renewal or design of business models (Wright et al. 2012), and standards can represent the backbone of this process. Test laboratories, consultancies and educational services can use standards as a core element of their business models. Test laboratories, for instance, specialize in the application of standardized procedures. By integrating new standards in the value proposition, they can address the requirements of new customers. As such, standards constitute an integral part of the business model, since the decision of which standards to include in or eliminate from the portfolio determines the cost structure (e.g., additional investments) and potential sources of revenue. Some consultancies would never be able to do business without standards because they entirely build their business models around standards (e.g., quality standards). For instance, in technology areas where it is difficult to get a good overview of the relevant standards, entrepreneurs launch new start-up companies to provide advice around the requirements and application of standards for companies that need consultancy services in the corresponding area.

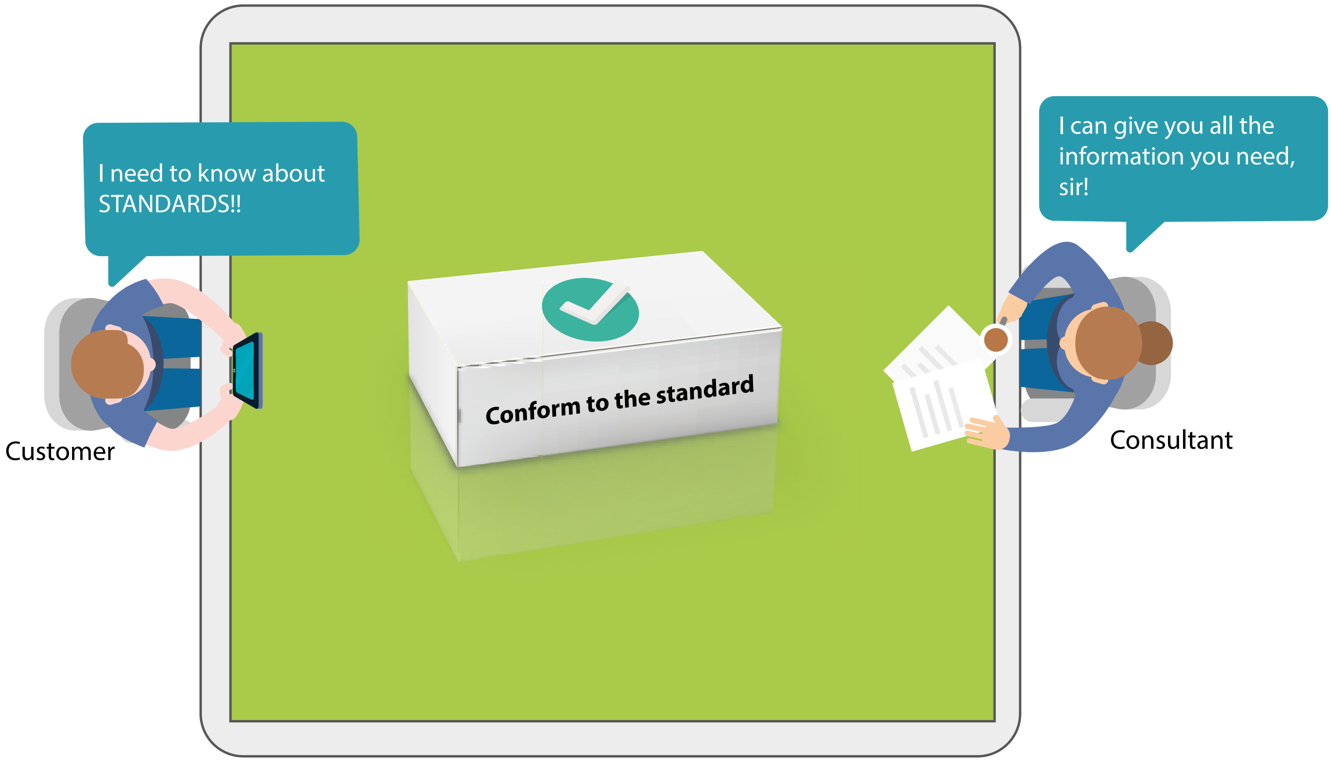


Figure 5.14: Business model innovation through standardization

5.4.5 INNOVATION IMPULSES

Standards can provide innovation impulses, for example when an existing standard is updated or after a new one is introduced. When standards are changed over time, companies comply with the updated standard by making their products fit the requirements of the new version. The development of a completely new standard can also drive companies to change their products.

However, changes in standards can only be transferred to innovations if certain conditions are fulfilled. First, the company should accept the change. Second, the company should be capable of integrating the requirements or solutions provided in the standards in its innovation process. Thus, the change of standards released by national or international SDOs can be a source for innovation. It also provides a strong incentive to companies to actively participate in standardization processes.

However, the updates of standards can be perceived as a burden for the company because of additional development efforts. For instance, one company in the biotechnology field stated that the change of standards could put the company in a position where it needs to update already manufactured products (stock), and this leads to extra costs that are not welcomed by the company.

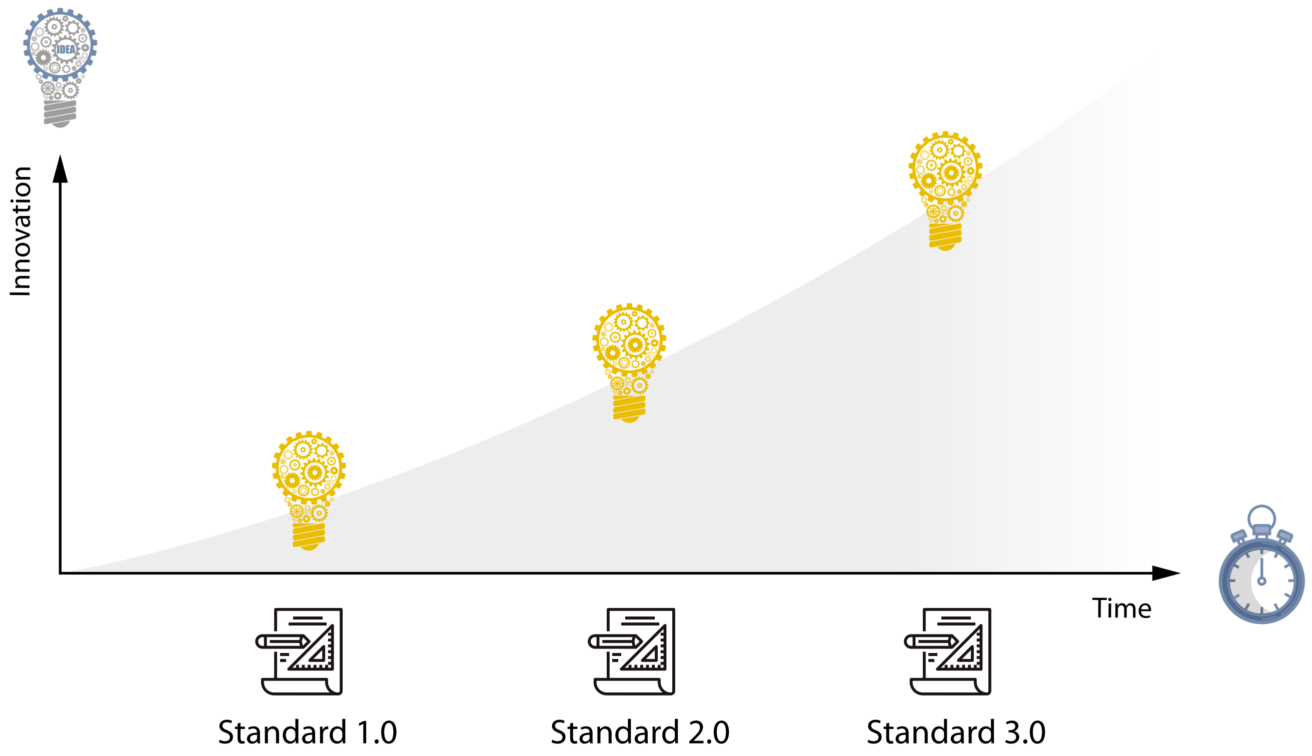


Figure 5.15: Innovation impulses through standardization

5.4.6 INNOVATION COMMUNICATION

Companies may want actively to communicate their innovation capabilities. Companies that are active in standardization can signal know-how and high competence to their outside environment and business partners, especially if they operate in the Business-to-Business (B2B) field. For instance, producers that participate in standardization can achieve compatibility of their products with market requirements and increase the level of trust of their customers in the offered solutions. Such companies benefit their customers as they do not incur the risk that the product they bought becomes obsolete after the standard has been published. In general, the communication of innovation capabilities through participation in standardization makes customers have more confidence in the company's products and technologies, especially in areas with rapid technology development. For example, a company in the field of nanotechnology continuously informs its customers about its standardization activities, and the customers are happy to receive this up-to-date information. Taken from this perspective, innovation communication can positively affect the diffusion of technology.

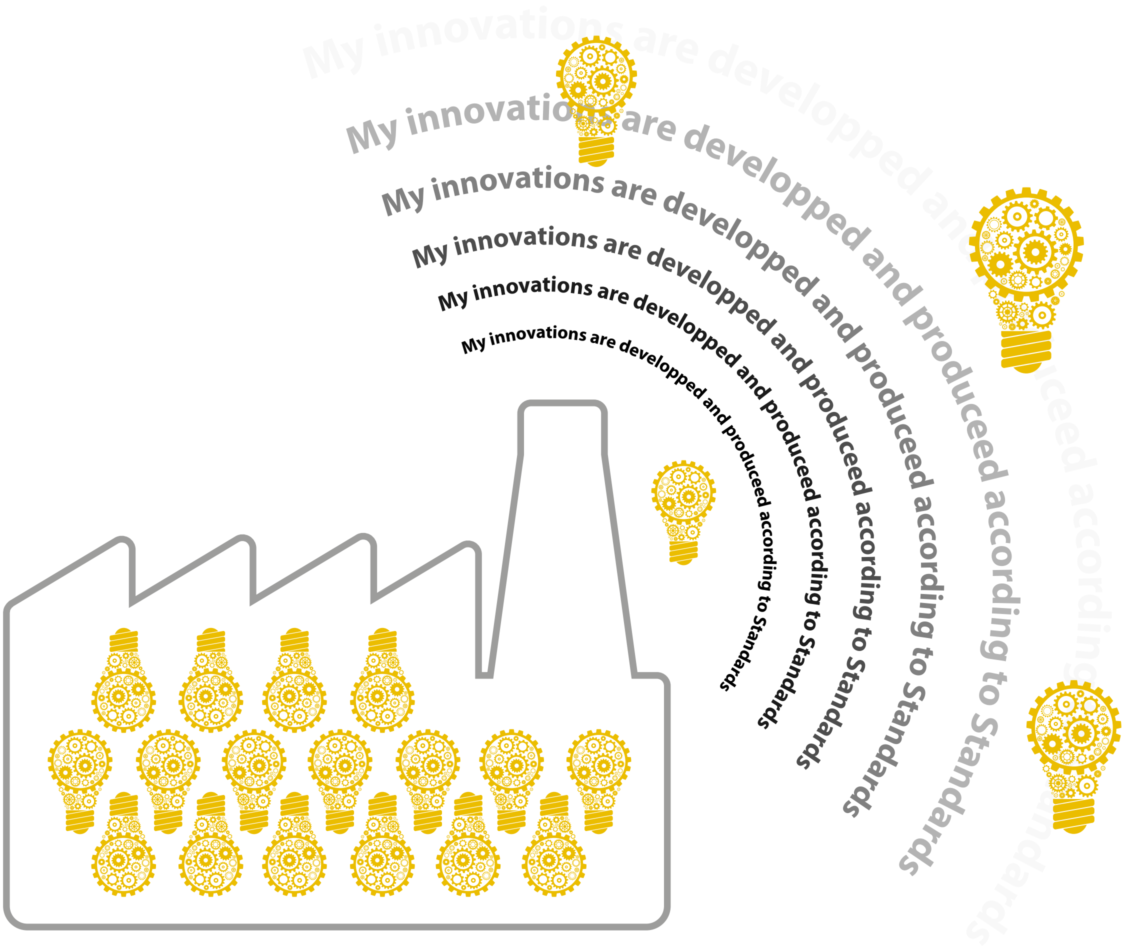


Figure 5.16: Innovation communication through standardization

5.4.7 ABSORPTION OF INNOVATION

The process of standardization supports knowledge exchange. During the standardization committee meetings, there is an inflow and outflow of knowledge among participants. To make sense of this knowledge, companies need to develop their absorptive capacity. Absorptive capacity denotes the ability of companies to transfer and apply novel and useful external knowledge (Teece 1998; Cohen and Levinthal 1990). Companies may not only absorb important technical knowledge, but also identify new markets. For example, a company that produces devices that switch off electric current to protect machines and people from electric shocks noted that not only was the development of standards important for the company, but also the discussions with committee members that led to the identification of new application areas for the company's own products. This company was able to scale up its businesses from about 20 people in the 70s to about 700 employees currently with the help of standardization.

Note that innovation diffusion and absorption are two sides of the same coin. As the knowledge is revealed within the standardization processes, diffusion occurs, if the companies active in standardization absorb and adopt the innovation. In addition, as people with different backgrounds participate in the standardization committee, it is more likely that new areas of application of an existing technology or product are discovered.

5.5 SUMMARY

This chapter provides a comprehensive overview on the basics of standardization and innovation. First, standards can hamper innovation if standardization is not adequately managed over time or if the standard induces a lock-in effect. For instance, the keyboard example (QWERTY vs. DVORAK) shows that people can find it difficult to change an established standard, even when the new solution is better. Nevertheless, we argue that the positive contribution of standards and standardization to innovation more than outweighs its negative impacts.

We define innovation as a process and as an output of that process. Standards and standardization can offer an essential contribution to innovation as both a process and an output, but they are more effective in promoting incremental and evolutionary, rather than radical and disruptive innovations. The analogy between the pruning of a tree and standardization perfectly illustrates how and why standards can support innovation and growth. In the same way that pruning increases the fruitfulness of a tree, standardization supports innovation-led growth by channelling and focusing the energy that companies spend to develop a given innovation. A business landscape without standards would lead to energy distributed over many possible evolutionary paths, resulting in large waste of resources, redundancies, and slower progress in general.

Standards and standardization activities can be effectively related to the technology life cycle, which consists of four phases: introduction, growth, maturity and decline. There are three types of standards that can be used during these phases. Anticipatory standards are forward-looking and solve expected interoperability problems. As such, they can support the introduction phase of a technology. Enabling standards are established during the growth phase and improvement of a technology or products to enhance robustness and scale of an agreed-upon or a dominant design. Responsive standards are created at the end of technology development, during the maturity and decline phase. Their aim is to pick up on and document best practices.

Standardization and standards can be very useful during the research process. Research results can be used to draft new standards. The reverse is also possible because standards can provide input for the research process. Therefore, there is a recursive knowledge flow from standardization to research. The research and innovation process consists of five different phases: pure basic research, oriented basic research, applied research, experimental development, and diffusion. These phases are supported by different types of standards. Terminology standards facilitate efficient communication and are required in basic research as well as in the transfer of knowledge to oriented basic research. Measurement and testing standards can be used to check whether specific requirements such as performance criteria have been met, while ensuring the comparability of the results. Interface standards allow interoperability of components, whereas compatibility, quality and variety-reducing standards support diffusion.

The last section of this chapter dealt with the innovation potential from standards and standardization. Standards and standardization can support innovation in seven ways. Standards can promote efficient and target-oriented innovation, as products developed in compliance with available standards are more likely to be accepted by the market and have better chances of success. Companies that participate in standardization committees can communicate their involvement actively, resulting in a good reputation and positive signs to the outside environment and business partners that they are innovative. The update of standards can also generate impulses for innovation, even though some companies may find such changes bothersome and annoying. During the standardization process, companies may gain valuable knowledge that they can use to differentiate their products. The standard can be used as a basic requirement, and companies can deliberately decide to exceed the requirements proposed in the standard to generate innovation. It is also possible that some companies build their business models around standards. Some consulting services are specialized in providing advice to companies with respect to relevant standards and their contents. Finally, participation in standardization enables companies to identify new knowledge, which can be used to nurture the innovation process or to identify new markets. Hence, these aspects demonstrate how standards and standardization can boost innovation. Companies that are aware of these advantages are in a better position to leverage standards and standardization to strengthen their innovation capabilities.

5.6 QUIZ

1 - WHAT IS INNOVATION?

(See Section 5.2.1 for hints)

a) *Innovation is a new invention.*

b) *Innovation happens only at the product and service level.*

c) *Innovation is the combination of invention and commercialization.*

d) *Innovation is incremental when there is a considerable improvement of performance within a short period of time.*

2 - AN ENTERPRISE RESOURCE PLANNING (ERP) SYSTEM THAT IS ALREADY USED BY OTHER COMPANIES IN A SECTOR, BUT ACTUALLY IMPLEMENTED FOR THE FIRST TIME BY A PARTICULAR COMPANY IS A …

(See Section 5.2.1 for hints)

a) *New-To-the-Market (NTM) innovation*

b) *New-To-the-Firm (NTF) innovation*

c) *New-To-the-World (NTW) innovation*

d) *Disruptive innovation*

3 - QWERTY IS…

(See Section 5.2.2 for hints)

a) *superior to DVORAK.*

b) *not a standard.*

c) *a SDO standard.*

d) *a de facto standard.*

4 - THE ANALOGY BETWEEN STANDARDIZATION AND TREE PRUNING ILLUSTRATES…

(See Section 5.2.2 for hints)

a) *the potential of standards in supporting innovation and growth.*

b) *how standards inhibit innovation.*

c) *that standards lead to a waste of innovation resources.*

d) *the chaotic nature of the innovation process.*

5 - AT WHICH PHASE IN THE TECHNOLOGY LIFE CYCLE DOES A DOMINANT DESIGN EMERGE?

(See Section 5.2.3 for hints)

a) *Introduction*

b) *Growth*

c) *Maturity*

d) *Decline*

6 - ANTICIPATORY STANDARDS…

(See Section 5.2.3 for hints)

a) *proceed in parallel with market growth and improvement of technology.*

b) *are "forward-looking" answers to expected interoperability problems.*

c) *are created at the end of technology development*

d) *are not conducive to innovation, as they inhibit creativity.*

7 - THE INNOVATION PROCESS CONSISTS OF…

(See Section 5.3.3 for hints)

a) *Pure basic research, oriented basic research, applied research, and experimental development*

b) *Pure basic research, oriented basic research, applied research, and diffusion*

c) *Pure basic research, oriented basic research, applied research, experimental development and diffusion*

d) *Pure basic research, applied research, experimental development, and diffusion*

8 - INNOVATION IS SUPPORTED…

(See Section 5.4 for hints)

a) *only by standards.*

b) *neither by standards nor by standardization.*

c) *only by the standardization process.*

d) *by standards and by standardization.*

9 - EXCEEDING THE REQUIREMENTS OF STANDARDS IS…

(See Section 5.4.3 for hints)

a) *an innovation potential, as it provides impulses for the improvement of products and technologies.*

b) *a cost-increasing factor.*

c) *not an innovation potential, as competitors will strive to do the same.*

d) *not allowed because of regulations.*

➜ ***SOLUTIONS PAGE 257***

5.7 GLOSSARY

- Innovation: "An innovation is the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD 2005, p. 46).
- Incremental innovation: When the performance of an existing technology improves in small steps over time. It is also called evolutionary.
- Radical innovation: In the case where the technology achieves a high level of performance over a very short time period, the innovation is referred to as radical or revolutionary.
- Invention: "Something that has never been made before, or the process of creating something that has never been made before" (Cambridge Dictionary n.d.).
- Innovation teams: As innovation requires multiple skills, in most cases multiple people form a team to gather a wide range of skills to keep the innovation engine running (Eckert n.d.)
- Absorption capacity: A firm's "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, p. 128).
- Technology lock-in effect: The idea that the more a user uses and learns about a specific technology, the more unlikely it is that he switches (The Independent 2010).
- Penguin effect: "Even if users unanimously favour a switch, each user may prefer the other to switch first". This is based on the following analogy: penguins who have to enter the water to look for food often delay doing so because they fear possible predators. The penguins would prefer another penguin to test the water first. (Farrell and Saloner 1986, p. 943)
- Economies of scale: The average costs per unit of output decrease with the increase in the scale of the output being produced by a firm. (OECD 2003)
- Anticipatory standards: "Forward-looking" answers to expected interoperability problems. They are essential for successful network systems. Examples of anticipatory standards are: X.25, Integrated Services Digital Network (ISDN), Secure Sockets Layer (SSL), Bluetooth, Universal Mobile Telecommunications System (UMTS).
- Enabling standards: Standards that proceed in parallel with market growth and improvement of technology and products to enhance the agreed-upon design by extending robustness and scale. One example of enabling standards is the V.90 client modem.
- Responsive standards: Sometimes also called "business standards", as they contribute to achieving maximum returns associated with an already established technology. For instance, Transport Layer Security (TLS) is a responsive standard following the establishment of Secure Sockets Layer (SSL). TLS/SSL are cryptographic protocols to secure communication over a computer network.

5.8 LIST OF ABBREVIATIONS

- B2B: Business-to-Business
- DAB: Digital Audio Broadcast
- DIN: German Institute for Standardization
- ERP: Enterprise Resource Planning
- Fraunhofer IIS: Fraunhofer Institute for Integrated Circuits
- GSM: Groupe Spécial Mobile—Global System for Mobile communications
- IEEE: Institute or Electrical and Electronics Engineers
- ISDN: Integrated Services Digital Network
- ISO: International Standardization Organization
- ITU: International Telecommunication Union
- MPEG: Moving Picture Expert Group
- MP3: MPEG-1 Audio Layer III
- NPO: Non-Profit-Organization
- NTF: New-To-the-Firm
- NTM: New-To-the-Market
- NTW: New-To-the-World
- OECD: Organisation for Economic Co-operation and Development
- R&D: Research and Development
- SDO: Standards Development Organization
- SIG: (Bluetooth) Special Interest Group
- SME: Small and Medium-sized Enterprises
- SSL: Secure Sockets Layer
- TLC: Technology Life Cycle
- TLS: Transport Layer Security
- TRIZ: A Theory of inventive Problem Solving
- UMTS: Universal Mobile Telecommunications System

5.9 REFERENCES

- Abbott, L. (1955). Quality and Competition: An Essay in Economic Theory. New York: Columbia University Press.
- Abdelkafi, N., & Makhotin, S. (2014). Seizing Opportunities for the Support of Innovation through Committee Standards and Standardization: Insights from German Companies. International Journal of IT Standards and Standardization Research, 12, 38–56 (2014). doi:10.4018/ijitsr.2014070103
- Baldwin, C. Y., & Woodard, C. J. (2009). The architecture of platforms: A unified view. In A. Gawer (Ed.), Platforms, markets and innovation (pp. 19–44). Edward Elgar: Cheltenham, UK & Northampton, US.
- Blind, K. (2009). Standardisation: A catalyst for innovation (Inaugural addresses research in management series, EIA-2009-039-LIS). Rotterdam: Rotterdam School of Management, Erasmus University Rotterdam.
- Blind, K. (2013). The Impact of Standardization and Standards on Innovation: Compendium of Evidence on the Effectiveness of Innovation Policy Intervention.
- Blind, K., & Gauch, S. (2009). Research and standardisation in nanotechnology: Evidence from Germany.
  The Journal of Technology Transfer, 34, 320–342 (2009). doi:10.1007/s10961-008-9089-8
- Bower, J. L., & Christensen, C. M. (1996). Disruptive technologies: Catching the wave. Journal of Product Innovation Management, 1(13), 75–76.
- Brockhoff, K. (1999). Forschung und Entwicklung: Planung und Kontrolle (5th ed.). München: Oldenbourg Wissenschaftsverlag.
- Cambridge Dictionary. (n.d.). Invention. https://dictionary.cambridge.org/de/worterbuch/englisch/invention. Accessed 14 February 2018.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly, 35, 128–152 (1990). doi:10.2307/2393553
- David, P.A. (1985). Clio and the economics of QWERTY. American Economic Review, 75 (2), 332-337.
- David, P. (1995). Standardization policies for network technologies: The flux between freedom and order revisited. In R. Hawkins, R. Mansell, & J. Skea (Eds.), Standards, Innovation and Competitiveness: The Politics and Economics of Standards in Natural and Technical Environments.
- de Vries, H. (2006a). IT Standards Typology. In K. Jakobs (Ed.), Advanced Topics in Information Technology Standards and Standardization Research, Volume 1 (pp. 1–26): IGI Global.
- de Vries, H. (2006b). The paradox of standardization and innovation. ISO Focus, 3(3), 40–43.
- Eckert, B. (n.d.). Top 10 Innovation Drivers. http://innovationexcellence.com/blog/2011/12/23/top-10-innovation-drivers/. Accessed 14 March 2018.

- Egyedi, T. M., & Sherif, M. H. (2008). Standards' dynamics through an innovation lens: Next generation ethernet networks. In 2008 Innovations in NGN - Future Network and Services, An ITU-T Kaleidoscope Conference (K-INGN), Geneva, Switzerland, 12.05.2008 - 13.05.2008 (pp. 127–134): IEEE. doi:10.1109/ KINGN.2008.4542258
- Farrell, J., & Saloner, G. (1986). Installed base and compatibility: Innovation, product preannouncements, and predation. The American Economic Review, 940–955.
- Liebowitz, S.J. & Margolis, E.M. (1990). The fable of the keys. Journal of Law & Economics, Vol. 33, Issue 1, pp. 1-26.
- Linder, J., & Cantrell, S. (2000). Changing business models: Surveying the landscape. Accenture Institute for Strategic Change.
- OECD. (2003). Economies of Scale. https://stats.oecd.org/glossary/detail.asp?ID=3203. Accessed 14 February 2018.
- OECD. (2005). Oslo manual: Guidelines for collecting and interpreting innovation data (3rd ed., SourceOECD). Paris: OECD.
- OECD. (2015). Concepts and definitions for identifying R&D. In OECD (Ed.), Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development (pp. 43–79, The Measurement of Scientific, Technological and Innovation Activities). Paris: OECD Publishing.
- Perera, C. (2010). Standardization and Innovation. In W. Hesser, A. J. Feilzer, & H. J. de Vries (Eds.), Standardisation in companies and markets (3rd ed., pp. 403–442). Hamburg, Rotterdam: Helmut-Schmidt- Universität; Erasmus University of Rotterdam.
- Prahalad, C. K., & Hamel, G. (1990). The Core Competence of the Corporation. Harvard Business Review, 79–91 (1990). doi:10.1016/B978-0-7506-7088-3.50006-1
- Schneiderman, R. (2015). Modern Standardization. Hoboken, New Jersey: IEEE Press, John Wiley & Sons.
- Schumpeter, J. A. (1934). The Theory of Economic Development. Cambridge, Massachusetts: Harvard University Press.
- Sherif, M. H., Egyedi, T. M., & Jakobs, K. (2005). Standards of quality and quality of standards for telecommunications and information technologies. In T. M. Egyedi & M. H. Sherif (Eds.), Proceedings of the 4th International Conference on Standardization and Innovation in Information Technology: September 21- 23 2005, ITU, Geneva, Switzerland (pp. 208–217). Piscataway NJ: IEEE.
- Spath, D., Pastewski, N., & Lang-Koetz, C. (2010). Managing New Technologies for Resource Efficient Innovations: Results from Current Studies.
- Swann, G. M. P. (2000). The Economics of Standardization. Final Report for Standards and Technical Regulations Directorate Department of Trade and Industry. Manchester Business School. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/16506/The_ Economics_of_ Standardization_-_in_English.pdf. Accessed 1 January 2015.

- Swann, G. M. P. (2010). The Economics of Standardization: An Update. Report for the UK Department of Business, Innovation and Skills (BIS) (Version 2.2).
- Teece, D. J. (1998). Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. California Management Review, 40(3), 55–79.
- The Independent. (2010). Facebook may "lock in" its internet dominance. http://www.independent.co.uk/incoming/facebook-may-lock-in-its-internet-dominance-5519916.html. Accessed 15 March 2018.
- Wright, C., Sturdy, A., & Wylie, N. (2012). Management innovation through standardization: Consultants as standardizers of organizational practice. Research Policy, 41, 652–662 (2012). doi:10.1016/j. respol.2011.12.004.

6 A STRATEGIC PERSPECTIVE ON STANDARDIZATION

LEARNING OBJECTIVES

- Students should gain knowledge of the different criteria (strategic, commercial, technical) behind why an organization decides how to participate in standardization.
- Students will gain an idea of the choice of which SDO to join.
- Students will gain a view of the way in which coordination takes place and how this is achieved.
- Students will obtain a clear view on the method of standardization – consensus being the major principle.

6.1 INTRODUCTION

This chapter explains how companies can leverage standardization from a strategic viewpoint, with the objective of being successful in the market. These criteria can be strategic, commercially and/or technically motivated.

It also discusses different strategies that organizations may have for participation in standardization, and the choice of which SDO to join, as a function of the scope of the organization's activities and of geographical location. It also looks at the more technical aspects of standardization, including the implementation of standards.

There are organizations who become active in standardization to follow up on developments in public policy where standardization is a tool to be supported. These criteria are also further reasons to be considered.

This chapter also addresses the operation of standardization efforts and SDOs, especially in relation to the emphasis on consensus in ICT standardization and the benefits this brings. Voting is also covered but this is not as prevalent as elsewhere.

In addition, the communication aspects of standardization efforts are discussed, again from the perspective of a participating organization.

The chapter concludes with guidance on how to select standards for a given application. It elaborates (or defines) criteria for the selection of the most suitable standards.

6.1.1 STRATEGIC VALUE OF STANDARDS

Although also addressed in other parts of this textbook it is worth re-iterating that the strategic perspective has three components: (1) business, (2) technological, and (3) political/legal.

From a business viewpoint, standards can have many benefits:

- Enabling cooperation with competitors, by sharing different perspectives that help the creation of innovative solutions
- Making technology accessible to all
- Achieving economies of scale, lowering production costs, etc.
- Lowering investment risks - enabling higher investments, sharing the risk of starting new endeavours (hence lowering the barriers to assume such risk)
- Achieving a global reach of technology
- Fostering global collaboration
- Levelling the playing field, while enabling all stakeholders to participate on the same footing
- Allowing multi-vendor solutions: avoiding lock-in, allowing more flexible supply chains, thereby easing production lines.
- Ensuring that a standard is based on a technology that is owned by an organization
- Evaluating the intellectual property

From a technology perspective standards can achieve many advantages such as:

- Boosting innovation as each standard release is the basis for the next step of innovation
- Supporting the transfer of new scientific evidence to innovation
- Avoiding the reinvention of the wheel
- Speeding-up technology uptake
- Ensuring Interoperability and supporting multi-vendor solutions
- Landing pad for R&D; easy way of making research and development reach the global market
- Enabling the ease of deployment
- Ensuring the higher availability of expertise in all domains (from design to deployment)
- Avoiding unnecessary fragmentation - several solutions to the same problem

Standards and standardization can support policies and legal issues:

- Complying with legislation e.g. through the use of harmonised standards throughout Europe
- Complying with public policy objectives that are set by government
- Making access to regulated markets easier
- Making technology accessible and available to all while considering the needs and requirements of the weakest thus facilitating inclusiveness
- Engaging governments in technology development
- Enforcing technologies to be safe and secure
- Ensuring respect for privacy and customer rights
- Working together with industry to understand and enable the development and deployment of new technologies

6.2 DIFFERENT STRATEGIES FOR PARTICIPATION

This section addresses the organizational, technology and technical aspects of participation in standardization, as well as motives, objectives, and strategy.

6.2.1 ORGANIZATIONAL STRATEGIES

Organizations can be classified according to which role they play and intend to play in the standardization ecosystem.

The role that standardization plays for the organization is a function of how important standardization and/or participation in standardization is for the overall, primarily business-oriented, strategy. Active participation should be seen as a strategic tool that needs to be carefully managed and needs to be aligned with the organization's business strategy. The different strategies that organizations can follow are illustrated in Table 6.1.

Table 6.1: Organizations classified by their participation strategy

LEADER	CONTRIBUTOR	FOLLOWER	SPECTATOR
■ Participation in standards setting activity is business critical.	■ Active participation in standardization process ■ Less interested in the strategic direction followed by an SDO.	■ Full membership privileges wanted ■ Not interested in influencing the strategic direction	■ Main motivation: intelligence gathering ■ No active contribution to the creation of a standard

An organization may have a differentiated approach and may participate in different domains with different objectives, such as the protection of its business interests, early warning for technological and market developments, promotion of IPR and internal standards, avoiding duplication between countries or continents, etc. This means that different roles may be taken, such as a leader in one domain, contributor in another and spectator in another, etc. Because of this differentiated approach, an organization may be expected to be a leader in other domains in addition to its main priorities.

The business strategy is supported by a set of technology as well as research and development strategies. The standardization strategy of an organization is therefore driven by both the business strategy itself and by the technology strategies. A possible example is the movement by an organization into a new standardization activity where results from R&D activity are contributed.

From the public policy perspective, there are many examples that demonstrate how public authorities can achieve leverage through standardization and standards in policy making. For example:

- develop a large competitive single market,
- reducing barriers to new entrants,
- establishing minimum levels of quality for services and products where public administration plays a role, promote ubiquitous access to digital services and diminish the "digital divide",
- promote accessibility (e.g. among the young, the elderly, people with disabilities…),
- ensuring continuity of critical infrastructure (emergency "blue light" services (police, fire and ambulance), but also "yellow light" services such as electricity, gas, water, etc.),
- protection of minors; promotion of cultural diversity, cybersecurity, prevention of terrorism/organised crime …).

6.2.2 TECHNICAL FOCUS

Where and how to participate will be a function of the technical needs and priorities of an organization. Priority will certainly be given to standardization topics related to the core activities of the organization. For example, an organization with a particular interest in security will be drawn to those SDOs with strong security based activities and may become involved in related standardization work. This participation can also be done in more than one SDO.

However, the development of these core activities may depend on the availability and functionality of the infrastructure (telecom and non-telecom) and related activities such as privacy and security requirements and support. Therefore, the organization may decide to be present in domains of activity related to, but outside of its core activities.

Table 6.2: A simplified, non-exhaustive overview of the ICT standardization ecosystem

ORGANIZATION	TYPICAL TECHNICAL FOCUS OF ICT ACTIVITY
ITU	Interoperable telecom specifications incl. architecture, services protocols, addressing/ numbering plans.
ISO	ICT, architecture, services and protocols, incl. application protocols
IEC	Electrotechnical standards, incl. connectors and electrical safety, EMC and tests.
JTC 1	ICT, architecture, services and protocols, incl. application protocols
ETSI	ICT, interoperable telecom specifications, incl. architecture, services and protocols and tests
CEN	ICT, architecture, services and protocols, incl. application protocols.
CENELEC	Electrotechnical standards, incl. connectors and electrical safety, EMC and tests.
CEN/CENELEC	ICT architecture (OSI model) services and protocols, incl. application protocols.
IEEE	A wide range of technical and electrotechnical domains, incl. LAN and MAN specifications, addressing rules (IP, URL), AI, IoT, automotive, robotics, home automation, etc.
IETF	All Internet related specifications, incl. protocols, generic applications, addressing rules (IP, URL).
ECMA INTERNATIONAL	Media specifications, ICT specifications fed into ETSI, ISO/IEC, IEEE, etc.
3GPP	Develop technical specifications for the 3rd generation of mobile, cellular telecommunications, UMTS, LTE and 5G
ONEM2M	Global community that develops IoT standards to enable interoperable, secure, and simple-to-deploy services for the IoT ecosystem.

Architecture, including networking architecture, is essential in standardization as well as in the technology strategies supporting a business strategy. In standardization, for example, at the ITU and ETSI, the architecture is defined as part of the three-stage development process as agreed by the ITU (see Chapter 4, Section 4.2.4).

6.2.3 LOCATIONS AND RELATIONS AMONG SDOS

In deciding in which SDOs and technical committees to participate in, the interrelations among the SDOs, and the status of an SDO with respect to public authorities, can play an important role. For example, for ETSI members, the status of ETSI as a recognized EU standardization body, along with its relations with the ITU, CEN/CENELEC, the CEPT and the IEEE are important, and have probably played their part in member organizations choosing to participate in ETSI activities.

The geographical location, in particular in which continent, and the locations where meetings take place also play a role in deciding in which SDO to participate.

The geographical location may create organizational difficulties for some organizations, as this location may not coincide with its geographic establishment. For example, the standardization activity may take place in one continent, whereas the entity with the corresponding technical responsibility within the organization is located in another continent. However, due to the Covid pandemic, standardization meetings now take place entirely on-line or have the possibility to allow remote attendance (hybrid meetings) and this is very likely to continue in the future. However, some organizations are looking forward to resuming physical meetings.

It should be noted that SDOs are typically Non-Governmental Organizations (NGOs), with the legal status of non-profit organizations.

An exception is the ITU, which became a United Nations organization, mainly due to its long history of existence —since 1865 —as an international committee.

Table 6.3 illustrates the main characteristics of major standardization organizations, including their type of membership. The membership ranges from individuals (e.g. IEEE and the IETF), to companies/organizations (e.g. ECMA International) and national delegations (e.g. ISO and ITU).

Table 6.3: A simplified classification of SDOs by geographical scope and technical domain

ORGANIZATION	TYPE	HEADQUARTERS	RECOGNITION	DOMAIN OF ACTIVITY	MEMBERS	STANDARDS "FEEDING"
ITU	UN	Geneva (CH)	UN	Telecom + RF spectrum	National delegations	
ISO	NGO	Geneva (CH)	Multi-national	ICT	National delegations	>JTC1
IEC	NGO	Geneva (CH)	Multi-national	Electrotechnical	National delegations	>JTC1
JTC 1	NGO	Geneva (CH)	Multi-national	Joint Committee ITU and ISO	National delegations	>ISO/IEC
ETSI	NGO	Sophia Antipolis (FR)	Multi-nat. / EU	ICT and Telecom	Direct Members	>ITU
CEN	NGO	Brussels (BE)	Multi-nat. / EU	ICT	National delegations	>ISO
CENELEC	NGO	Brussels (BE)	Multi-nat. / EU	Electrotechnical	National delegations	>IEC
CEN/CENELEC	NGO	Brussels (BE)	Multi-nat. / EU	Joint comm. CEN + CLC	National delegations	>ISO + IEC
IEEE	NGO	New York (US)	De facto	ICT + electrotechnical	Individuals	>ISO
IETF	NGO	Fremont (US)	De facto	ICT (Internet)	Individuals	(>ISO + ITU)
ECMA INTERNATIONAL	NGO	Geneva (CH)	De facto	ICT	Organizations	>ISO

For more details on the coordination and cooperation among national, regional, and international SDOs, see Chapter 3.

In the EU, under the New Legislative Framework, the EC can "request" CEN, CENELEC or ETSI to produce "Harmonised Standards" that provide for simplified access to the single European market when cited in the Official Journal of the European Union (see Chapter 3, Sections 3.5.2 and 3.5.3). Such standards are therefore of strong importance to the market players and competitors.

In Europe, frequency harmonisation measures are studied by and decided on by the member states within the CEPT (European Conference of Postal and Telecommunications Administrations) organization. Due to the fact that ETSI has been created from the CEPT, their standards are co-ordinated with CEPT frequency harmonisation measures to promote harmonised requirements for products and for spectrum use. ETSI Members can initiate spectrum harmonisation actions and take part in detailed drafting within CEPT. Hence ETSI provides a route into this area and this is another reason for certain organizations to participate.

6.2.4 TECHNOLOGY STRATEGIES

Apart from presence and active participation in standardization, there are also key technology-related considerations for passive participation:

- The "radar" function: standardization gives an excellent insight into technologies and applications that may become important in the (near) future.
- The activity of other participants can be an indication of their level of R&D activity and positioning with respect to the state of the art, and/or an indication of the priority as well as importance that an organization gives to a certain development.
- The participation may be used to provide information for the formation of consortia, interest groups, fora, etc.
- The participation can help promote ideas and solutions, including IPR.
- The scale of the standards development may incite dialogue with public authorities, giving a preview of public support, legal measures and concerns.

As stated before, organizations may also decide to be active in standardization activities that do not correspond to their core activities. In this case, it is unlikely that these organizations will have the same level of competence in these domains, in comparison to their core activities and competencies, and therefore may have more limited possibilities to contribute.

EXAMPLE

A telecom services operator targeting involvement in Intelligent Transport Systems may need to follow standardization efforts related to telecom infrastructure, communication infrastructure and road infrastructure. However, the technical areas in which the operator would be able to significantly contribute on road infrastructure, for example, may be limited.

An organization leading in a domain may take an active role in new developments, or it may take a defensive role where it seeks to avoid the development of a competing standard should this be proposed. It might not look favourably at standardization activities that might result in competition to standards in which it has invested even though the development of competing standards would be a rarity.

6.3 CONDITIONS AND EXTERNAL INFLUENCES

This section addresses factors and boundary conditions that have an impact on the standardization process, from the perspective of a participating organization. In the following section, we will look at relations within the standards ecosystem as well as the external factors and influences.

Figure 6.1 gives a simplified but illustrative image of the standardization process, seen from the perspective of a participating organization.

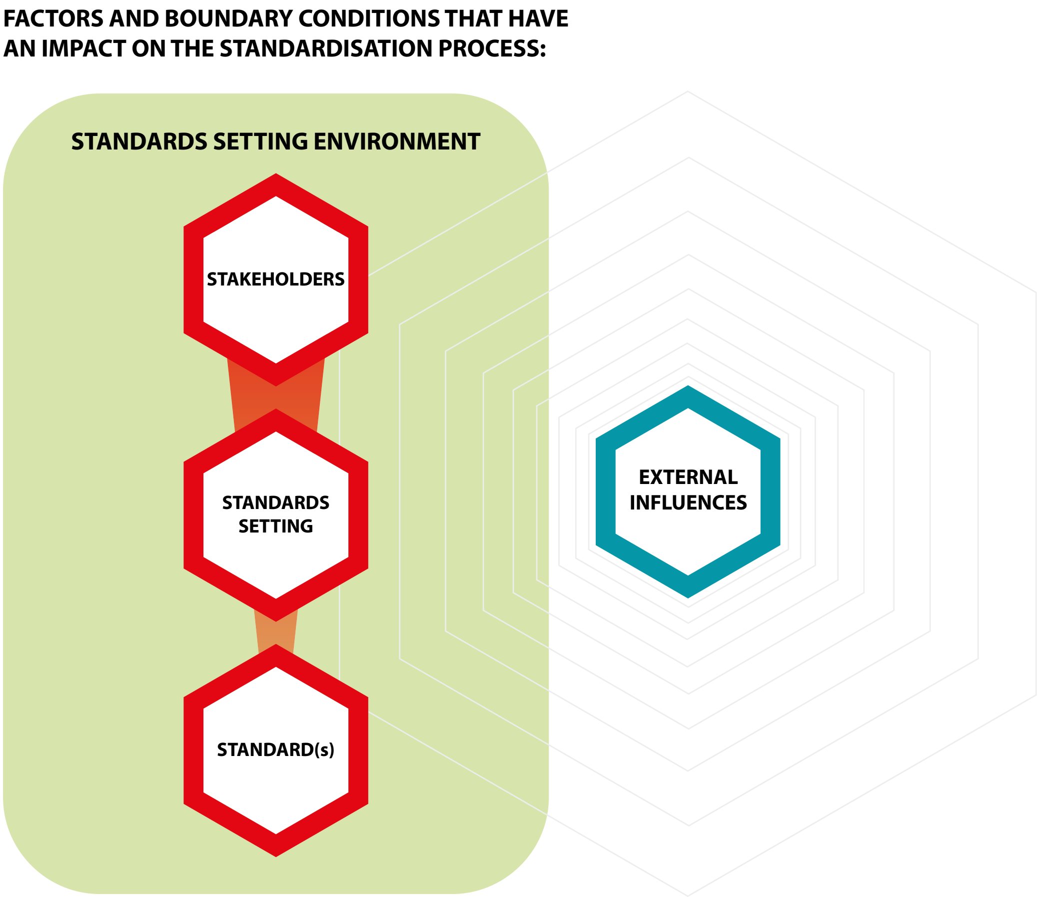


Figure 6.1: A very simple view of what influences a standard (Jakobs 2014)

6.3.1 MANAGING THE RELATIONSHIP BETWEEN STANDARDIZATION AND MARKETS

There is a strong interrelationship between standardization, technical development, and market development. Managing the relationship is challenging and needs to take into consideration, as far as possible, dynamic market trends, and market forces, as well as technology developments and their industrial applicability and maturity.

Active participation in standardization by a company/organization requires a good insight and knowledge about a company's or an organization's objectives, policies, market and financial position, and ongoing research and development. This may not be true for individual delegates but the need to give them a stronger knowledge from the technical and commercial angle is well acknowledged.

This also requires a deep insight and a good assessment of the technology's opportunities for development, roadmaps, and uncertainties. Uncertainties may include "unknown unknowns". Included in this latter category is unexpected competition developing among different technologies, i.e. the domain of application of one technology overlapping with the domain of application of another technology. But also the application of a given technology unexpectedly becoming more prominent in the market than was foreseen.

EXAMPLES

Here are a number of examples, in which most industry observers were surprised by the success of technology:

The first example is the importance of SMS and of roaming in GSM cellular wireless communications. In follow-on technologies (3G, 4G, 5G) and in regulation these have been taken fully into consideration.

A second example is the overlap in application domains between wireless communication and fixed network technology. Whereas there is still significant complementarity between fixed and wireless networks, the area of overlap is much larger than had been initially expected.

Another example is the use of generic data services on modern high speed networks (fixed as well as wireless) to support services such as voice over IP and conferencing over IP, strongly competing with the equivalent dedicated services such as voice, audio, video conferencing, etc.

A final example is the user interface, evolving from character mode to graphic mode, to colour graphic mode, to touch and voice recognition and then virtual reality.

6.3.2 MANAGING COOPERATION

Standardization is a competitive domain, but one that requires cooperation to produce results. This requires competitors to work together as partners. Standardisation is also a pre-competitive domain, that requires cooperation between competitors to produce results that provide benefit to all actors. When successful, all parties gain sufficient benefit to implement the standards voluntarily. Such cooperation can take two modes of operation: active cooperation and passive cooperation.

Active cooperation requires partners and competitors to work actively together on the development of a standard or specification, including technical details, as well as promotion outside of the SDO. This often reveals different visions, different product strategies, and interests that go well beyond the preferences of individuals or organizations.

As such, tensions may arise when working on technical issues, some of which may be related to diverging product strategies. For example, during the development of the specification for a carrier service, the requirements may be perceived differently by participants intending to use it for film and TV distribution and by participants targeting general "Internet" services, where the latter may accept much higher tolerances in quality-of-service parameters.

Passive cooperation may be a pragmatic attitude in standardization; it does not, however, give any indication of commitment for the support and adoption of the results, and therefore does not prevent less successful standards nor the proliferation of standards.

6.3.3 MANAGING SYNCHRONIZATION WITH TECHNOLOGY INNOVATION

Standardization may be considered as too early in time, in sync or following with regard to developments. It includes technology developments and trends, market developments and value chain ordering, market push and pull, societal trends and developments, and the legal and regulatory environment.

Leading, i.e. early standardization means that not all issues and requirements are fully known or understood. This results in standards of the anticipatory type (see Chapter 5).

In sync, i.e. "just-in-time" standardization, needs the process to be agile and may need flexibility to adapt to and stay in sync with technological development. By staying in sync, standards of the enabling type are produced (see Chapter 5).

Following, i.e. "late" standardization, may mean a catch-up with a de facto situation, or with a dominant design. This leads to the generation of standards of the so-called responsive type (see Chapter 5).

This point also covers the different speeds of development of ICT standards – especially covering large technological areas – and the different outlooks. In ICT standardisation there is not a huge gap between standards development and technology deployment. This is because those developing the standards are also those deploying the technology, and hence there is a strong interest in achieving this in sync and as fast as possible.

As a result the standardization takes place “in synch” so that technological development and market requirements are generally achieved at a complementary and supportive level of expected maturity. The update and maintenance of standards are also made possible with releases of updates when required.

Today, technology and markets are developing at a fast pace. However, this is only partially applicable to infrastructure, which has a greatly delayed connection to the fast developments of technology, as deployment and roll-out of infrastructure takes significantly more time. Therefore, equipment that interfaces with infrastructure will be developed in synchronization with the development of the underlying technology, at least for the interface and related parts.

6.3.4 DECISION MAKING – CONSENSUS MODE THE MAIN OPTION

Consensus is a major principle used in formal standardization and ICT standardization in particular and it is very important to recognise this as the way in which SDOs and others operate (see Chapter 4). This is the manner in which organizations collaborate and develop standards. It enables all participants to be active in developing standards and to achieve vast number of agreements during the drafting period.

Taking ETSI as an example, it operates by consensus and the vast majority of agreed output is obtained in this manner and without any need for a vote. Voting (in ETSI) is rare. Most decisions are based on consensus, supporting voluntary application of the standard. This can also be said for many of the bodies in this field. It also means that the work is normally produced promptly and without significant conflict. However, other organizations may move to a vote for decision making.

Different standards organizations have different voting rules, such as:

- weighted National voting on ENs, based on category, size, etc.; for example: ETSI, CEN/CENELEC
- individual standardization professionals vote, based on regular attendance; for example: IEEE802, IETF

Also, the interests of an SDO as an organization itself may play a role in how it handles standardization developments. The SDO's operational entities, in other words its secretariat and governance entities, likely have a role in relations with members, other SDOs and with public authorities. The organization's overall vision, roadmaps and interests may play a role in the evaluation to accept or reject proposals for new standards. This might even play a role in the voting on the acceptance or rejection of a standard, for example whether the standard fits in with the organization's views and cooperation with partner organizations.

6.3.5 MANAGING PHASES OF STANDARDIZATION

Standardization needs to consider the following external aspects of management.

Standards need to comply with legal, regulatory, and other requirements concerning materials, safety, safe practices, accessibility, security, etc. Standards may indeed on occasion be included in regulation if the legislator decides to do so.

Standards need to coexist with existing systems or those developing in parallel. The concept of coexistence is becoming increasingly important. In particular, coexistence is of importance for access to the frequency spectrum. In the past, radio systems were mostly allocated unique frequency bands; however, due to the sharp increase in the cumulative bandwidth required for wireless systems, frequency spectrum management now accepts reuse, overlap with and sharing of frequency bands, which introduces significant coexistence requirements.

Although this may be achieved only partially, standards need to achieve interoperability among the different implementations of equipment and services using them.

6.4 COMMUNICATION WITHIN STANDARDIZATION ACTIVITIES

The requirements for the "standardization professional" include the right mix of leadership, technical and/ or market vision, technical competence, communication skills and representativeness, diplomacy, and negotiation skills (see Chapter 4).

Meeting all these requirements requires highly skilled and communicative professionals that gain with full support from top management. Because of this the organization needs to recruit or train standardization professionals and give them the means to communicate with all levels of the organization (see also Chapter 4). These professionals may be disseminated in the different units of the organization, or gathered in a dedicated standardization team communicating with the rest of the organization.

Often, however, only some of these conditions are met and, consequently, standardization teams may lack some of the critical support needed to fully perform their tasks.

One of the reasons for this is that standardization teams would need access to top-level decision makers in a large part of the organization, as a "non-resident" in order to explain/present standard developments. This requires privileges that, in an organization, may be restricted to high-level officials e.g., vice-presidents and higher.

An alternative would be for the individual standardization professional or for the internal standardization team to obtain a high level of recognition from other entities in the organization. However, this may lead to incomplete access to the necessary information and to informal exchange of information.

One solution is to have a "dedicated standardization team" with access to top management to coordinate and stimulate the support and effectiveness of standardization activities. For example, this could raise an issue where developments in standardization could be alerted at an early stage to enable an organization to react promptly to developments which may have an impact on the position in the market of the organization. This should be a long term effort. The organization should provision and secure the necessary resources, as well as "capture" the standardization professionals it involves in its standardization work. This can raise awareness and also change participation levels.

6.5 CHOOSING STANDARD(S)

6.5.1 THE STANDARDIZATION PROCESS FROM AN IMPLEMENTATION PERSPECTIVE

The ultimate goal of standardization is the implementation of the resulting standards in products, services, and processes for the benefit of users and industry as a whole. Hence the selection of which standard(s) to follow is very important throughout.

Excellent examples of successful standardization are the sets of standards for 2G, 3G, 4G and 5G mobile networks. These sets of standards have achieved wide acceptance in global markets. Technically, these standards excel in achieving interoperability, as is demonstrated by almost flawless international roaming capabilities.

Interoperability testing has become a highly popular way in which to gain knowledge of whether products meet with the requirements of a standard or standards and it can improve the development of the standards process and the implementation process. The testing events can be found in various forms but perhaps most clearly as Plugtests (in ETSI), Hackfests or Plugfests in other SDOs/organizations.

6.5.2 WHAT TO TAKE INTO CONSIDERATION

Since the need for compliance with numerous standards and specifications is increasing, and the perception of the distinction between SDO standards and de facto standards is decreasing, this section gives some practical considerations and steps to select the most suitable set of standards and specifications to adhere to when implementing a given application.

In some cases, choosing the standards needed to adhere to may be rather simple. For example, when the intention is to bring to the market products supporting access to 2G, 3G, 4G and 5G networks, the choice is obvious (even though in practice there are many optional features). There is a complete suite of standards and tests available.

Less clear, however, is the choice when, for example, products are aimed at the "smart anything everywhere" market, where there is a choice of many different wireless networks (including supporting access to "LPWANs" such as LoRa, Sigfox, Ingenu, in addition to 2G, 3G, 4G or 5G).

Some considerations, criteria, and guidance for selecting the standard(s) in such cases are required. Note, however, that these criteria are only intended to help and provide guidance, and cannot be used as, a "1-2-3 decision machine".

Interest in standards in a specific case may range from the need to specify compatibility and/or interoperability in procurement, purchasing sub-systems or systems required to implement certain standards, to developing "in-house" products or services that need to comply with standards and interoperate with other implementations. The issue of "developing products that comply with standards" is particularly challenging.

Some important criteria are integrated into questions to help organizations in the standards evaluation task.

- **Completeness:** is this standard / set of standards all that is needed, or is it the tip of the iceberg; what other standards are needed to support or complement this/these standard(s)?
- **Stability:** is this standard new and still developing; is it mature and widely adopted and tested; is it aging and needs to be brought up to date (legacy components, coexistence, and interoperability with more recent systems); is there an installed base, and what is its influence (stability, but also innovation inertia)?
- **Maintenance:** is maintenance of the standards ensured; are there other mechanisms to learn about issues, workarounds, and de-facto reference implementations?
- **Interoperability and conformance:** are good conformance tests and test facilities available; what is the required level of interoperability, does it need to be demonstrated, is it a condition sine qua non; what is the scope of the required interoperability: some functions, a subset, all functions; is interoperability required with the standard or with a dominant implementation (that itself may be only partially compliant with the standard or specification); are good interoperability tests and test facilities available; what level of interoperability is demonstrated by products on the market?

Assuming that implementation of the standard(s) is targeted, then interoperability is of key importance. Interoperability is often achieved only partially. Conformance is a prerequisite, but not a sufficient condition for interoperability. Complementary plugtests/plugfest/hackfest testing is a very useful addition, but by itself may not guarantee general interoperability either.

The next step in the evaluation process would be to allocate a weight to these parameters, which may range from less important to a condition sine qua non, in other words, a blocking factor if not met.

6.5.3 SUPPORTING STANDARD “X” – WHAT’S NEXT?

After making a choice, you implement a specific set of standards and specifications. This choice, but equally the results of the detailed evaluation that led to this choice, may influence your position: you are now a stakeholder with an interest in a specific standard "X". And this then may be an argument to change some of your priorities in participation in standardization. This may include increased participation, or more focused participation.

For example, the interest may now be on increased involvement, supporting, improving or completing the selected standard(s) and specifications, adding or improving interoperability tests and testing, etc.

6.5.4 WHAT IF A SUITABLE SET OF STANDARDS OR SPECIFICATIONS CANNOT BE FOUND?

If, after your internal evaluation, you cannot come up with a suitable set of standards or specifications, it is recommended that you consult with your partners (suppliers, customers, and competitors). If the subject appears suitable for an existing SDO, then direct your request, along with your reasons, to what you consider to be the most suitable SDO. Some SDOs are offering possible routes to follow. For example, ETSI offers the Industry Specification Group (ISG) route where work can be carried out with other stakeholders and specific ETSI members to establish possible specifications. The ITU also offers their Focus Groups as an alternative. If the subject appears less suitable for an existing SDO, then consider pitching it to a suitable industry forum.

If the subject does not appear to fit anywhere, then consider setting up your own forum or an ISG, together with partners, including competitors. An industry specification developed in this manner could later try the PAS (Publicly Available Specification) process described in Chapter 3 (or an ETSI Group Specification if an ISG is the route chosen). It could also become a SDO standard if, in the meantime, interest in the subject has increased and become more widespread.

6.6 SUMMARY

IIn this chapter, participation in standardization is described from the perspective of an organization interested in getting involved.

In addition to the different reasons that organizations may have to participate, this chapter examined how to choose a SDO to participate in, as a function of the domain of activities and possibly of geographical location. It also presented technology aspects.

This chapter also addressed the operation of standardization efforts and organizations, the use of consensus building, different voting systems (e.g. national weighted voting, membership voting and one by one voting) and rights, and external influences. Among the important external influences are market trends and developments, which may also be considered the most difficult influences to deal with. It is also considered that standardization in general is closely linked to technological development. However, this is not a guarantee that each standard has taken all relevant technological development sufficiently into account. The relevance may evolve, or become visible only (long) after a standard has been published.

As presented, participation in standardization requires internal and external communication within an organization. It also requires in-house company objectives and policies to be linked with external standardization. To succeed in their tasks, teams of standardization professionals should have the possibility to communicate with virtually everybody anywhere in the organization.

Finally, the chapter discussed some considerations to help evaluate and choose standards for a target application. It also introduced the consequences of both the evaluation and the resulting choices. Indeed, a stakeholder that takes a different perspective can influence certain standards activities.

6.7 QUIZ

1 - WHEN IS AN ORGANIZATION PARTICIPATING IN STANDARDIZATION CONSIDERED A "LEADER"?

(See Section 6.2 for hints)

a) *When it develops more standards than others*
b) *When other organizations use its ideas*
c) *When standardization is business critical for the organization*
d) *When it pays the highest membership fees*

2 - WHAT IS THE FORMAL STATUS OF MOST STANDARDIZATION ORGANIZATIONS?

(See Section 6.2for hints)

a) *They are part of the ministry of internal affairs*
b) *They are part of the ministry for trade and foreign affairs*
c) *They are, non-governmental organizations (NGOs) registered as legal entities, like non-profits*
d) *They are part of United Nations organizations, like the IMF and WHO*

3 - CAN AN ORGANIZATION BE A MEMBER OF BOTH CEN/CENELEC AND ETSI?

(See Section 6.2 for hints)

a) *No, CEN/CENELEC has national organizations as members, ETSI only accepts companies*
b) *Yes, but only national standards organizations can be a member of both CEN/CENELEC and ETSI*
c) *No, because ETSI only accepts commercial organizations that pay a membership fee*
d) *Yes, because commercial organizations can be members of both CEN/CENELEC and ETSI*

4 - WHICH STANDARDS ORGANIZATIONS HAVE A "ONE MAN, ONE VOTE" RULE?

(See Section 6.3 for hints)

a) *CEN/CENELEC, because each member organization can vote only once*
b) *ETSI, as only one person can vote from each organization*
c) *IEEE and the IETF, as votes are given to individuals with regular attendance*
d) *ITU, as only the Director is allowed to vote*

5 - IS IT EASIER TO OBTAIN A LARGE VOTING RIGHT IN ETSI THAN IN THE IETF?

(See Section 6.3 for hints)

a) *Yes, because you can "buy" votes by accumulating high membership fees*
b) *No, because in the IETF an organization can send many people to a few meetings*
c) *They are about the same, as both require resources: in the IETF an organization could send more people, in ETSI an organization would need a significant amount of revenue and fees*
d) *Yes, because in the IETF an organization gets disqualified if it sends too many people*

6 - WHAT MAKES A STANDARD PROPRIETARY?

(See Section 3.1 for hints)

a) *It is widely used*

b) *An organization holds an essential patent limiting its use by others*

c) *It is very comprehensive and comes with a complete test suite*

d) *It has been developed in isolation by a single or a closed group of organizations*

7 - WHO IS RESPONSIBLE FOR THE MAINTENANCE OF STANDARDS?

(See Section 4.2 for hints)

a) *In the EU, the European Commission*

b) *ETSI and CEN/CENELEC*

c) *Strictly speaking, nobody: there is a moral but no legal obligation for the organization that has developed and/or adopted and published a standard to maintain the standard*

d) *The users, as they represent the biggest test environment*

8 - TO TEST INTEROPERABILITY, IS ONE-TO-ONE TESTING SUCH AS "PLUGTEST" BETTER THAN CONFORMANCE AND INTEROPERABILITY TESTING?

(See Section 6.5 for hints)

a) *One-to-one testing, such as "plugtest", and interoperability testing are equivalent*

b) *One-to-one testing, such as "plugtest", and interoperability are complementary*

c) *One-to-one testing, such as "plugtest", is better because it tests two systems connected to each other*

d) *Interoperability testing is better as it tests against a reference implementation*

➜ ***SOLUTIONS PAGE 259***

6.8 GLOSSARY

- Backdoor policy: To switch to another SDO when a first-choice SDO does not want to undertake or accept a new standardization activity.
- Proprietary standard: A standard developed and controlled by a single or a small group of organizations

6.9 LIST OF ABBREVIATIONS

- CEPT – The European Conference of Postal and Telecommunications Administrations
- IEC – International Electrotechnical Commission
- ISO – International Organization for Standardization
- JTC1 – Joint Technical Committee 1 (an ISO/IEC Joint Technical Committee)
- SDO – Standards Development Organization
- SSM – (Corporate) Strategic Standardization Management

6.10 REFERENCES

- Abdelkafi, N., & Makhotin, S. (2012). Seizing Opportunities for the Support of Innovation through Committee Standards and Standardization – Insights from German Companies. (12), pp. 38-56.
- Jakobs, K. (2007). ICT Standards Development — Finding the Best Platform. In G. Doumeingts, J. Müller, G. Morel, & B. Vallespir, Enterprise Interoperability (pp. 543-552). London: Springer.
- Jakobs, K. (2013). Success in ICT standards setting. A closer look at some influencing factors. 8th International Conference on Standardization and Innovation in Information Technology (SIIT), pp. 1-10.
- Jakobs, K. (06 2014). Managing corporate participation in international ICT standards setting. International ICE Conference on Engineering, Technology and Innovation (ICE), pp. 1-9.
- Office Open XML. Wikipedia. https://en.wikipedia.org/wiki/Office_Open_XML. Accessed May 2018.

7 IPR AND STANDARDIZATION

LEARNING OBJECTIVES

- Students should know the most common types of intellectual property rights and should, for a given type of creation, be able to tell what type of intellectual property right could protect that creation.
- Students should be able to understand when a patent is standard essential, and how these come into existence.
- Students should know what type of challenges and concerns come with essential patents, and know the different types of policies that SDOs have adopted to deal with these challenges and concerns.
- Students should have a basic understanding of the legal aspects of essentials patents, and the type of disputes and struggles that surfaced over the years
- Students should know what patent pools are and how they can play a facilitating role between patent owners and standards' implementers.
- Students should be able to understand why the intersection of standards and patents is relevant to regulators, and what type of activities these have employed.

7.1 INTRODUCTION

In standardization, various participants bring innovative ideas. At the same time, innovative ideas may be subject to intellectual property rights (IPRs), which may limit the usage of these ideas. In fact, many standardization participants are also very active in applying for IPRs on the results of the research and development they engage in. For this reason, it is important for anyone interested in standardization to have a good understanding of the interplay between IPRs and standards.

This chapter starts by introducing the different types of IPRs and their main characteristics (Section 7.2). It then reviews the ways in which IPRs can be relevant to standards and standardization (Section 7.3). Focusing further on patents essential to standards (called Standards-Essential Patents or SEPs), the chapter explains the inherent tension between these two elements (Section 7.4) and discusses the different IPR policies that SDOs have introduced to address this tension (Section 7.5). It continues by explaining the role of the legal system in the various conflicts that have emerged (Section 7.6) and the role that patent pools play in making licenses available (Section 7.7). The next section discusses how policy makers and regulators look at the public interest dimension of these challenges (Section 7.8). The chapter concludes with a summary (Section 7.9).

DISCLAIMER:
This chapter is intended to be a laymen's personal introduction into the topic of IPRs and standards. It is by no means intended to provide legal guidance or to provide an interpretation of the IPR policies of ETSI or any other standard body. When dealing with standards and IPR, any party should consider the appropriate law and the applicable IPR policies of standards bodies and consult legal counsel where appropriate.

7.2 IPRS AND ITS DIFFERENT FORMS

7.2.1 BASICS OF IPR

Laws for the protection of intellectual property exist in virtually any country around the world. They date back many centuries; for instance, the well-documented patent system of the Venetian republic from the 15th century has remarkable similarities with the modern patent systems as we know now (Machlup & Penrose, 1950). Countries have laws to protect intellectual property for several reasons. Firstly, they give expression to the moral and economic rights of creators. Secondly, they can promote creativity and the dissemination and application of its results, and encourage fair trading contributing to economic and social development (WIPO, 2008). When creativity is of a technical nature, we call those inventions, and when these intentions are applied successfully into products and services, we call those innovations.

Just as creations by humans can take many different forms, there are different types of intellectual property rights that protect these creations. The most common types of IPRs are (see also Figure 7.1):

- Patent, which predominantly protects solutions to a specific technological problem, that is, an invention.
- Copyright, which protects creative expressions. Examples of such creative expressions are texts, books, music, movies, works, of art, but also, for instance, software code.
- Industrial design, which protects the visual design of "utilitarian" objects, including their shape, configuration or composition of pattern or colour. Examples are a specific type of chair, or a car design.
- Trademark, which protects words, signs or symbols that represents a company or products. Examples are "Nike", but also this company's "Just do it" tagline and its wing-like symbol.
- Trade secret, which is a piece of information (invention, formula, etc.) not known to the public, used for economic benefit by a holder that makes efforts to maintain its secrecy. Examples include the Coca-Cola formula, and Google's search algorithm.

Note, however, that a trade secret is not a 'right' like the other items in this list and may be better described as 'IP' than as 'IPR'.

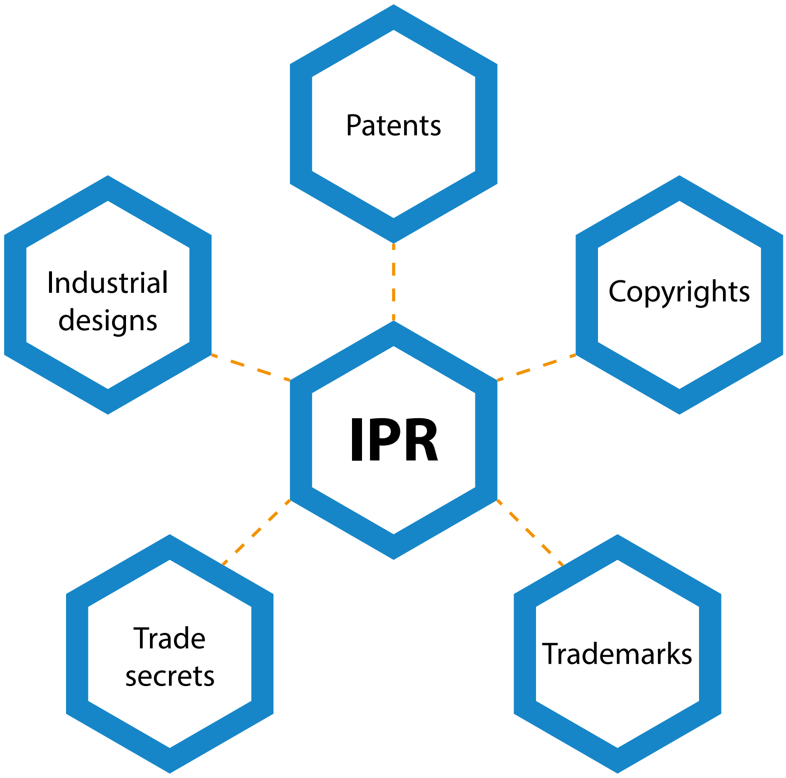


Figure 7.1: Types of IPR

Depending on the type of IP, the creator may need to apply for a right (e.g., patent, trademark), or may automatically receive the right (e.g., copyright). But what does it mean to own an IPR? This can be best described as follows: an IPR provides its owner with the right to exclude others from making use of the creation. It may use this right to 'keep the creation to itself'. But it may also choose to allow others to use the creation, for instance for monetary compensation, which is known as a license. The rights conferred by IPRs are temporary: the exclusive rights for patents usually ends after 20 years, while copyrights last for much longer: international agreements stipulates that they must last for at least 50 years after the death of the author.

Especially in the context of patents, it is important to stress that while an IPR allows the holder to exclude others, it does not offer the right to use the creation: it is well possible that using a patented invention also requires the use of inventions that were already patented by other organizations or individuals. In such a case, a permission (license) by these others is needed.

7.3 WAYS IN WHICH IPRS CAN BE RELEVANT TO STANDARDS AND STANDARDIZATION

IPRs can be relevant to standards and standardisation in different ways.

Firstly, standards are text documents, and the question of copyright arises. A common approach here is that anyone participating in standardisation agrees to transfer any possible copyright regarding his or her contribution to the standard-developing organisation, which then becomes the copyright holder of the text of the eventual standard.

Secondly, standards are often known by a name and associated with certain logos (or symbols or emblems, think of GSM, Wi-Fi, Bluetooth and CD). These names and logos have important signalling roles; mentioning them signals that a particular device is compatible with that standard. In order for implementers or users of the standards to use these names and symbols, it is relevant to know who the actual copyright owner is, and how the owner lets others (e.g., device makers) use that name or logo. Often, the SDO will be copyright owner of the name, but this is not always the case. For example, the well-known ‘GSM’ logo is owned by the GSM Association (GSMA), and not by ETSI, the SDO that developed this standard. And for the IEEE 802.11 series of standards for Wireless Local Area Networks, known generally to the public as ‘Wi-Fi’, this latter tradename and associated well known logo are owned by the Wi-Fi Alliance, a not-for-profit organisation that provides certification of devices based on this IEEE standard, and which allows the use of the Wi-Fi name and logo products that successfully complete interoperability certification testing.

Thirdly, the implementation of a standard into a product or service may require the use of certain intellectual property rights. This may be particularly the case of patented technical inventions, which is then known as a Standard Essential Patent (SEP; see also the next section) but may also include the use of copyrighted software code, insofar the standard requires the implementer to use exactly that specific code in order to implement the standard. Such Standard Essential Copyrights, as we could call them, are rare, compared to Standard Essential Patents.

It is this third type of relation between standards and IPR that has been the topic of many discussions and strategic conduct in recent years, and that will be the further focus of this chapter. Also, the chapter will focus on patents only, not on other forms of IPR.

7.4 THE TENSION BETWEEN PATENTS AND STANDARDS

7.4.1 A CLASH OF PRINCIPLES

The patent system and the standardisation system have many things in common. They are both systems institutionalized to serve the public benefit. For instance, standards can promote innovation (see Section 5.2.2), and the patent system promotes the creation of technical solutions (inventions) and the use of these in products and services (innovation), as discussed in Section 7.1 above.

Despite such important commonalities, there is an uneasy relationship between patents and standards, which creates tension and calls out for thoughtful considerations and policy. The underlying reason for this tension is as follows: patents aim to promote innovation by granting temporary rights to exclude others from using technological innovations, whereas standards aim to promote innovation by an endeavour to make technical solutions available to all interested parties without any undue barriers. The same goal, but entirely different mechanisms.

This tension is specifically there for so-called Standard Essential Patents (SEPs). While there are slightly different definitions of SEPs (for a discussion, see Bekkers & Updegrove, 2013), the basic concept is that without the use of the technology protected by that patent, it is impossible to make a product that satisfies the standard. That means that, without having obtained a permission (a license) to use the patented technology (or being the owner of that patent itself), an implementor cannot make or sell a product that complies with the standard. This creates a particularly strong position for the patent owner. Whereas in ‘normal’ circumstances, an implementer can choose not to implement a certain feature in a product if it cannot obtain the necessary licenses, or ‘invent around’ to create a similar feature using a technology different from the one that is patented (Lemley & Shapiro, 2007), in the case of a SEP both approaches are, by definition, not possible, since implementing the standard requires the use of the SEP. If a standard is covered by many SEPs, then each implementer must obtain licenses for each of these SEPs – insofar relevant for the product in question.

We will illustrate the status of being a SEP with two examples. The left panel of Figure 7.2 shows a block diagram for a so-called closed power control loop communications system, a technology that forms a fundamental basis for Wideband Code Division Multiple Access (W CDMA), a fundamental technology that is used in many telecommunications standards such as 3G and Wi-Fi. Taking this picture and assuming there is a patent that protects such a power loop, then it is well possible that such a patent is essential to the ETSI UMTS (3G) standard, which is based on W CDMA – there may be no way to implement that standard without using the technology covered by this patent. Yet, an ultimate determination of essentiality can only be made by deeper investigation of the granted patent and the final text of a relevant standard. The right panel of Figure 7.2 shows a phone keyboard with a predictive text entry technology known as T9, which was present on many mobile phones before the smartphone made the physical keyboard on mobile phones obsolete. While the T9 technology, originally developed by Tegic Communications, was covered by patents, these patents were not essential to the GSM or UMTS standard, as there is nothing in the definitions of these standards that require the inclusion of this specific predictive text entry technology. (ETSI could have done so, in the same way these standards include other specifications concerning the user interface but did not do so in the case of T9.) Therefore, a phone lacking T9 text entry can still perfectly comply with the standard. Note that even though these patents are not essential to the named standards, they can be still quite valuable: T9 text entry was valued by many consumers, and in consequence, many phone makers would be willing to pay for the necessary patent licenses so they could include this feature on their device and make the phone more attractive for prospective buyers.

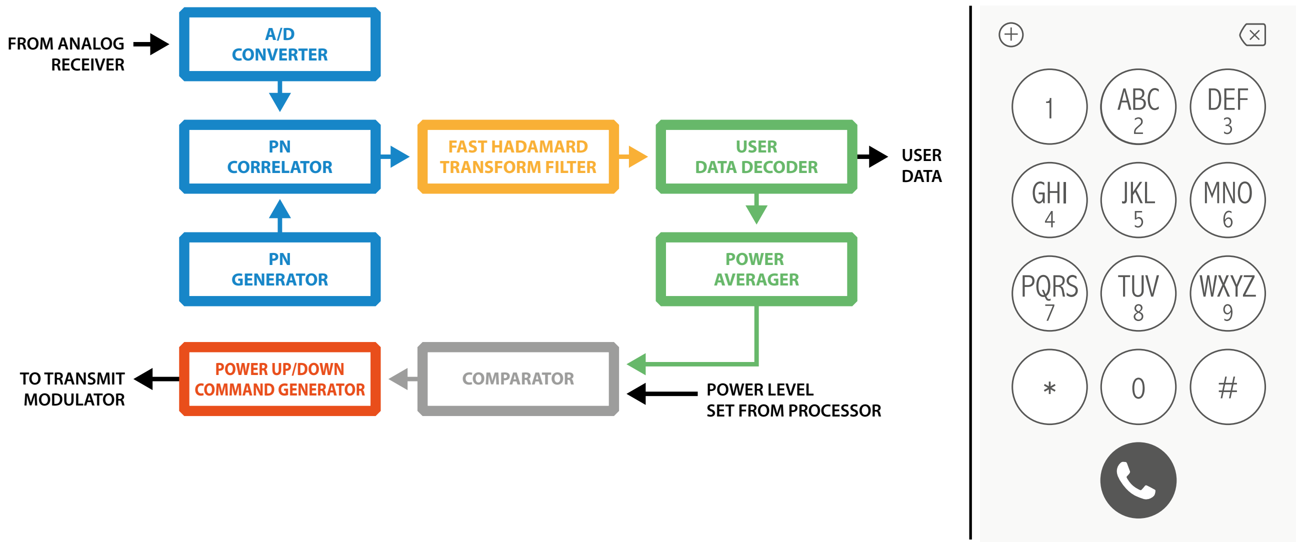


Figure 7.2: Block diagram for a closed power control loop (left) and keyboard supporting T9 predictive text entry technology (right)

7.4.2 HOW SEPS COME INTO EXISTENCE

How does one obtain a SEP? One can of course wait and hope that others establish an SDO standard that uses a technology that is covered by one of your patents. But more commonly, a patent owner will actively promote its own patented technologies for inclusion into the standard by participating in the standardization process and submitting technical proposals (contributions). Alternatively, a party can choose to acquire SEPs on the market by buying them from a SEP owner. Such transactions demonstrate that SEPs represent a valuable asset. For example, in 2010, a consortium that included Apple, Microsoft, and Ericsson paid US$ 4.5 billion for the patent portfolio of Nortel, believed to contain many SEPs.

Given these positive incentives, how many SEPs do exist? In practice, many standards do not require the use of any patented technology at all. In fields such as telecommunications and consumer electronics, however, it is common that standards are covered by many patents. Therefore, the above question is hard to answer precisely. Technically, one could take the text of (a particular version of) the standard, and the text of the (granted) patent, and come to a determination, whether that patent is essential to that standard. This calls for a considerable effort, which also requires specific expertise. In many technical areas, the number of patents to check is huge. The best indication we have is patents and patent applications that are declared by their owners to be potentially essential to a standard in the course of the standardisation process (more on the obligation to make such declarations is provided in Section 7.5). Note the words *potentially essential*: by this declaration, the patent owner expresses the belief that these patents may or may be essential to an ETSI standard. Yet, at the time of such a declaration, the precise content of the final standard is not yet known, and the technology in the declared patent may eventually not be included in the standard at all. Furthermore, by the time of such declaration, the ultimate scope of the patent may not be yet known either – this only becomes known at the moment when that patent is actually granted (or granted at all).

A study carried out for the European Commission (Bekkers, 2020b) investigates such declaration data for ETSI. By February 2019, the ETSI database included a total of 261,735 patents declared by their owner to be potentially essential. Note, however, that many of these patents may relate to the same underlying invention, but protected in different countries, thus resulting in considerable overlap. For instance, the invention(s) protected by United States patent US 5,056,109, which is about a closed power control loop as discussed in the previous section, are protected by patent EP 0500689 B1 of the European Patent Office (EPO), in Canada by patent CA 2072989 C, in Japan by JP 2776632 B2, in South Korea by patent KR 100215947 B1, and so on. In this context, counts of patent families (grouping of patents that cover the same invention) are more meaningful, as they tell us more about the number of patented inventions, instead of in how many countries the owners have applied for patents on these inventions. In fact, SEP licensing negotiations are typically about worldwide patent portfolios, not negotiations for each individual country. Therefore, it is more informative to talk in terms of patent families, which are grouping of patents that cover the same invention. The 261,735 patents mentioned above are part of slightly over 25,000 patent families. As noted above, not all these declared patents will eventually be *factually essential* for the final standard, but it is likely that for all ETSI standards, that number is still likely to be into the thousands.

One may, of course, wonder why patents are not assessed on factual essentiality, so we know exactly which patents are essential or not. The main reason is that carrying out such assessments in a reliable way is a very challenging task, requiring very specific expertise and objectivity. Both patents and standards use very specific, but different language. Without extensive expertise, it is hard to establish the precise boundaries of the patent (i.e. what the patent protects and what not) and to determine whether the protected matter in the patent is in fact the only way to satisfy the requirements as stated in the standard. Still, in 2017, the European Commission published an important document (EC, 2017) that took the position that more transparency is needed and that is desirable that information on factual essentiality would be available to market players, and in 2020, a study carried out at the request of the European Commission reported on the feasibility and design of a large-scale system for essentiality assessments (Bekkers et al., 2020a). After the publication of that report, EC Executive Vice-President Vestager announced that the "Commission will explore setting up an independent system of third-party essentiality checks [...]" (EC, 2020b: p.2).

But, as long as such a system is not in place, declarations of potentially essential patents is the best data we have. As illustrated in Figure 7.3 below, the number of declarations of potential SEPs is growing over time. This is no surprise, as there are clear incentives for companies to own standard essential patents. They can be a significant source of licensing revenue (as every implementer of the standards has no choice but to seek a license) and can be used in licensing negotiations with other parties that own SEPs as well (cross-licensing of SEPs). The specific position that a SEP owner enjoys, however, can also be a cause of concern, and hence, in the next sections, we discuss such concerns (Section 7.4.3) and IPR policies – such as FRAND – that determine the rules of the game.

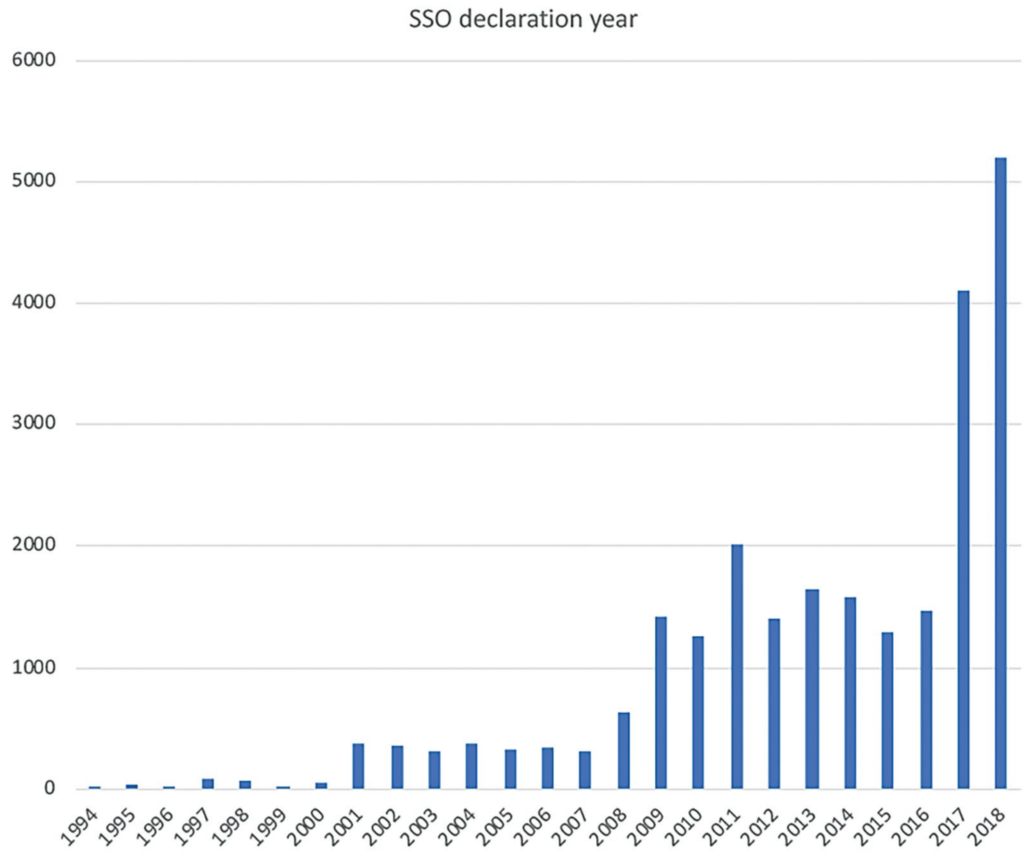


Figure 7.3: Number of declared potentially essential patent families to ETSI by declaration year. Source: Bekkers, 2020b

7.4.3 CONCERNS WHEN PATENTS COVER STANDARDS

While patented technology can bring innovative and valuable solutions into a standard, the inclusions of this technology can also raise a number of concerns, depending on the actual conduct of the patent holders. Following a study carried out for the European Commission (EC 2014), we now discuss four major concerns:

NON-AVAILABILITY OF LICENCES

This refers to the situation where SDOs and their participants, after having finalized and published a standard, find out that one or more owners of essential patents are not willing to license these. As a result, all the time and effort spent on the standard would be wasted.

EX POST PATENT HOLD-UP

This refers to the situation where essential patent owners, aware of the fact that implementers have no choice other than obtaining a license from them, use the resulting bargaining power to demand a significantly higher licensing fee than they could have obtained in a licensing negotiation where implementers were not yet 'locked into' the standard. Such a use of bargaining power is known as 'hold-up' in the economic literature, and the fact that this bargaining power is unleashed if negotiations take place *after* the inclusion of the patented technology in the standard is known as 'ex-post' in the economic literature (Lemley & Shapiro, 2007).

ROYALTY STACKING

Here, the concern is that if a standard covers many essential patents, the total amount of royalties for a single product that implements that standard (and hence needs to license all the associated essential patents) mounts up to such a level that the product is no longer commercially viable. This problem could be exaggerated if a single end product includes multiple standards (such as a mobile phone, that incorporates 3G and 4G mobile communications, WiFi, Bluetooth, and much more). Note that royalty stacking is different from ex-post patent holdup, as it could occur even when the license fee for each individual SEP – looked at in isolation – may be seen as reasonable and not higher than what would have been agreed in ex-ante negotiations.

UNDUE DISCRIMINATION

This refers to the situation where an essential patent owner treats implementers differently, resulting in discrimination. For instance, a SEP owner may feel an incentive to treat a company that is its most direct competitor in its own product market differently from a company that is only active in other product markets. Also, established players may treat each other in a more favourable way than they treat newcomers.

Note that all the above are concerns for the implementers especially (even if many SEP owners are also implementers themselves, and if they are not, they still could suffer in more indirect way of the above effects). Having that said, patent owners have also expressed other concerns – that are also related to the policies that we will discuss in Section 7.5 below. One of these concerns is known as ‘hold-out’, and refers to the situation where the implementers, being aware that these policies place restrictions on the conduct of patent owners, delay negotiations for licenses as much as they can, or may negotiate without the real intention to conclude license agreements at all.

7.5 IPR POLICIES AT SDOS

SDOs have already been long aware of the difficult relationship between patents and standards. Back in 1932, the American Standards Association (ASA), predecessor of the current-day ANSI, noted possible undesired effects when standards would require patented technologies, while they concluded that ‘“As a general proposition patented designs or methods should not be incorporated in standards.” They also noted that “each case should be considered on its merits, and if a patentee be willing to grant such rights as will avoid monopolistic tendencies, positive consideration to the inclusion of such patented designs in a standard might be given.” (Contreras, 2015:43).

Yet, it took until the 1980s and 1990s before intensive discussion started at almost all large SDOs to adopt IPR policies. Some SDOs adopted policies that cover patents only (e.g., IEEE, ISO and IEC), others developed policies that cover all IPR, including copyright (e.g., ETSI and IETF). Each SDO had its own discussion and made its own choice in terms of the policy it adopted, matching its objectives, its specific technical context, and its culture. Moreover, each SDO has its own rule-making mechanism (Baron et al, 2019). Still, these policies can be broadly categorized into two main categories: commitment-based and participation based policies.

COMMITMENT-BASED POLICIES

Commitment-based policies (for instance at ISO, IEC, ITU, ETSI and IEEE) consist of two main elements: disclosure and commitment. Under such policies, members (or participants in standardisation) have the obligation to inform ('disclose', 'declare') the SDO when they believe they own patents that may be or may become essential to a standard. This may be the case, for instance, when a patent owner submits a proposal (contribution) for that standard that covers its own patent(s), or when solutions are suggested by others that cover its patent(s). The disclosure triggers the second element, commitments. It works as follows. After disclosure, the patent owner is requested to commit itself to making licenses for these patents available at Fair, Reasonable and Non-Discriminatory (FRAND, sometimes referred to just as RAND) conditions for implementations to comply with the standard, if the patent indeed becomes essential. Some SDOs (including ETSI) simply seek FRAND statements. Should patent owners be willing to make licenses available for free, they can do so, but the FRAND statement itself does not require this. (The patent owner, however, must ensure not to discriminate across its licensees, for instance by offering free licenses to some and paid licenses to others.) Other SDOs (including ISO, IEC, ITU and IEEE) allow submitters to choose between a FRAND and a Royalty Free (RF) commitment (meaning that no monetary compensation is sought). Submitters are free to choose, but once they have chosen Royalty Free, they cannot later undo this and start asking for monetary compensation. Other SDOs (such as IETF in case of security standards), may always seek Royalty Free (RF) commitments, thus not allowing the patent owner to select a licensing commitment that allows for monetary compensation at all.

Patent owners can choose not to make the requested commitment, and in that case, the SDO will avoid making a standard that would require the patented technology in question. Yet, in practice, patent owners generally do make such commitments. After all, it is much more interesting to have a patented technology implemented in, say, millions of devices, and be restricted to a FRAND fee, than to be able to ask any license fee you want but no one implementing the patented technology at all.

PARTICIPATION-BASED POLICIES

Participation-based policies (used for instance at W3C and HDMI Forum) require that all members of the SDO are willing to license all their essential patents at specified conditions, such as FRAND or Royalty Free, and this commitment is a condition of membership. Sometimes, members are allowed to opt-out of this commitment for a specific patent, if certain conditions are met (for instance within a defined number of days after a draft standard has been published). If a member opts out for a specific patent, then the SDO will avoid making a standard that would require that specific patent – that is, it will change the draft standard. Some SDOs with participation-based policies additionally have disclosure rules, but most do not. Participation-based patent policies are most common in smaller SDOs, focusing on relatively narrow technological areas. In such 'smaller' environments (such as W3C and HDMI Forum), participants are more willing to accept such a policy that in 'broad' environments (such as ISO), where work commences on many different technology areas and it would be hard to track all those areas.

Regardless of the above policy type, obtaining a FRAND or RF commitment from all (known) owners of potentially essential patents is the main mechanism to address the four possible concerns discussed in Section 7.4.3 above (which were: non-availability of licences, ex post patent hold-up, royalty stacking, and undue discrimination).

As explained, many SDOs have disclosure policies, which generate lists of patents that may be or may become essential to a standard. Almost all SDOs make these lists publicly available; in fact, the data shown in Figure 7.3 above was generated on the basis of the database made available by ETSI.

7.6 IPR, STANDARDS, AND THE LEGAL SYSTEM

How can one be sure that a party respects the commitments it made to an SDO in terms of licensing essential patents, or respected other obligations related to standards and IPR, such as disclosure obligations? To answer this question, we need to look at the legal system. Important elements are patent law, private law, and competition/antitrust law. Patent law is relevant here because it is this body of law that allows a patent holder to prevent others from making, using, selling, or importing the patented invention without permission. Private law is relevant because it governs contracts and other relationships between companies and other parties. Finally, competition/antitrust law is important because it places restrictions on the conduct of parties (or groups of parties) that have a dominant market position.

While SDOs seek to have licensing commitments in place for all potentially essential patents (and thus also for all factual essential patents), they usually do not see it as their role to enforce such commitments. SDOs instead acknowledge that, if parties themselves fail to successfully conclude licensing agreements, then national courts of law have the sole authority to resolve such IPR disputes. Depending on the country (jurisdiction), in which a court case takes place, the role of different bodies of law may vary. In the US SEP court cases, private law often plays a central role; (examples of landmark cases include Microsoft vs. Motorola (2013), In re Innovatio (2013), and TCL v Ericsson (2017). In European SEP court cases, competition/antitrust law generally plays a more central role. The Huawei v ZTE case, in which the German court asked the Court of Justice of the European Union (CJEU) for interpretation or validity of the relevant EU law, can be seen as a landmark case (CJEU, 2015).

Disputes have not been limited to the landmark cases mentioned above, however. In fact, there have been many cases where parties indeed went to court for disputes over SEPs, and when the number of cases started to rise significantly in the 2010s, the media started talking of the ‘smartphone wars’. While certainly not exhaustive, the Wikipedia page titled “Smartphone patent wars” lists over 100 legal conflicts, while smartphones are certainly not the only product category relevant for standards and IPR.

How can we understand such legal struggles between patent owners and implementers over patents in standards? Possible explanations include (a) that the number of patents essential to standards has increased a lot over the years (see Section 7.4.2) as well as the number of different owners of these patents, (b) essential patents are traded a lot, including acquisitions by new owners that have a strategy, in which patent assertion (i.e. accusing others of patent infringement) or litigation (i.e. patent court cases) plays a major role. Furthermore, (c) standards are becoming more relevant for a wide variety of markets, which also brings together parties that have very different business cultures, expectations, etc., (d) the relevant markets often have very considerable commercial interest, and (e) these markets are subject to strong market dynamics. The latter is well illustrated by the mobile phone / smartphone market, where Nokia, once market leader in mobile phones, later saw its market share diminishing and eventually left that market, while new parties (Blackberry, Samsung, Apple) have entered that market segment and have become very successful. Obviously, such changes in market position can have effects on the patent strategies of these companies. Former incumbents, displaced from their markets, may give a greater importance to exploitation of their patents. If such patent strategies become more and more pronounced, legal struggles may follow.

7.7 PATENT POOLS

In practice, there are many standards for which SEP ownership is fragmented across many owners. When an even larger number of implementers then needs to have separate (bilateral) licensing negotiations with all these owners, the required time and resources may result in considerable transaction costs for the involved parties. In addition, with many SEP owners, each setting their own fee, there is the risk of royalty stacking (see Section 7.4.3). Recognizing such inefficiencies, patent owners started to experiment in the 1980s with setting up joint licensing programs for technical standards (staring with the one for Compact Disc Audio), later evolving into what we now know as patent pools. In such a pool, a central entity, called the pool administrator, can license out a bundle of patents, on behalf of the participating patent owners. As shown in Box 7.1, such pools bring along significant advantages for both implementers and patent owners. The pool formula indeed works very well in various areas, and successful examples of pools are shown in Box 7.2.

Box 7.1: Advantages of patent pools

ADVANTAGES FOR (PROSPECTIVE) LICENSEES	ADVANTAGES FOR PARTICIPATING PATENT OWNERS
■ Provide a one-stop shop for access to patent licenses ■ Lower transaction costs and (usually) a discounted licensing fee compared to multiple individual licenses ■ Create a level playing field (fewer competitors that do not pay royalty fees) ■ Reduce uncertainty, increase transparency	■ Helps to promote the overall adoption and success of the technology ■ Lower transaction costs ■ May lead to higher profits because of more efficient licensing and royalty collection

In standards-based pools, the pooled patents are available to licensors participating in the pool, as well as to external licensees. The licensees are offered standard licensing terms, typically with a menu of “patent packages” relevant for specific product categories (there could be different categories for a CD disc and a CD player, or different categories for a mobile phone and for a mobile network infrastructure element). Many pools have a high degree of transparency, and the licensing fees, pool patents, but also lists of licensors and signed-up licensees can be consulted on their websites.

Regulatory agencies have repeatedly investigated patent pools (and patent pool proposals) in order to understand whether they comply with competition/antitrust law; after all, when brought together, such patent owners easily represent a dominant market position and thus will be subject to such rules. While the assessment of competition authorities depends on many design aspects of pools, they have generally looked favourably at pools, concluding that the pro-competitive aspects are stronger than the anti-competitive ones. One important condition, however, is that pools only bring together complementary patents, not substitute patents. Because factual SEPs are by definition complements, pools comply with these conditions by setting up extensive mechanisms for essentiality testing, aiming to ensure that no non-SEP enters into their pool. Another important condition set by regulators is that an implementer must always be allowed to negotiate with an individual patent owner as well for a license, and not be forced to license only via the pool. Also, from the perspective of patent owners, patent pools are voluntary, and while some are happy to join a pool, others are of the view that they rather engage in bilateral licensing rather than becoming part of a pool.

One interesting element is of course at what level the overall pool licensing fee is to be set, and how that total licensing is distributed over the participating patent owners. After all, patent owners may have different views on their expected payback, and the patents themselves may differ in value or technical merit. Agreeing on the royalty fee and the royalty allocation among pool members, while being attractive to as many prospective pool members as possible (and preventing members to drop out), is a delicate process during the formation of a pool (see Layne-Farrar & Lerner, 2011). Some pools base the allocation just on national patent counts (so, of the pool licenses a product in country X, it is counted how many patents in the pool cover that product in country X); while other pools differentiate between patents of higher value and lower value.

If pools have advantages for both patent owners and licensees, why has the pool model not overtaken bilateral licensing, and do we only see pools for a limited number of standards? Among the reasons for that is that pools are difficult and expensive to set up. Especially, pools are set up at an early stage (which makes more sense than setting them up late, when many bilateral contracts are already in place), then there is significant uncertainty over whether the critical mass will be reached (in terms of overall market success of the standard and its products, but in terms of the number of patent owners that will eventually join the pool) and the start-up costs can be earned back. Relatedly, there is usually a wide diversity of interests and views across (potential) pool participants, making it hard to find a set of agreements and rules that everybody is willing to endorse. Also, companies might be of the opinion that the freedom and flexibility they have when they do bilateral licensing (including possibilities to cross-license, if the other party has patents as well that they would like to have access to) outweighs the advantages of pools (for more detail, see Uijl et al., 2013). As noted above, participating as a patent owner in a pool does not rule out bilateral negotiations, but if the implementer choses to license from the pool, the patent owner cannot insist to have bilateral negotiations instead.

While pools for mobile telecommunications (2G, 3G and 4G) have failed to materialize or had rather limited success, one might argue that this may change in the future. The Internet of Things (IoT), Industry 4.0 and all sorts of smart technologies are rapidly bringing us into a new world where a patent owner for a SEP in this area not only needs to negotiate with makers of mobile phones, but with a very wide landscape of all different kinds of implementers, possible at many different levels in the value chain (such as chipset, module, subsystem, end product). In such a new world, where transaction costs might be much higher than in the past and in which it may be more important than ever to have a single, harmonized licensing model, pools might make sense where they did not work before. For example, the creation of Avanci, which licenses 2G, 3G and 4G SEPs for connected cars, and has announced to do so for IoT in the future, could be foreshadowing this development, as it includes many patent owners that were previously not (widely) participating in patent pools.

Box 7.2: Selection of licensing administrators and their pool

LICENSING ADMINISTRATOR	DESCRIPTION AND SELECTION OF ACTIVE POOLS
MPEGLA	US-based licensing administrator that pioneered the MPEG2 pool for video coding (used in DVD, among other applications) in the 1990s. At its heydays having over 25 licensors and over 1400 licensees, this pool has served as an example for many others. Current pools include various modern audio and video coding protocols, but also wireless power, EV charging, and video ports (DisplayPort).
VIA Licensing	US-based licensing administrator, founded in 2002 and owned by Dolby Laboratories. It has active pools in the field of audio and video coding, but also for 3G and 4G mobile telecommunications and other technologies.
SISVEL	Italy-based licensing administrator that started licensing third-party patents in the 1990s and developed into a patent pool covering wireless communications (including Wi-Fi, 2G, 3G and 4G mobile telecommunications, audio and video coding, and television broadcast especially the DVB standard).
One-blue	US-based licensing administrator, founded in 2011 and focusing Blu-ray, the successor of the DVD.
Avanci	US-based licensing administrator, founded in 2016 and initially focusing on licensing mobile telecommunications SEPs for connected cars and has announced activities aimed at the IoT.

7.8 PUBLIC INTEREST AND ACTIVITIES BY REGULATORS

The relation between patents and standards cannot be properly understood without considering the public interest dimension into account. While it is tempting to look at very visible legal struggles between often large firms, on the background there are important questions concerning the proper functioning of markets for all current and future stakeholders, to ensure a proper environment that promotes innovative conduct but at the same time safeguards that there are no undue barriers for market entry, no unnecessary friction, and that, in the end, the public benefit is best served.

Already in the 1990s, when a conflict started to emerge that endangered the introduction of the newly-created GSM standard, which eventually became one of the greatest European technology successes in the last century (Bekkers et al, 2002), the European Commission realized that just leaving fundamental questions regarding patents in standards just to the parties may not be enough. In fact, all around the globe, policy makers and regulators have recognized that questions surrounding patents and standards also have a significant public interest dimension to them.

The public interest issues are manyfold, and the focus of the discussion has changed over time (see Box 7.3, where we also mention that this list is not exhaustive, and the topics are not unique to only the time frame measured).

Box 7.3: Broad overview of main public interest topics over time

PERIOD	MAIN PUBLIC INTEREST TOPICS
1990s	Market access (esp. possible exclusion of market parties by nonavailability of licenses).
2000s	Concerns regarding possible abuse in terms of excessive licensing fees. Concerns over sale of SEPs where the successor did not deem itself bound to FRAND commitments.
2010s	Increasing interest for geopolitical dimension.
2020s	Especially in the light of the broad use of standards by the Internet of Things, vertical industries, Industry 4.0, increasing interest in transparency on SEP ownership and factual essentiality, possible frictions in the market, and the relation between (FRAND-based) standards and open source.

Given the many and rich public interest topics over time, it goes beyond the scope of this chapter to provide a detailed and exhaustive discussion of each of them. Instead, the below section provides a broader overview and starting points for further reading. Besides that, the below sections also provide insights into the various roles of governments in this field. We focus mainly on Europe, because that is where arguably the most policy attention was paid to this topic, but similar developments took place in other parts of the world.

Along the different roles of governments, we discuss below commissioned studies (Section 7.8.1), public consultations (Section 7.8.2), official policy documents (Section 7.8.3), and competition law / antitrust enforcement (Section 7.8.4).

7.8.1 GOVERNMENT-COMMISSIONED STUDIES

To get a better understanding of the nature of the issues, and investigate potential solutions, policy makers and regulators have commissioned several studies in this area. The box below provides an overview of the most important studies, where we see that the focus changes from more general questions in the early years towards more specific topics (such as SDO governance and essentiality determination) in more recent years.

Studies carried out for the European Commission:

- Study on the Interplay between Standards and Intellectual Property Rights (Blind et al, 2011)
- Patents and Standards: A modern framework for IPR-based standardization (Bekkers et al. 2014)
- Landscaping Study on SEPs (Pohlmann & Blind, 2016)
- Licensing Terms of Standard Essential Patents (Pentheroudakis & Baron, 2017)
- Study on SDO governance (Baron et al., 2019)
- Pilot Study for Essentiality Assessment of Standard Essential Patents (Bekkers et al., 2020a)

Studies carried out for the National Academies of Science in the US

- Patent challenges for standard-setting in the global economy: Lessons from the ICT industry (Maskus et al, 2013)

7.8.2 PUBLIC CONSULTATIONS

Following studies and internal considerations, policy makers often hold public consultations in order to provide all stakeholders with the opportunity to comment on policy options and intended measures. In this context, the most relevant ones are the 215 EC Public Consultation on Patents and Standards, where almost 90 stakeholders submitted their views, totalling over 1600 pages, and the 2017 EC consultation Patents and Standards.

7.8.3 POLICY DOCUMENTS

Policy makers and regulators also issued a number of policy documents that are of large importance to the topic of IPR and Standards. Arguably, the European Union has been most active in this respect. These are some of its most relevant policy documents:

- The so-called 'Horizontal Guidelines' (EC, 2011). This document explains how the European Commission will apply competition law to specific situations and has a considerable section that focuses on patent and standards.
- Setting out the EU approach to Standard Essential Patents" (EC, 2017), a Communication where the European Commission sets out the major challenges in the field of patents and standards and announces the policy actions it intends to take in this field.
- The European Commission 2020 IP Action Plan (EC, 2020a), which confirms further steps along the route of the 2017 communication.

7.8.4 COMPETITION LAW / ANTITRUST ENFORCEMENT

In Section 7.6 above, we already discussed how competition law can be applied by national courts when conflicts about SEPs arise. In addition, government bodies are also tasked with enforcing competition/antitrust law, usually acting upon investigations of complaints that are submitted by stakeholders. In the field of SEPs, there have been several such cases. In Europe, these include the 'RAMBUS' case (ruling 2009), the 'Qualcomm' case (dropped in 2009), the "IPcom" case (dropped in 2009 after that party committed itself to FRAND licensing), the 'Motorola' and 'Samsung' case (both with decisions in 2014).

7.9 SUMMARY

Virtually every country around the world has laws for the protection of intellectual property, including the protection of technical innovations by patents. Standards are created by stakeholders, and during standardisation meetings, they contribute innovative ideas, and these ideas can provide great value to the standard to be created. Yet, these ideas may be subject to patent protection, and if these ideas are eventually integrated into the standard, those that make products that comply to the standard will need the permission of the patent owner (a 'license') in order to implement these inventions into their products. Such patents are known as standard-essential patents (SEPs).

SEPs create specific challenges and concerns, and almost all SDOs have introduced specific policies relating to the inclusion of patented inventions in their standards, typically aim at ensuring the availability of licenses for such patents at specific conditions. The most common set of conditions are known as FRAND (Fair, Reasonable and Non-Discriminatory) and Royalty-Free. Given the large commercial stakes at play, it will not come as a surprise that disputes between patents owners and standards' implements do arise, for instance on what a 'fair' or 'reasonable' compensation is for an essential patent. Here, parties can (and do) resort to national legal systems.

For a number of standards, patent pools have been created, via which patent owners collectively license out their relevant essential patents. This one-stop shopping approach offers considerable advantages for patent owners and standards' implementers alike, but is often difficult to set up, especially when interests diverge a lot.

Regulators around the world have recognized the importance of a well-functioning market where standards and patents intersect. Not only have they published valuable studies on this topic, but they also adopted policies and initiatives in this area. Moreover, they also serve as enforcement agencies for competition law / antitrust enforcement.

7.10 QUIZ

1 - WHICH ONE OF THE FOLLOWING INSTRUMENTS IS NOT CONSIDERED A TYPE OF IPR?

(See Section 7.2.1 for hints)

a) *Patents*

b) *Trademarks*

c) *Standards*

d) *Copyright*

2 - WHICH TYPE OF INTELLECTUAL PROPERTY RIGHT COULD BE OBTAINED FOR A TEXT THAT IS CONTRIBUTED TO A STANDARD DEVELOPMENT ORGANISATION?

(See Section 7.2.1 for hints)

a) *Patents*

b) *Trademarks*

c) *Industrial design*

d) *Copyright*

3 - WHO TYPICALLY OWNERS THE COPYRIGHT ON THE TEXT OF THS STANDARD?

(See Section 7.3 for hints)

a) *The individual copyright owners who contributed text parts to the standard*

b) *The government of the country the SDO is located in*

c) *The government of the country designated in the SDO patent policy*

d) *The SDO*

4 - CAN A PATENT BE ESSENTIAL TO A TECHNICAL STANDARD?

(See Section 7.3 for hints)

a) *No*

b) *Yes, but such a situation is rather rare*

c) *Yes, and this is quite common*

5 - CAN A COPYRIGHT BE ESSENTIAL TO A TECHNICAL STANDARD?

(See Section 7.3 for hints)

a) *No*

b) *Yes, but such a situation is rather rare*

c) *Yes, and this is quite common*

6 - WHICH OF THE BELOW IS NOT A WAY TO OBTAIN A SEP?

(See Section 7.4.2 for hints)

a) *By applying for a patent for an invention that is required in order to implement an existing standard*

b) *By actively promoting its own patented technologies for inclusion into the standard by making technical contributions*

c) *By acquiring a SEP on the market*

d) *Wait and hope that others establish an SDO standard that uses a technology that is covered by one of your patents*

7 - A COMPANY OWNS A PATENT ON A MOBILE PHONE DESIGN WHERE THE PHONE IS MADE OF TWO PARTS CONNECTED BY A HINGE (POPULARLY KNOWN AS A CLAMPSHELL OF FLIP PHONE). CAN THAT PARTY REQUIRE MOBILE PHONE MAKERS TO TAKE A LICENSE ON THAT PATENT?

(See Section 7.4.1 for hints)

a) *No, because such a patent would be essential for the standard and therefor creates an exemption to obtain a license*

b) *Yes, because such a patent would be essential for the standard and thus an implementer should obtain a license*

c) *Only if the phone maker produces a phone with a hinge construction as protected by the patent (the patent is not essential)*

8 - WHY IS A PATENT THAT IS DECLARED TO BE POTENTIALLY ESSENTIAL BY ITS OWNER NOT NECESARILLY ESSENTIAL?

(See Section 7.4.2for hints)

a) *The precise content of the final standard is not yet known, and the technology in the declared patent may eventually not be included in the standard at all*

b) *By the time of such declaration, the ultimate scope of the patent may not be yet known*

c) *Both answers above are true*

9 - IN WHICH OF THE BELOW SITUATIONS ARE YOU ALLOWED TO ASK FOR A MONETARY COMPENSATION WHEN LICENSING OUT A SEP?

(See Section 7.5 for hints)

a) *The SDO allows you to choose the type of commitment and you chose to submit a RF licensing commitment*

b) *The SDO allows you to choose the type of commitment and you chose to submit a FRAND licensing commitment*

c) *The SDO only allows for RF licensing commitment and you submitted a RF licensing commitment*

d) *You earlier submitted an RF licensing commitment but later upgraded that to a FRAND commitment*

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7.11 GLOSSARY

- Intellectual Property Rights: "Intellectual property rights refers to the general term for the assignment of property rights through patents, copyrights and trademarks. These property rights allow the holder to exercise a monopoly on the use of the item for a specified period." (OECD 2005)
- Fair, Reasonable and Non-Discriminatory (FRAND): A concept that aims to ensure that licenses for all essential patents for a given standard are available against certain conditions.
- Standard Essential Patent (SEP): A patent protecting an invention that is indispensable in order to make a product that satisfies the specific standard. In other words, without having obtained a permission (a license) to use the patented technology (or being the owner of that patent itself), an implementor cannot make or sell a product that complies with the standard.
- Participation-based policy: An SDO IPR policy that require that all members of the SDO are willing to license all their essential patents at specified conditions, such as FRAND or Royalty Free, and this commitment is a condition of membership.
- Commitment-based policy: An SDO IPR policy that requires members (or participants in standardisation) to inform the SDO when they believe they own patents that may be or may become essential to a standard, and where known owners of such patents are requested (but not obliged) to commit to license such patents at specific conditions such as FRAND or Royalty Free conditions.

7.12 LIST OF ABBREVIATIONS

- ANSI: American National Standards Institute
- ASA: American Standards Association
- CD: Compact Disc
- CJEU: Court of Justice of the European Union
- DVD: Digital Versatile Disc
- EPO: European Patent Office
- ETSI: European Telecommunications Standards Institute
- EV: Electric Vehicle
- FRAND: Fair, Reasonable and Non-Discriminatory
- GSM: Global System for Mobile communications
- GSMA: GSM Association
- HDMI: High-Definition Multimedia Interface
- IEC: International Electrotechnical Commission
- IEEE: Institute of Electrical and Electronics Engineers
- IETF: Internet Engineering Task Force
- IoT: Internet of Things
- IP: Intellectual Property
- IPR: Intellectual Property Right
- ISO: International Organization for Standardization
- ITU: International Telecommunication Union
- MPEG: Moving Picture Experts Group
- RAND: Reasonable and Non-Discriminatory
- RF: Royalty Free
- SDO: Standards Development Organisation
- SEP: Standard Essential Patent
- UMTS: Universal Mobile Telecommunications System
- W-CDMA: Wideband Code Division Multiple Access
- W3C: World Wide Web Consortium

7.13 REFERENCES

- Baron, J., Conteras, J., Husovec, M. and Larouche, P. (2019). Making the Rules: The Governance of Standard Development Organizations and their Policies on Intellectual Property Rights, Thumm, N. editor(s), EUR 29655 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-00022-8, doi:10.2760/207268, JRC115004.
- Bekkers, R., Duysters, G. & Verspagen, B. (2002). 'Intellectual property rights, strategic technology agreements and market structure: The case of GSM.' In: Research Policy Vol. 31 Issue 7, pp. 1141-1161. DOI: 10.1016/S0048-7333(01)00189-5.
- Bekkers, R. , Birkman, L., Canoy, M., de Bas, P. Lemstra, W. , Ménière, Y. , Sainz, I., van Gorp, N. , Voogt, B., Zeldenrust, R., Nomaler, N., Baron, J., Pohlman, T., Martinelli, A. (2014). Patents and Standards: A modern framework for IPR-based standardisation. A study prepared for the European Commission Directorate-General for Enterprise and Industry. Brussels: European Commission. ISBN 978-92-79-35991-0. DOI: 10.2769/90861.
- Bekkers, R., & Updegrove, A. (2013). A study of IPR policies and practices of a representative group of Standards Setting Organizations worldwide. Updated version. Washington, DC: National Academies of Science.
- Blind, K., Bekkers, R., Dietrich, Y., Iversen, E., Köhler, F., Müller, B. et al. (2011). Study on the Interplay between Standards and Intellectual Property Rights (IPRs). Final Report. Study commissioned by the European Commission Tender No ENTR/09/015 (OJEU S136 of 18/07/2009). Brussels: European Commission.
- Byeongwoo Kang, Rudi Bekkers (2015). Just-in-time patents and the development of standards. Research Policy 44, 1948–1961. DOI: 10.1016/j.respol.2015.07.001.
- CJEU - Court of Justice of the European Union (2015). Judgment of the Court (Fifth Chamber) of 16 July 2015 in Huawei Technologies Co. Ltd v ZTE Corp. and ZTE Deutschland GmbH. Request for a preliminary ruling from the Landgericht Düsseldorf. Case C-170/13. ECLI identifier: ECLI:EU:C:2015:477. Düsseldorf: CJEU.
- Contreras, J. (2015). A brief history of FRAND: analyzing current debates in standard setting and antitrust through a historical lens. Antitrust Law Journal 80(1):39.
- EC (2011). Communications from the Commission (2011/C 11/01): Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co- operation agreements.
- EC (2014), 'Patents and standards: A modern framework for IPR-based standardization: A study prepared for the European Commission Directorate-General for Enterprise and Industry', Brussels: European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. doi: 10.2769/90861.
- EC (2017). Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee: Setting out the EU approach to Standard Essential Patents - COM (2017) 712 final. European Commission, Brussels.
- EC (2020a). Making the most of the EU's innovative potential – An intellectual property action plan to support the EU's recovery and resilience. COM(2020) 760 final. European Commission, Brussels.
- EC (2020b). Speech by Executive Vice-President Vestager at the Press Conference on the Data Governance Act and the Action Plan on Intellectual Property, 25 November 2020, Brussels.

- In re Innovatio (2013). In re Innovatio IP Ventures, LLC Patent Litigation, No. C11-9308 2013 WL 5593609 (N.D. Ill. Sept. 27, 2013) (Holderman, J.).
- Layne-Farrar, A. & Lerner, J. (2011). To join or not to join: Examining patent pool participation and rent sharing rules. International Journal of Industrial Organization 29(2), 294-303.
- Lemley, M. A., & Shapiro, C. (2007). Patent holdup and royalty stacking. Texas Law Review 85, 1991-2049.
- Machlup, F., & Penrose, E. (1950). The patent controversy in the nineteenth century. The Journal of Economic History, 10(1), 1-29.
- Maskus, K., Bekkers, R., Block, M.S., Contreras, J., Gilbert, R. J., Goodman, D. J., Marasco, A., Simcoe, T., Smoot, O., Suttmeier, R., Updegrove, A. (2013). In Maskus, K., & Merrill, S. A. (Eds.). Patent challenges for standard-setting in the global economy: Lessons from the ICT industry. Committee on Intellectual Property Management in Standard-Setting Processes Board on Science, Technology, and Economic Policy, Policy and Global Affairs. National Research Council of the National Academies. Washington, D.C: The National Academies Press. DOI: 10.17226/18510; ISBN 978-0-309-29312-9.
- Microsoft vs. Motorola (2013), Microsoft Corp. v. Motorola, Inc., No. C10-1823, 2013 WL 2111217 (W.D. Wash. Apr. 25, 2013) (Robart, J.).
- Pentheroudakis, C. and Baron, J. (2017). Licensing Terms of Standard Essential Patents: A Comprehensive Analysis of Cases, Thumm, N., editor(s), JRC104068, EUR 28302 EN, Publications Office of the European Union, Luxembourg, 2017.
- Pohlmann, T. and Blind, K. (2016). Landscaping study on Standard Essential Patents (SEPs). A study prepared for the European Commission DG GROW Unit F.5. Berlin: IPlytics.
- Rudi Bekkers, Emilio Raiteri, Arianna Martinelli, Elena M. Tur. (2020b) Landscape Study of Potentially Essential Patents Disclosed to ETSI. Nikolaus Thumm (ed.). Publications Office of the European Union, Luxembourg, JRC121411, doi:10.2760/313626, ISBN 978-92-76-20786-3.
- Rudi Bekkers, Joachim Henkel, Elena M. Tur, Tommy van der Vorst, Menno Driesse, Byeongwoo Kang, Arianna Martinelli, Wim Maas, Bram Nijhof, Emilio Raiteri, Lisa Teubner (2020a). Pilot study for essentiality assessment of Standard Essential Patents, Thumm, N. editor(s), EUR 30111 EN, Publications Office of the European Union, Luxembourg, JRC119894, doi:10.2760/68906, ISBN 978-92-76-16666-5.
- TCL v Ericsson, (2017). TCL v Ericsson 8:14-CV-00341 JVS-DFMx (United States District Court, Central District of California December 22, 2017).
- Uijl, S. d., Bekkers, R., & de Vries, H. J. d. (2013). Managing Intellectual Property Using Patent Pools: Lessons from Three Generations of Pools in the Optical Disc Industry. California Management Review, 55(4), 31-50. DOI: 10.1525/cmr.2013.55.4.31.
- World Intellectual Property Organization, 2008: WIPO Intellectual Property Handbook: Policy, Law and Use.

8 AN ECONOMIC PERSPECTIVE ON STANDARDIZATION AND PUBLIC PROCUREMENT

LEARNING OBJECTIVES

- Students should understand that standards and standardization are an important basis for a functioning economic system.
- Students can get valuable insights into the far-reaching impacts of standardization on the economy, and how different stakeholders can benefit from these impacts.
- Students should be able to explain the impact of standardization on public procurement. They should also be able to recall the most important policy and legal frameworks in this area and link the benefits of standardization to different stakeholders such as citizens and businesses.

8.1 INTRODUCTION

Standards constitute an important instrument in the diffusion of new technologies and technological know-how. Their contribution to economic growth is well documented in various empirical studies. For instance, in Germany, in the period between 2002 and 2006, standards and technical rules were responsible for the generation of 0.7 to 0.8% of the Gross Domestic Product (GDP). The impact of standards has been also studied in the context of trade. Swann (2010a, p. 2) reviewed many empirical studies in this regard and concluded "that there is often, but not always, a positive relationship between international standards and exports or imports". In an empirical analysis, Blind et al. (2018) found that ISO 9000 has a quality performance signalling effect. Furthermore, it decreases transactions costs due to lower information asymmetries between sellers and buyers and increases the level of trade among countries.

Although our world is heavily reliant on standards, their actual effects on the economy are less obvious. Like patents, standards incorporate codified knowledge and provide companies with state-of-the-art knowledge in terms of technical solutions or performance requirements. Standards created through formal standardization are, by definition, open, and not controlled by a single company. They benefit all market players who can refer to the same knowledge base. Thus, standards foster competition and prevent the occurrence of lock-in effects or high switching costs.

Standards also support the compatibility between different technical platforms and systems. Without standardized interfaces, the industries based on complementary products, such as the various apps we can find in app stores or the wide range of video games for game consoles, cannot flourish. Moreover, standards help us to assess the quality of products and services that we can buy and prevent the proliferation of product variants towards an unmanageable level. They support companies in achieving focus in markets and building up critical mass.

Public authorities use standards in the context of public procurement to guarantee a high quality of public services. Companies cannot apply for public tenders unless they comply with the indicated standards. Thus, governments can indirectly encourage the adoption of standards by companies, while supporting the innovative strength and technological progress of a nation.

This chapter provides an in-depth analysis of the economic contribution of standards and their role in public procurement. Whereas Section 8.2 focuses on the economic contribution of standards to the GDP, Section 8.3 highlights the real economic effects of standards. Section 8.4 addresses public procurement and explains how governments can benefit from standardization. Finally, Section 8.5 summarizes the contents of the chapter.

8.2 THE ECONOMIC CONTRIBUTION OF STANDARDS

Several studies have dealt with the contribution of standards to economic growth in different countries such as the United Kingdom (DTI 2005), Germany (Blind et al. 2011), France (Miotti 2009), and Canada (Haimowitz and Warren 2007). The effects of standards on economic growth have been calculated using regression analysis (a statistical method for estimating relationships among variables).

8.2.1 CONTRIBUTION OF STANDARDS TO THE GDP

Blind et al. (2011) estimated the contribution of standards to the German GDP. Toward this aim, they used the Cobb- Douglas production function to represent the relationship between economic input (capital and labour) and output (e.g., products and services). Blind et al. (2011) also acknowledge Robert Solow's work that human knowledge leads to an improvement in the quality of labour and capital, thus inducing a sustainable economic growth.

The qualitative improvement of labour and capital in a country are captured by Total Factor Productivity (TFP). TFP, however, is not only a function of technical progress, in other words, the generation of knowledge, but also depends on the wide dissemination of this knowledge among companies. The more companies can leverage that knowledge, the higher their production output (Blind et al. 2011). It is noteworthy that the authors do not only consider the standards elaborated by the national standardization bodies, but also standards of European and International origin. To estimate TFP, Blind et al (2011) reason as follows. Knowledge can be produced and used inside a country or produced abroad and used by institutions in that country. In addition, the diffusion of knowledge is best represented by the number of standards. First, standards are not subject to property rights and can be applied without restrictions as in the case of patents where licensing fees can constitute a barrier against the exploitation of knowledge. Second, standards are developed in-consensus by experts that bring technical knowledge from their companies. Third, standards are documents that contain knowledge in a codified form. Codification of knowledge facilitates its diffusion. Hence, TFP depends on three factors:

- Technological knowledge generated in a country (number of patents)
- Technological knowledge imported from abroad (number of technological licence payments abroad)
- The level of diffusion of this technological knowledge (number of standards)

Obviously, standards are components of the economic input and the benefits of standardization for economic growth lie in the dissemination of technological knowledge. In the Cobb-Douglas production function, economic output increases in capital and labour. But the rate of growth diminishes over time. This effect of diminishing marginal returns is counteracted by technical progress. In other words, even if capital and labour stay the same, we can still witness an economic growth due to the production and diffusion of knowledge (Blind et al. 2011). This idea is at the essence of the "knowledge economy" concept: rather than in terms of production, the growth of an economy depends on the quality, quantity and accessibility of information available (Oxford Living Dictionaries n.d.).

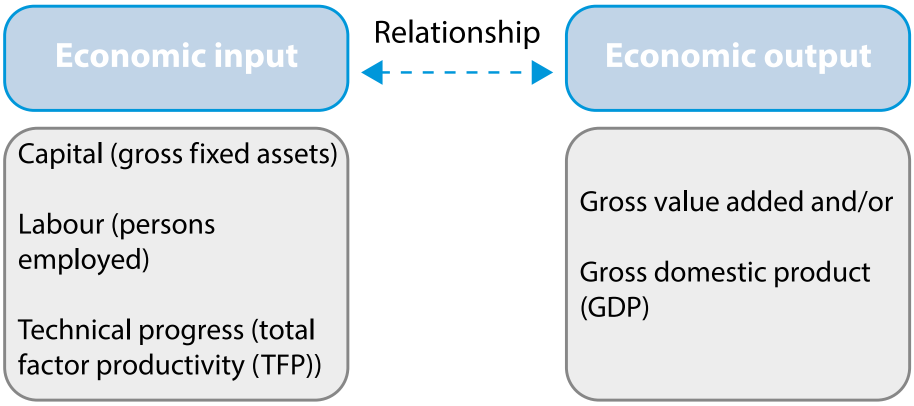

Figure 8.1: Correlation between economic input and output

Blind et al. (2011) found that standards had an increasing contribution to GDP throughout the 1970s. Between 1986 and 1990, the contribution was negative. In this regard, Blind et al (2011, p. 15) mention: "Because 1,300 standards on graphic symbols were withdrawn during mid-eighties, the size of the standards collection during that time only marginally reflects the dissemination of technical knowledge. The negative values for the period from 1986 to 1990 can thus be seen as reflecting the adjustment of the standards collection.". Since the German reunification, however, the contribution of standards has been estimated to have stabilized at a level of between 0.7 and 0.8% of GDP. In monetary terms, this equates to some €16.77 billion a year (from 2002 to 2006 in Germany). Table 8.1 shows the contribution to growth of various production factors, including standards, in Germany, whereas Table 8.2 summarizes data regarding the contribution of standards to GDP in other countries: France, United Kingdom, Canada, and Australia.

Table 8.1: Contribution to growth of various production factors, in %; based on Blind et al. (2011)

	1961-1965	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1992*-1996	1997-2001	2002-2006
CAPITAL	2.30%	1.70%	1.60%	1.10%	0.90%	0.90%	0.90%	0.50%	0.30%
LABOUR	0.70%	0.10%	-0.50%	0.60%	-0.40%	1.20%	-0.70%	0.60%	-0.30%
PATENTS	0.50%	0.50%	-0.60%	0.60%	1.00%	0.00%	-0.70%	-0.60%	-0.60%
LICENCES	0.90%	0.80%	0.90%	0.30%	0.50%	2.00%	1.70%	0.10%	0.50%
STANDARDS	0.40%	0.60%	1.80%	1.20%	0.70%	-0.02%	0.70%	0.80%	0.70%
SPECIAL FACTORS	0.01%	0.01%	-0.70%	-0.20%	-1.30%	0.01%	0.01%	-1.10%	1.10%

* There is no reliable data for 1991 due to German reunification.

Table 8.2: Contribution of standards to GDP in countries other than Germany; based on Blind et al. (2011)

COUNTRY	PUBLISHER	PERIOD	GROWTH RATE OF GDP	CONTRIBUTION OF STANDARDS
FRANCE	Association Française de Normalisation (AFNOR) (2009)	1950–2007	5.4%	0.8%
UNITED KINGDOM	Department of Trade and Industry (DTI) (2005)	1948–2002	2.5%	0.3%
CANADA	Standards Council of Canada (2007)	1981–2004	2.7%	0.2%
AUSTRALIA	Standards Australia (2006)	1962–2003	3.6%	0.8%

Note: The table covers different periods, as no consistent data was available.

8.2.2 COSTS OF STANDARDIZATION AND STANDARDS FROM THE COMPANY'S PERSPECTIVE

This section focuses on the costs of standardization and standards. We do not look at the total development cost of standards, but rather on the single company perspective. The estimation of total costs requires the evaluation of the contribution of all companies and other stakeholders that are actively involved in drafting the standards.

Industry funds most of the costs of developing standards by supplying voluntary experts who participate in the drafting work of the SDO technical bodies, by paying membership subscriptions, and by purchasing published standards. In the Impact Assessment published in the Commission Staff Working Paper (2011), it is estimated that industry funds about 93% to 95% of the European Standardization System.

In 2015, Ernst & Young (EY) consulting company wrote a report, published by the European Commission, in which it independently reviews the European Standardization System (ESS). The authors of the review note, without providing figures about SME financial capacity, that "despite representing 99% of the market, SMEs appear to have individually very limited resources to invest in standardisation (even based on cost-benefit logic) and therefore experience difficulties in participating, while their business can be highly impacted by standardisation work" (Ernst & Young 2015, pp. 32-33).

For example, in the case of ETSI, SMEs pay a yearly fee of € 6000 for membership (membership fees by 2021). This is a relatively small amount of money compared to the membership fees that large organizations are required to pay. In addition, to supply experts that participate in the development of the standards, SMEs incur travel costs, and staff costs (working hours of experts). Thus, for SMEs to participate in standardization work, the perceived long-term benefits of standardization should more than compensate for the incurred costs. To estimate the real benefits of standardization, SMEs should be aware of the advantages of standardization for their business.

Because of the costs that the attendance of standardization committees generates for SMEs and the required upfront investment in research and development to create technical solutions that can be brought to standardization, the question is whether SMEs can meaningfully contribute to standardization processes supported by SDOs. This question was asked by Gupta (2017).

Based on a rich dataset of the 3rd Generation Partnership Project (3GPP) (see e.g. Chapter 4 for more details) that developed the global second, third, and fourth generation (2G, 3G, 4G) cellular standards (Baron and Gupta 2018), the author confirms the low participation level of SMEs and start-ups (15% of overall participation). However, "the likelihood that such technical contributions will be accepted is similar to contributions from non-SMEs or non-start-ups" (Gupta 2017, p. 1). The author concludes that the formal standardization process based on openness, adopted by 3GPP, does not discriminate SMEs and start-ups, and this can encourage SMEs to achieve higher levels of participation in standardization work.

8.3 THE ECONOMIC EFFECTS OF STANDARDIZATION

The table below summarizes the positive and negative effects of four of the most important types of standards from an economic perspective. They are grouped by their main purpose, for example to ensure compatibility or distribute knowledge (information/measurement standards). The occurrence of the listed positive and negative effects is highly linked to a standard's characteristics such as de facto or SDO standard. Moreover, the market structure, in terms of the number and size of market players, as well as competitive aspects play a major role when it comes to determining the probability of occurrence of the effects.

Table 8.3: Effects of standards; based on Swann (2000); Pham (2006); Blind (2013)

	POSITIVE EFFECTS	NEGATIVE EFFECTS
COMPATIBILITY/INTERFACE STANDARDS	■ Network externalities ■ Avoiding lock-in in old technologies ■ Increased variety of system products ■ Efficiency in supply chains	■ Anti-competitive, leading to monopoly ■ Lock-in in old technologies in case of strong network externalities
MINIMUM QUALITY/SAFETY STANDARDS	■ Avoiding adverse selection ■ Creating trust ■ Reducing transaction costs	■ Regulatory capture ■ Increasing entry barriers
VARIETY-REDUCING STANDARDS	■ Economies of scale ■ Building focus and critical mass	■ Reduced choice ■ Leading to monopoly, market access barriers
INFORMATION/ MEASUREMENT STANDARDS	■ Facilitating trade ■ Reduced transaction costs ■ Providing codified knowledge	■ Regulatory capture

The following sections deal with all four types of standards and describe their economic benefits and drawbacks. These standards are compatibility/interface standards, minimum quality/safety standards, variety-reducing standards, and information measurement standards.

8.3.1 COMPATIBILITY/INTERFACE STANDARDS

A key role of standards is to ensure compatibility, which according to ISO (25010) consists of two components: coexistence and interoperability. Coexistence means that an IT service/product shares a common environment as well as resources with other independent services/products without adverse side effects, whereas interoperability is the ability of components to effectively work with one another.

In the ICT sector, the diffusion of compatibility/interface standards can be explained by two economic concepts: switching costs and network effects. Switching costs can emerge when users move from one technology or product to another. Recall the example of QWERTY and DVORAK keyboards. Learning to use the DVORAK keyboard at a high level of proficiency comes at a cost for the typist. Therefore, users may prefer to stick to the old standard to not incur the costs of switching to DVORAK. Because of the money invested into the integration of an old interface standard, producers may also be reluctant to switch to another standard.

Examples of switching costs (Parr et al. 2005) are:

- Acquisition costs: when new equipment must be bought or adapted.
- Training costs: associated with learning to use a new product
- Testing costs: if there is uncertainty with respect to the suitability of alternative products/ services

As far as the network effect is concerned, we can distinguish between direct and indirect network effects. A direct network effect means that the value of a given product, software or technology increases as more people and organizations use it. Examples are the telephone, fax, Facebook, and Twitter. Hence, the value of the technologies or products depends on the number of people that can be reached. The larger the network, the higher the value of the technology or the product. Indirect network effects arise when the value of a good or service does not depend directly on the number of users, but rather on the availability of complementary and compatible components. For example, the value of video game consoles depends on the availability of video games. The more video games, the greater the choice, and the better for the consumer.

High switching costs and large network effects can lead to lock-in effects. Sometimes, markets get locked in with inferior products, services, or technologies because producers and customers will only switch to a better design when everyone else does so too. If nobody moves on to the next standard, everybody settles for the current solution or standard. In addition, the lock-in effect will dominate if the players that operate in the market cannot afford the switching costs.

When a standard is not developed according to the principles of formal standardization and is owned by – let us say – one single organization, lock-in is more likely to happen, because one party has full control over the standard. For the market, lock-ins also mean high barriers to market entry. These barriers arise because of the high costs imposed by the owner of the standard or the patents in terms of licensing fees. In addition, switching to another environment would not be possible, because of the large critical mass of users that is required to escape the lock-in. Lock-ins can result in monopolies that are not conducive to competition (according to antitrust and competition laws) (de Vries et al. 2008).

EXAMPLE 1

A case in point is the Microsoft Windows operating system. The Microsoft Windows Application Programming Interface (API) supports vendor lock-in by using Microsoft's own file formats. In terms of the Windows API, Microsoft's general manager for C++ development, Aaron Contorer, stated in an internal Microsoft memo drafted for Bill Gates: "The Windows API […] is so deeply embedded in the source code of many Windows apps that there is a huge switching cost to using a different operating system instead" (European Commission 2004, pp. 126–127). In contrast to machine code, source code is written in human-readable programming language such as Python or C++. An API is a piece of code, which enables two software programs to communicate with each other. Through a Microsoft-exclusive franchise, Microsoft grants other suppliers the right to use the Windows API to produce systems according to its specifications. This allows the development of many third-party programs, which increase the Windows platform's value. The strategic role of API is to maintain the network effect and prevent competition. Thus, the use of Microsoft's own file formats in Microsoft's application software drives the lock-in effect, at least until 2008 before Microsoft went to ISO (Deek and McHugh 2007).

EXAMPLE 2

Another case in point is Apple's iPod. Digital music files with Digital Rights Management (DRM) are purchased from Apple's iTunes store. Advanced Audio Coding (AAC) format is only compatible with Apple's iTunes media player software. Consequently, users could not play purchased music in other software environments. After the launch of the iPod in 2001 and a licence deal with major music companies, Apple controlled almost 75% of the US market for paid music downloads. However, the DRM conditions and incompatibility with other music players caused conflicts with consumer rights. Since 2009, and after several suits for "unlawful bundling", DRM has been removed from digital music files (Raustiala and Sprigman 2012).

Open standards have several positive effects. Referring to a standard as open or not depends on the openness of the standardization process (please see Chapter 4.2 for more details). One generally accepted characteristic of an open standardization process is that any entity, be it an organization or individual, can participate in the creation of the standard. The output of an open standardization process is then considered as an open standard. As formal standardization is expected to meet all the principles of open standardization, the standards created through that process are, by definition, open standards. Thus, any standard made by, for instance, ISO, IEC, CEN, CENELEC, ETSI, or ITU is an open standard. With an open standard, the risk of lock-in is reduced, because the standard is freely available, leading to lower barriers to entry and lower switching costs for consumers.

In general, compatibility standards help companies to reduce transaction costs. If buyers know that a particular piece of software is compatible with a specific operating system, the burden to verify that the software will run as expected is low. This reduction in transaction costs facilitates the division of labour, as low transaction costs support market coordination (Coase 1937; Williamson 1989; Picot et al. 2013). The computer industry is a good example of the division of labour that is supported by standardized interfaces. A computer consists of components with predefined interfaces (called modules) that are outsourced to suppliers all over the world. The globalization of the industry has been possible only because of internationally accepted compatibility standards. In this way, suppliers can focus on small portions of the value chain to achieve economies of scale and, for instance, sell computer components to an international market.

Generally accepted compatibility standards reduce the barriers to entry for small-scale entrants producing "add-on" products. For example, in recent years, we have witnessed a growth of industries producing iPhone "apps". Many of these companies are micro-entities that would not be able to enter the software market at all in the absence of well-established platforms with accepted compatibility standards. Note, however, that Apple's API (Application Programming Interface) is a de facto standard and not a SDO standard.

8.3.2 MINIMUM QUALITY/SAFETY STANDARDS

Minimum quality standards refer to the minimum acceptable level of requirements. These standards can be related to the reliability, durability, or secondary effects and safety of products and services, as well as to other fields such as working conditions. A minimum quality standard can relate, for instance, to fuel-economy or carbon dioxide emissions generated through car usage. When adopted by regulation, such standards are compulsory by law, making it necessary for car producers to respect the minimum quality standard (e.g., Ronnen 1991). Minimum quality standards can have a welfare-improving effect on the economy, as they can be applied in the fields of health and natural environment. The application of a fuel-economy standard leads to an improved kilometre per litre performance as well as lower environmental impact (Ronnen 1991). These standards help reduce the level of risk felt by buyers, thus improving trust between traders. For instance, in the commodity market, traders must be able to buy and sell large volumes without even seeing their goods. This assumes the existence of clearly designed standards and possibly certifications that confirm that the traded commodities meet certain levels of quality or requirements. However, these kinds of standards can be misused and may have a negative effect. For instance, if they are set at an unnecessarily high level, they can function as a barrier to entry (Swinnen 2015; Locksley 1990).

Because customers face a huge variety of different products, they often find it difficult to assess which option is best suited for their purpose. When buyers cannot distinguish between different product variants, the quality sellers may not be able to sustain a price premium, as their costs are likely to exceed those of lower quality sellers. This is called Gresham's law: "bad drives out the good". Bad sellers who only sell lower quality products drive out good-quality sellers by undercutting them in price of the product. In the worst case, the market will break down, leading to market failure (Swann 2000).

Figure 8.2: Customer confronted with a large variety of products

This problem is a clear example of information asymmetries between buyers and sellers. Information asymmetry occurs when one party has more or better information (in this case, the seller) than the other (the buyer), which makes it hard for the one with less information to make an informed decision. Leland (1979) showed that minimum quality standards could help overcome information asymmetries, as they function as a reference and define the minimum requirements a product should have. In this way, buyers can make faster and easier decisions. Some companies even trade on their reputation and can sustain a price premium for their products that are of a quality well above the minimum threshold in the relevant standard. The standard functions in this way as reference for the distinguishing feature. For instance, "ex post restitution" (e.g., a guarantee) can also work as a substitute for a certified minimum quality standard.

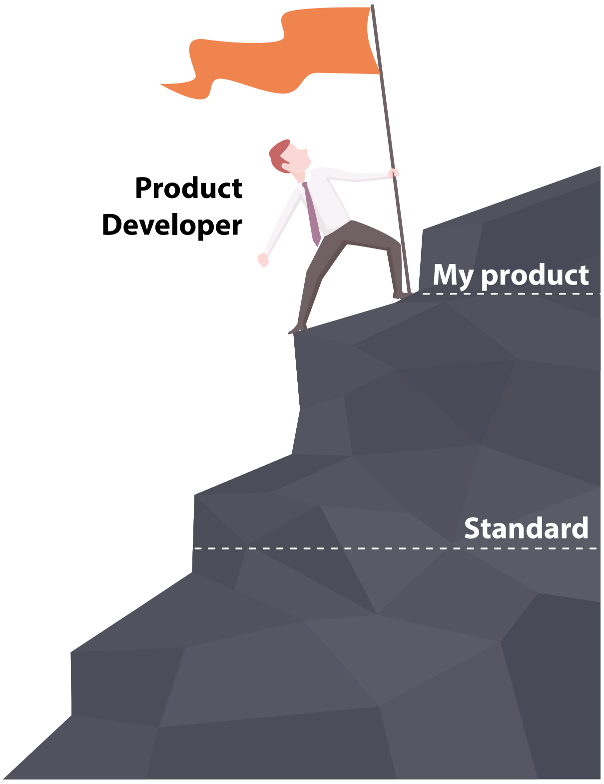

Figure 8.3: Standards set a target level for quality

Minimum quality standards exhibit many advantages. For instance, ISO 9000 and ISO 14000 certifications ensure that sellers/suppliers have implemented quality management and environmental management systems according to the requirements of the standards. Although these certifications do not mean that the product itself is certified, they increase the level of trust between sellers and buyers. Consequently, they decrease transaction and search costs caused by economic exchange and make it possible to define products in a way that reduces buyer uncertainty. Thus, the buyer's risk goes down, and the buyer needs to spend less money and time to evaluate different products before making a purchase. In the case of product certification, this can function as a shortcut for buyers, as certification constitutes proof of compliance with a standard (Pham 2006; Swann 2000, 2010a).

For market entry, the effects of minimum quality standards are uncertain. When the characteristics of products are documented in a standard, the playing field between incumbent and entrant gets levelled. However, in its absence, incumbents may have an information advantage over entrants. Some quality standards can be set at an unnecessarily high level to deter newcomers from entering a market. Though these standards may impose a cost burden on incumbents, the cost burden on entrants can be even greater. This is an effective approach to increase barriers to market entry, which is referred to as "raising rivals' costs" (Salop and Scheffman 1983).

The concept of "regulatory capture" can be considered a variant of the "raising rivals' costs" concept. Some producers may lobby to persuade the regulator to define regulations in their interest rather than in the interest of the buyer/customer (original intention of standards). "Some high-cost and high-quality producers may find it in their interest to lobby for an unnecessarily high minimum quality standard, because that will in effect exclude their lower cost, lower quality rivals from the market" (Swann 2000, p. 8). Therefore, minimum quality standards should be open and defined cooperatively (e.g., through formal standardization) to ensure that all interested parties are not excluded, and to overcome Gresham's Law. Minimum quality standards can also protect third parties, such as in the area of health or environment to reduce the negative impacts of low quality products.

Standards have a positive effect on safety, and there are many areas where safety can be supported by means of standards. Recall an example of a company in Chapter 5 that has been actively involved in creating standards on technical solutions that prevent users of electric devices from electric chocks. Over time, this company could discover new market applications for its technology during the standardization process. Hence, standardization resulted in the development of safety standards (electric shock prevention) that served more than one market. Another example for safety standards concerns workplace safety. These standards specify the requirements on management systems to ensure Occupational Health and Safety (OHS) for workers, visitors or any other person present in the workplace (e.g., da Silva and Amaral 2019). For example, ISO 45001 helps organizations "…to conceive proactive systems to prevent injuries and worsening health problems as a result of occupational activity" (da Silva and Amaral 2019, p. 124). Another area is food safety. For example, food can be irradiated to decontaminate it and killing harmful bacteria, to increase its shelf duration by keeping it fresh for longer time, or even to avoid insects spreading out in other geographical regions. In this context, international standards have been created to cover many areas related to food irradiation: human health, plant protection, labelling, dose delivery, quality assurance and facility management (Roberts 2016).

8.3.3 VARIETY-REDUCING STANDARDS

Variety-reducing standards reduce the variability of key product characteristics. These standards have two main functions: (1) to support the achievement of economies of scale and (2) to prevent market fragmentation.

These standards support economies of scale by minimizing the proliferation of minimally differentiated products or models. For instance, standard clothing sizes also mean compromises for non-standard customer sizes and individual wishes, thus constraining choice. However, these standards have a positive effect on price and transaction costs on the customer's side, since customers do not have to choose from many product variants.

Variety reduction can also prevent market fragmentation and support a joint vision. In effect, some technologies get stuck in the pre-paradigmatic stage because suppliers and users are too dispersed. A lack of focus or critical mass prevents the development of a market (Swann and Watts 2002). Therefore, standards can play an important role in achieving focus and cohesion amongst pioneers, especially in the formative stages of a market (Moore and Benbasat 1991).

This way, standards can shape future technological trajectories and consequently constitute an instrument for the development of new markets (Dosi 1982; Swann and Gill 1993).

For suppliers, less fragmentation also means lower risk level (even if they face more competition). Variety-reducing standards can decrease the barriers to entry because they act against variety proliferation, which incumbents can use to limit competition from small-scale entrants with low capability of providing a similar variety level. Variety-reducing standards do not need to be defined publicly because economies of scale, which is the best-known function of this type of standard, can also be obtained with an idiosyncratic model range. Note, however, that a store selling clothes in idiosyncratic sizes may not be able to succeed (Swann 2000; Pham 2006).

8.3.4 INFORMATION/MEASUREMENT STANDARDS

Information and measurement standards contain codified knowledge and product descriptions. They constitute an important instrument for technology transfer, as they codify the work and experience of generations of experts in their specific fields and support the dissemination of best practices. As such, they have a positive effect on the market by diffusing knowledge (Temple and Williams 2002).

EXAMPLE

Digital image compression (ANSI n.d.)

With the rapid diffusion of image and video processing applications and the further advancement of multimedia technologies, compression methods became more and more important during the early 1990s. International standardization noticed this trend and released several standards describing different compression methods, such as JPEG (Joint Photographic Experts Group). These standards offered the industry new solutions for saving storage space and reducing transmission rate requirements. Thus, compression standards laid the foundation for innovative applications, services, and even markets. Many companies of all sizes have based their software products on these compression methods, which are used by millions of users worldwide today. The JPEG standard itself and its descendants are comprised in various applications, such as the sharing of digital images, remote sensing, archiving, digital cinema, and image search and retrieval.

Measurement standards describe "those devices, artefacts, procedures, instruments, systems, protocols, or processes that are used to define (or to realize) measurement units and on which all lower echelon (less accurate) measurements depend" (Sharp 1999). They can enable advances in process control, thereby supporting the achievement of economies of scale. Especially in manufacturing, they foster the precision of production and support market players in producing products and services of higher quality to demonstrate their superiority. Measurement standards can lead to lower transaction costs and less risk between trading partners, as they can build on widely used and accepted standard methods that help the assessment of the quality of raw materials, products and services. Thus, measurement standards also support the effective division of labour (Swann 2010a).

Standards that primarily carry information or codified knowledge have various economic effects on the market. They support capacity building via their main function of spreading state-of-the-art knowledge. When information standards are publicly available, they can foster equal competitive conditions in markets — even between incumbents and entrants. As a result, information standards prevent information asymmetries between market players, and lower the barriers to entry. In addition, companies often refer to standards in contracts or job offers by using the link as a shortcut to a specific description of products or skills. Hence, information standards support the reduction of transaction costs and the achievement of a feasible division of labour (Swann 2000, 2010a, 2010b; Blind 2013).

Although measurement and information standards are usually treated as a separate category of standards, they could also be seen as hybrids of the three aforementioned types, as all standards contain the two types of codified knowledge to at least some extent (Swann 2000).

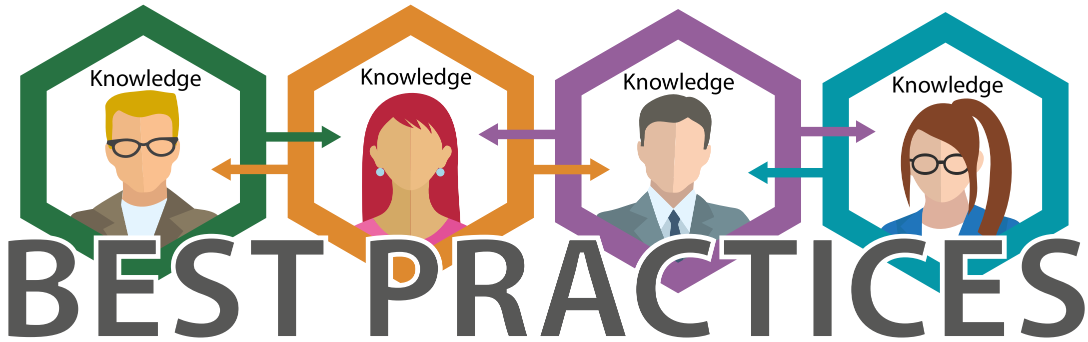

Figure 8.4: Exchange of implicit knowledge

8.3.5 SUMMARY

Obviously, standards have many advantages and are conducive to economic growth. However, from the buyer's and user's perspective, the four types of standards (compatibility/interoperability, minimum quality/safety, variety reducing, and information/measurement) do not seem to contribute equally to demand-side effects: network effects, economies of scale, reduction of information asymmetries, and lowering uncertainty and risk. Whereas compatibility and interoperability standards are particularly suited to supporting network effects, variety-reducing standards have a special positive impact on economies of scale. Minimum quality and safety standards lead to less uncertainty and risk, while information standards are particularly effective in reducing information asymmetries (Table 8.4). Note, however, that the categories of standards introduced in this chapter are identical to the characteristics of the standards themselves. In effect, some standards may combine different characteristics, e.g., compatibility and variety reducing. Thus, one specific standard may show, in full or partially, one or several of these characteristics, and consequently combines many of the benefits provided in Table 8.4.

Table 8.4: Different types of standards and their demand-side effects (Blind 2013)

	DIFFERENT TYPES OF STANDARDS AND THEIR MAJOR DEMAND-SIDE EFFECTS FOR INNOVATION			
	GENERATION OF NETWORK EFFECTS	ACHIEVEMENT OF ECONOMIES OF SCALE	REDUCTION OF INFORMATION ASYMMETRIES	LOWERING UNCERTAINTY AND RISK
COMPATIBILITY/ INTEROPERABILITY	X			
MINIMUM QUALITY/ SAFETY				X
VARIETY REDUCING		X		
INFORMATION			X	

8.4 PUBLIC PROCUREMENT AND STANDARDIZATION

The public sector can use standards in the context of public procurement (e.g., in tender specifications) to foster demand-side effects. This way, governments can achieve innovation diffusion to the private sector, as companies and other organizations applying for public tenders must comply with specific standards.

DEFINITION

Public procurement is the process by which public authorities (e.g., government departments or local authorities) purchase work, goods, or services from companies, for example, the building of a state school, purchasing of furniture for a public prosecutor's office, or contracting cleaning services for a public university (Blind 2013).

EXAMPLE

Disseminating accessibility standards through public procurement

Without access to ICT, persons with disabilities cannot get equal access to education, everyday services, and social and other areas of life. To achieve an inclusive society, ETSI released a new standard (EN 301 549) that is intended in particular for use in public procurement to ensure that software products, web applications and digital devices satisfy basic accessibility requirements. By referencing the standard in public tenders, governments can improve the accessibility of ICT for their own employees and the public (e.g., ticket vending machines, websites). Companies applying for these tenders need to comply with the accessibility criteria laid down in the standard, thus promoting the spread of the standard (ETSI 2014; Rice 2015). For more details on the standard, see Chapter 3.

Public procurement accounts for a substantial portion of trade in Europe. For example, in 2017, the estimate of total general government expenditures on works, goods, and services was 2049.8 billion euros. This is about 13.3% of European GDP (European Commission, 2019). In the context of public procurement, standards yield many positive effects. They improve the quality of public services and infrastructures, leading to high customer and citizen satisfaction. The improvement of public services generates more competition among regions, and this can increase regional attractiveness. Furthermore, by integrating innovations in the public sector, cost savings can be made, such as lower maintenance and repair costs or lower energy consumption.

Note that in general, industry can be strongly influenced by the rules of governments. Christy Hubbard, product marketing manager for Adobe's ePaper Solutions Group, once stressed the following in an interview:

"When government says you need to build technology a certain way, for vendors like ourselves that's a very compelling maxim. We need to build products that can be sold to the government. It's not very practical for us to build multiple versions of our products" (Marsan 2001).

Less positive effects, however, can result when new features or improved functionalities trigger higher purchasing prices. Sometimes, innovative technologies can bear higher risks for the user but also, for instance, for the environment, and they can increase maintenance costs due to less operational experience. In addition, there may be very limited competition, since the innovation to be purchased by the public sector may only be produced by a small number of companies (or even just one).

According to Blind (2013), standards referenced in public tenders lead to the creation of innovative products that can reduce production costs and lower the price paid by public procurers. Furthermore, they secure the interoperability of the purchased innovation with already existing infrastructure and can push competition, increasing the innovation pressure among competitors for public tenders. In addition, they reduce the risk of lock-in to a specific supplier and trigger direct innovation effects for companies through the implementation of newly released standards. In general, this results in reduced risk related to costs, health, environment, and safety, while facilitating positive spill-overs through innovation supporting procurement processes in the private sector.

Standards come into play at various stages of the procurement process (Figure 8.5). Before procurement, appropriate standards should be analysed and then referenced. During procurement, they support the selection of proposals, as only those proposals that comply with the standards are retained. In addition, possible conflicts can be solved with the help of standards. After procurement, standards can reduce transaction costs by identifying possible deviations and enable easier monitoring of technology by taking newly released standards into account (Blind 2013).

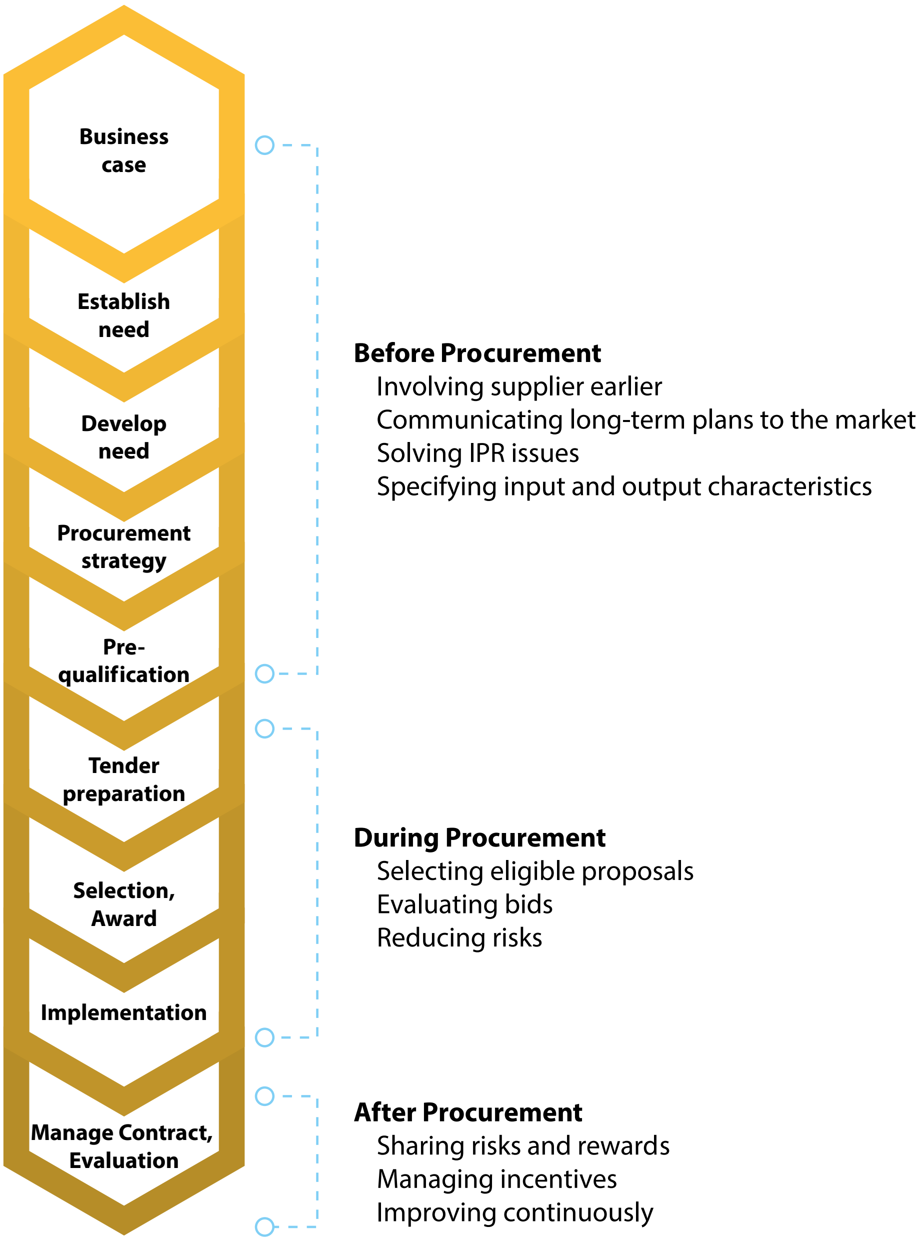

Figure 8.5: The procurement process (Blind 2013)

With the support of the European Commission, CEN developed a guide for referencing standards in public procurement in Europe (CEN 2018). Since it was inspired by similar guides published previously in Spain and in Denmark, the guide is intended to be used and tested at first at the national level. However, the plans are to use it as the basis for a formal CEN Guide in the future. The guide contains relevant information on public procurement, e.g.,

- It makes reference to the Directive 2014/24/EU on public procurement,
- It indicates in which procedures of public procurement standards can be referenced,
- It indicates how to ensure that the referenced standards are implemented in the contract phase,
- It describes the order of priority for referencing standards: European standards first, then less widely implemented standards cross-border. Note that most international standards are recognised and implemented in Europe.

8.5 SUMMARY

Standards play an essential role in the dissemination of technologies and know-how and, as such, contribute to a nation's GDP. In this chapter, we took a closer look at the positive and negative economic effects of standards. We dealt with the four most relevant types: compatibility/interface, minimum quality/ safety, variety-reducing and information/measurement standards.

Compatibility standards can have positive effects on the economy if they are elaborated based on the principles of formal standardization. They can support network externalities, avoid lock-ins, and foster an increased variety of system products as well as more efficiency in supply chains. On the negative side, when compatibility standards are owned privately by one or more organizations, they can lead to monopolies and, in the case of strong network externalities, to lock-in effects.

Minimum quality or safety standards support the avoidance of adverse selection, help increase trust between different market players and reduce transaction costs. If minimum quality criteria are set unnecessarily high, i.e., inspired by lobbyists, quality standards can also function as a market barrier.

Variety-reducing standards can increase economies of scale and support a company in building focus in markets and achieving critical mass. An obvious negative side effect is the general reduction of choice. At the same time, variety-reducing standards can lead to monopolies or market barriers if a market player misuses the standard to limit competition, e.g., when incumbents intend to drive small-scale entrants with lower capabilities of providing variety outside the market.

When publicly available to all market players, information/measurement standards provide codified knowledge, facilitate trade and reduce transaction costs. Like minimum quality/safety standards, they are vulnerable to the effect of regulatory capture.

In general, standards have an influence on a variety of economic effects, such as prices, productivity, market entry, competition, innovation, trade, outsourcing, and market failure.

Governments can use standards in the context of public procurement to foster demand-side effects. Through public procurement, governments can diffuse innovations to the private sector, as companies and other organizations that apply for public tenders must comply with those standards. However, this procedure can lead to negative effects. For instance, new features or improved functionalities in standards can trigger higher purchasing prices. In addition, innovative technologies bear higher risks for users and also, for example, the environment, and they can increase maintenance costs due to little operational experience.

8.6 QUIZ

1 - TO WHAT EXTENT DID STANDARDS CONTRIBUTE TO GERMANY'S GDP BETWEEN 2002 AND 2006?

(See Section 8.2.1 for hints)

a) *Between 0.07 and 0.08%*

b) *There is no evidence that standards contributed to the GDP*

c) *Between 0.7 and 0.8%*

d) *Between 7 and 8%*

2 - TOTAL FACTOR PRODUCTIVITY (TFP) IS AN ESSENTIAL PARAMETER THAT DETERMINES THE QUANTITY OF ECONOMIC OUTPUT PRODUCED IN A COUNTRY. IT PLAYS AN IMPORTANT ROLE IN ESTIMATING THE CONTRIBUTION OF STANDARDS TO THE GDP. ON WHICH FACTORS DOES THE TFP DEPEND?

(See Section 8.2.1 for hints)

a) *Technological knowledge generated in a country (number of patents),*

b) *Technological knowledge imported from abroad (number of technological licence payments abroad)*

c) *The level of diffusion of this technological knowledge (number of standards)*

d) *Technological knowledge generated in a country (number of papers)*

3 - WHO BEARS THE COSTS OF DEVELOPING, UPDATING AND DISTRIBUTING STANDARDS?

(See Section 8.2.2 for hints)

a) *Standardization is financed by governments as the resulting standards contribute to the economy as a whole*

b) *The costs are generally incurred by companies, academia and other organizations by participating in the standard-setting process, or by purchasing standards*

c) *50% of the costs are covered by the state and the remaining 50% are covered by companies participating in standard setting*

d) *SDOs cover the costs via crowdfunding initiatives and voluntary donations*

4 - VARIETY-REDUCING STANDARDS REDUCE THE VARIABILITY OF KEY PRODUCT CHARACTERISTICS. WHICH ECONOMIC EFFECTS ARE MAINLY ASSOCIATED WITH THIS TYPE OF STANDARD?

(See Section 8.3.3 for hints)

a) *They support economies of scale*

b) *They support network effects*

c) *They prevent lock-ins into old technologies*

d) *They can prevent market fragmentation*

5 - THE GLOBALIZATION OF THE COMPUTER INDUSTRY HAS ONLY BEEN POSSIBLE BECAUSE OF INTERNATIONALLY ACCEPTED COMPATIBILITY STANDARDS. HOW DO COMPATIBILITY STANDARDS SUPPORT THE DIVISION OF LABOUR IN THE COMPUTER INDUSTRY?

(See Section 8.3.1 for hints)

a) *They stipulate the exact tasks for all market players in the value chain*

b) *Through predefined interfaces, the production of computer components can be outsourced to suppliers all over the world*

c) *Suppliers can focus on small portions of the value chain to achieve economies of scale and sell computer components to an international market*

d) *They describe which activity of the value chain should be conducted in a certain geographic area for environmental protection reasons*

6 - MINIMUM QUALITY STANDARDS REFER TO THE MINIMUM ACCEPTABLE LEVEL OF REQUIREMENTS. WHAT ARE THE EFFECTS OF MINIMUM QUALITY STANDARDS FROM THE CUSTOMER/CONSUMER PERSPECTIVE?

(See Section 8.3.2 for hints)

a) *They make it easy to assess which product is best suited for their purposes*

b) *They make it harder to distinguish between different product variants*

c) *They help in assessing if a certain product is worth a certain price*

d) *They foster information asymmetries between buyers and sellers*

7 - WHICH STATEMENTS ARE TRUE?

(See Sections 8.3.1 and 8.3.2 for hints)

a) *The output of an open standardization process is an open standard. One generally accepted characteristic of an open standardization process is that any entity, be it an organization or individual, can participate in the creation of the standard*

b) *Open standards are especially attractive for enterprises seeking first-mover advantage*

c) *Open standards make it more likely for the market to get locked-in in inferior technology*

d) *Open standards enhance the market power of a single producer, leading to a monopoly*

8 - HOW DO DIFFERENT TYPES OF STANDARDS POSITIVELY INFLUENCE TRADE?

(See Section 8.3 for hints)

a) *Minimum quality standards can foster trust between trading partners*

b) *Information standards that provide codified knowledge can facilitate trade*

c) *Minimum quality standards help reduce the level of risk felt by buyers*

d) *Measurement standards can lead to lower transaction costs and less risk between trading partners*

9 - WHY DO GOVERNMENTS REFER TO STANDARDS IN OPEN TENDERS?

(See Section 8.4 for hints)

a) *To limit the number of applications to a manageable number, as only companies complying with the standard can apply*

b) *To improve the quality of public services and infrastructures*

c) *So that they can diffuse innovations to the private sector*

d) *They are legally obliged to refer to standards whenever possible*

10 - WHAT IS THE MAJOR DEMAND-SIDE EFFECT ON INNOVATION OF COMPATIBILITY STANDARDS?

(See Section 8.3.5 for hints)

a) *Achievement of economies of scale*

b) *Reduction of information asymmetries*

c) *Generation of network effects*

d) *Lowering uncertainty and risk*

11 - HOW CAN A TECHNOLOGY ACHIEVE DOMINANCE IN THE MARKET?

(See Section 8.3.1 for hints)

a) *By natural selection*

b) *By winning a standard race*

c) *By being released by a recognized SDO*

d) *Only a technology defined in a patent can achieve dominance in a market*

12 - WHAT ARE THE MAIN NEGATIVE EFFECTS OF MINIMUM QUALITY STANDARDS?

(See Section 8.3 for hints)

a) *Reduced choice*

b) *Regulatory capture*

c) *Raising rivals' costs*

d) *Avoiding adverse selection*

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8.7 GLOSSARY

- Gross Domestic Product: The OECD defines the Gross Domestic Product or GDP as "an aggregate measure of production equal to the sum of the gross values added of all resident and institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs)." (OECD 2001)
- Trade: "Trade is the activity of buying, selling, or exchanging goods or services between people, firms, or countries." (Collins dictionary n.d.)
- Outsourcing: Outsourcing is the action of "delegating (part of) activities to an outside contractor" (OECD 2002).
- Switching costs: A consumer faces switching costs when changing a brand, supplier or a product (Investopedia n.d.). Examples of switching costs are:
  - Acquisition costs: when new equipment has to be bought or adapted
  - Training costs: associated with learning to use a new product
  - Testing costs: if there is uncertainty as to the suitability of alternative products/services (Parr et al. 2005)
- Public Procurement: The process by which public authorities (e.g. government departments or local authorities) purchase work, goods or services from companies, for example, the building of a state school, purchasing of furniture for a public prosecutor’s office, or contracting cleaning services for a public university (Blind 2013).
- Lock-in effect: When a user of a product or service is dependent on a particular vendor because of prohibitive switching costs, therefore the effect is also called vendor lock-in. (Deek and McHugh 2007)
- Transaction costs: "The costs involved in market exchange. These include the costs of discovering market prices and the costs of writing and enforcing contracts." (OECD 2003)
- Gresham’s law: The assertion that "bad drives out good". The presence of "bad" products in a market, and the inability of the buyer to distinguish bad from good from the outset, means that the supplier of good products withdraws from the market, as he cannot get a satisfactory price (Akerlof 1970; Swann 2000, p. 35).
- Division of labour: "Specialization in work, which may be effected by breaking an activity into component tasks, or by assigning specific groups of persons to certain jobs or outputs." (OECD 2013)
- Information asymmetry: When one party in an economic transaction is more or better informed than the other.
- Public tender: "A bidding process that is open to all qualified bidders and where the sealed bids are opened in public for scrutiny and are chosen on the basis of price and quality." Also called competitive tender or open tender. (Business Dictionary n.d.)
- Regulatory capture: Some producers may lobby so skilfully that they persuade the regulatory agency to define regulations in the interest of the producers rather than in the interest of the customer. (Swann 2000, p. 8)

8.8 LIST OF ABBREVIATIONS

- AAC: Advanced Audio Coding
- AFNOR: Association Française de Normalisation
- ANSI: American National Standards Institute
- API: Application Programming Interface
- CEN: European Committee for Standardization
- CENELEC: European Committee for Electrotechnical Standardization
- DRM: Digital Rights Management
- DTI: Department of Trade and Industry (United Kingdom)
- ESS: European Standardization System
- ETSI: European Telecommunications Standards Institute
- EY: Ernst & Young Consulting Company
- GDP: Gross Domestic Product
- IEC: International Electrotechnical Commission
- ISO: International Standardization Organization
- ITU: International Telecommunication Union
- JPEG: Joint Photographic Experts Group
- SDO: Standard Development Organization
- SME: Small and Medium-sized Enterprises
- TFP: Total Factor Productivity
- 3GPP: 3rd Generation Partnership Project

8.9 REFERENCES

- Akerlof, G. A. (1970). The market for "lemons": Quality uncertainty and the market mechanism. The quarterly journal of economics, 488–500.
- ANSI. (n.d.). Joint Photographic Expert Group (JPEG) Image Coding Standard. https://share.ansi.org/shared%20documents/Other%20Services/SBB/JPEG_Case_Study.pdf. Accessed 16 February 2018.
- Baron, J., Gupta, K. (2018). Unpacking 3GPP standards. Journal of Economics and Management Strategy 20180; 27, 433–461.
- Blind, K. (2008). The Influence of Companies' Patenting Motives on their Standardisation Strategies. 13th EURAS Workshop, Sweden, June, 16.
- Blind, K. (2013). The Impact of Standardization and Standards on Innovation: Compendium of Evidence on the Effectiveness of Innovation Policy Intervention.
- Blind, K., Jungmittag, A., & Mangelsdorf, A. (2011). The Economic Benefits of Standardization: An update of the study carried out by DIN in 2000. https://www.din.de/blob/89552/68849fab0eeeaafb56c5a3ffee9959c5/economic-benefits-of- standardization-en-data.pdf. Accessed 10 July 2018.
- Blind, K., Mangelsdorf, A., & Pohlisch, J. (2018). The effects of cooperation in accreditation on international trade: Empirical evidence on ISO 9000 certifications. International Journal of Production Economics, 198, 50–59 (2018). doi:10.1016/j.ijpe.2018.01.033
- Business Dictionary. (n.d.). Open Tender.
- http://www.businessdictionary.com/definition/open-tender.html. Accessed 14 February 2018.
- Coase, R. H. (1937). The nature of the firm. Economica, 4(16), 386–405.
- Collins dictionary. (n.d.). Definition of "trade". https://www.collinsdictionary.com/dictionary/english/trade. Accessed 26 January 2018.
- Da Silva, S.L.C., Amaral, F.G. (2019). Critical factors of success and barriers to the implementation of occupational health and safety management systems: A systematic review of literature. Safety Science 117 (2019), 123-132.
- de Vries, H., de Vries, H., & Oshri, I. (2008). Standards Battles in Open Source Software. London: Palgrave Macmillan UK.
- Deek, F. P., & McHugh, J. A.M. (2007). Open source: Technology and policy. Cambridge University Press.
- DIN Deutsches Institut für Normung e. V. (2016). DIN launches innovation funding programme. https://www.din.de/en/din-and-our-partners/press/press-releases/din-launches-innovation-funding-programme-187120. Accessed 22 January 2018.
- Dosi, G. (1982). Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. Research Policy, 11(3), 147–162.
- DTI. (2005). The Empirical Economics of Standards.
- Ernst & Young (2015). Independent Review of the European Standardisation System Final Report, March 2015. https://op.europa.eu/en/publication-detail/-/publication/18221a52-2a07-46e3-be6e-e1b7d98a2ee8/language-en/format-PDF/source-50778362. Accessed 26 August 2021.

- ETSI. (2014). New European Standard on accessibility requirements for public procurement of ICT products and services. http://www.etsi.org/news-events/news/754-new-european-standard-on-accessibility-requirements-for- public-procurement-of-ict-products-and-services. Accessed 16 February 2018.
- European Commission. (2004). Commission Decision of 24.03.2004: relating to a proceeding under Article 82 of the EC Treaty (Case COMP/C-3/37.792 Microsoft).
- European Commission (2011). Impact assessment. (Publication nr SEC 671 final). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011SC0671&from=EN. Accessed: 26 August 2021.
- European Commission (2019). Public Procurement Indicators 2017. https://ec.europa.eu/docsroom/documents/38003/attachments/1/translations/en/renditions/native. Accessed 29.08.2021.
- German Federal Ministry for Economic Affairs and Energy BMWi. (n.d.). Patents. http://www.bmwi.de/Redaktion/EN/Artikel/Technology/patents.html. Accessed 22 January 2018.
- Gupta, K. (2017). The Role of SMEs and Startups in Standards Development (July 12, 2017). Available at SSRN: https://ssrn.com/abstract=3001513 or http://dx.doi.org/10.2139/ssrn.3001513
- Haimowitz, J., & Warren, J. (2007). Economic Value of Standardization.
- Investopedia. (n.d.). Switching Costs. https://www.investopedia.com/terms/s/switchingcosts.asp. Accessed 26 January 2018.
- Leland, H. E. (1979). Quacks, lemons, and licensing: A theory of minimum quality standards. Journal of political economy, 87(6), 1328–1346.
- Locksley, G. (Ed.). (1990). The single European market and the information and communication technologies (Studies in the information economy Urban and regional development). London: Belhaven Pr.
- Marsan, C. D. (2001). Web site accessibility goes mainstream. http://edition.cnn.com/2001/TECH/industry/06/15/web.site.accessibility.idg/index.html. Accessed 16 February 2018.
- Miotti, H. (2009). The Economic Impact of standardization: Technological Change, Standards Growth in France.
- Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. Information systems research, 2(3), 192–222.
- OECD. (2001). Gross Domestic Product (GDP). https://stats.oecd.org/glossary/detail.asp?ID=1163. Accessed 21 January 2018.
- OECD. (2002). Outsourcing. https://stats.oecd.org/glossary/detail.asp?ID=4950. Accessed 26 January 2018.
- OECD. (2003). Transaction Costs. https://stats.oecd.org/glossary/detail.asp?ID=3324. Accessed 14 February 2018.
- OECD. (2013). Division of Labour. https://stats.oecd.org/glossary/detail.asp?ID=6812. Accessed 17 September 2018.
- Oxford Living Dictionaries. (n.d.). Knowledge economy. https://en.oxforddictionaries.com/definition/knowledge_economy. Accessed 22 January 2018.

- Parr, A. N., Finbow, R. J., & Hughes, M. J. (2005). UK merger control: Law and practice (2nd ed.). London: Sweet & Maxwell.
- Pham, T. H. (2006). Economic Aspects of Standardization. In W. Hesser (Ed.), Standardisation in companies and markets (pp. 61–99). Hamburg: Helmut-Schmidt-University.
- Picot, A., Reichwald, R., & Wigand, R. T. (2013). Die grenzenlose Unternehmung: Information, Organisation und Management. Lehrbuch zur Unternehmensführung im Informationszeitalter. Berlin: Springer-Verlag.
- Raustiala, K., & Sprigman, C. J. (2012). The knockoff economy: How imitation sparks innovation. Oxford, New York: Oxford University Press.
- Rice, D. (2015). Public Procurement. Belgrade, 2015.
- Roberts, P.B. (2016). Food irradiation: Standards, regulations and world-wide trade. Radiation Physics and Chemistry 129 (2016), 30-34.
- Ronnen, U. (1991). Minimum Quality Standards, Fixed Costs, and Competition. The RAND Journal of Economics, 22 (4), 490-504.
- Salop, S. C., & Scheffman, D. T. (1983). Raising Rivals' Costs. The American Economic Review, 73, 267– 271.
- Sharp, D. B. (1999). Measurement Standards. The Measurement, Instrumentation, and Sensors Handbook, JG Webster, ed., CRC Press, Boca Raton, 5-1.
- Swann, G. M. P. (2000). The Economics of Standardization. Final Report for Standards and Technical Regulations Directorate Department of Trade and Industry. Manchester Business School. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/16506/The_ Economics_of_ Standardization_-_in_English.pdf. Accessed 1 January 2015.
- Swann, G. M. P. (2010a). International Standards and Trade: A Review of the Empirical Literature. OECD Trade Policy Working Papers, No. 97, OECD Publishing.
- Swann, G. M. P. (2010b). The Economics of Standardization: An Update. Report for the UK Department of Business, Innovation and Skills (BIS) (Version 2.2).
- Swann, G. M. P., & Gill, J. (1993). Corporate vision and rapid technological change: The evolution of market structure. New York, N.Y: Routledge.
- Swann, G. M. P., & Watts, T. (2002). Visualisation needs vision: The pre-paradigmatic character of virtual reality. Virtual society, 41–60.
- Swinnen, J. F. M. (2015). Quality standards, value chains, and international development: Economic and political theory. Cambridge University Press.
- Temple, P., & Williams, G. (2002). The Benefits of standards: Trading with and within Europe. Brussels. CEN Management Centre Publication.
- Williamson, O. E. (1989). Transaction cost economics. Handbook of industrial organization, 1, 135–182.

9 CONCLUSION

In a nutshell, this textbook on ICT standardization has two main parts. The first part is about an introduction to the basic knowledge, and the second is about delving into more advanced topics. Whereas Chapters 2, 3, and 4 are dedicated to the basics, Chapters 5, 6, 7, and 8 treat more advanced issues that are still relevant for students who wish to get a solid knowledge base on ICT standardization and standards. It is also important to emphasize that many of the standardization principles presented in this book apply beyond the ICT field. As such, students that aim to learn the basics of standardization can also benefit from this this book. Throughout the book, however, we have provided many practical examples and case studies from the field of ICT standardization to highlight the peculiarities of the field and to make readers benefit from the past learning experiences that are particular to ICT standardization.

We provided an extensive overview of the key concepts of ICT standardization to enable readers to orientate themselves in the tricky landscape of standardization. It describes and analyses the different organisations involved in standardization, their interplay, as well as the different features of their outcomes. We focus on the Standards Development Organizations (SDOs) and their production processes, which are complex: these involve technical resources and social elements under a strong organization. Standards support regulation and enable fair competition, and all of this should be in compliance with a set of fundamental principles. In addition, the roles of standardization professionals in general, and experts in particular, in SDOs and committees are clearly defined, even if they vary slightly among the different SDOs. Technical competence that is brought into the standardization committees by the experts is of prime importance, but a wide variety of soft and personal skills also help make a successful standardization expert.

This work also highlights the importance of standardization in the research and innovation process. It is true, however, that sometimes standards can hamper innovation if standardization is not adequately managed over time or if the standard induces a lock-in effect. Nevertheless, we argue that the positive effects of standards and standardization to innovation more than outweigh their negative impacts. By means of our in-depth analysis of so-called innovation potential in standardization, we illustrate the different aspects how standards and standardization can be conducive to innovation. Hence, contrary to popular belief, standards and standardization do support companies in improving their innovation capabilities. This book also sends an important message to students that are future researchers and scientists about the usefulness and value of standardization and standards for the research process. The results of the research process can be used in standardization to draw up new standards. The other way around is also possible, as standards can give input for the research process.

Organizations that intend to participate in standardization have to consider many aspects such as their corporate strategy, domain of activities, technological field where they are operating and their geographical location. Companies can also pursue different participation strategies such as being a leader, an active contributor, a follower, or even a spectator. The book additionally presents many contextual factors (contingencies) that companies should consider since these factors can have an influence on the strategic direction in the standardization process.

We also deal in-depth with Standards-Essential Patents (SEPs), a relevant topic in ICT standardization. Basically, because of the criticality of this issue, SDOs have developed policies such as FRAND (Fair, Reasonable and Non-Discriminatory) and Royalty-Free to cope with the induced challenges. We describe both policies at a good level of detail, while mentioning the problems that can derive from having patents required for the implementation standards distributed among many patent owners and highlighting some of the solutions that have been implemented so far such as patent pools.

Finally, we take a closer look at the positive and negative economic effects of standards. We deal with the four most relevant types of standards: compatibility/interface, minimum quality/safety, variety-reducing, and information/measurement standards. Furthermore, governments can use standards in the context of public procurement to foster demand-side effects. This way, governments can diffuse innovations to the private sector, as companies and other organizations applying for public tenders have to comply with those standards.

We hope that this book helps as much as possible students and practicing professionals in their learning journey toward ICT standardization and standards. The book could have addressed much more topics than the ones presented in this second edition. We had to make a choice to keep this volume at a reasonable size (number of pages) that does not demotivate the learners, while covering the essential topics that eases the access to the new field. We hope that we made a good choice, but the feedback of our readers, be it students, lecturers, or practitioners is very much welcomed to allow us to benefit from their experiences and improve this work further in the future.

ABOUT THE AUTHORS

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This 2nd edition of the textbook also contains contributions from two authors to the 1st Edition but who did not participate in this update:

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ANSWERS TO QUIZ QUESTIONS

CHAPTER 2 - INTRODUCTION TO STANDARDS - *P. 47*

1 - WHICH OF THE FOLLOWING STATEMENTS APPLY TO A "DE FACTO" STANDARD?

(See Section 2.1 for hints)

a) *it usually has very little impact, as it is recognized only within a restricted community of users; (wrong)*

b) *it is based on a winning technologic solution, which is widely and independently adopted by different producers/providers within a market segment and products developed on such basis are widely accepted by users/customers; (right)*

c) *it has been agreed through a formal process by members of an established organization. (wrong)*

2 - WHICH OF THE FOLLOWING STATEMENTS APPLY TO A "SDO STANDARD”?

(See Section 2.1 for hints)

a) *it has been developed through a fair process and by consensus by members of an established organization; (right)*

b) *it establishes mandatory characteristics of a product to be put on the market; (wrong)*

c) *it strictly and fully rules the design of an item. (wrong)*

3 - WHAT IS THE DIFFERENCE BETWEEN "REGULATIONS" AND "STANDARDS"?

(See Section 2.1 for hints)

a) *none, as standards "regulate" the characteristics of products; (wrong)*

b) *regulations define a set of characteristics an item needs to have to access a regulated market, while compliance with standards is on voluntary basis; (right)*

c) *standards only provide a set of best practices to design/develop a specific item and cannot cover critical issues (such as safety or security) that are governed by regulatory bodies. (wrong)*

4 - HOW ARE REGULATIONS AND STANDARDS RELATED?

(See Section 2.1 for hints)

a) *standards and regulations are the same thing; (wrong)*

b) *standards are sometimes turned into regulations; (wrong)*

c) *standards are often referenced by regulations. (right)*

5 - WHAT DO STANDARDS PROVIDE TO PRODUCT DEVELOPERS/DESIGNERS?

(See Section 2.1 for hints)

a) *a thorough set of design rules they are forced to comply with; (wrong)*

b) *references for a high-quality design; (wrong)*

c) *a minimum set of requirements in order to make the product meet certain well-defined objectives. (right)*

6 - HOW DO STANDARDS BENEFIT INNOVATION?

(See Section 2.2 for hints)

a) *by defining the products' characteristics related to the most critical aspects, so as to reduce design risks and time; (right)*

b) *by inspiring designers with innovative ideas; (wrong)*

c) *by constraining designers' choices, so as to speed up the design phase. (wrong)*

7 - HOW DO STANDARDS BENEFIT THE ENVIRONMENT?

(See Section 2.2for hints)

a) *by enforcing mandatory safety and sustainability characteristics for marketable products; (wrong)*

b) *by defining widely shared safety and sustainability requirements for products, often publicized to customers through proper product labelling; (right)*

c) *by forcing designers to follow detailed design rules that ensure products meet determined safety and sustainability requirements. (wrong)*

8 - HOW DO STANDARDS BENEFIT THE ECONOMY?

(See Section 2.2 for hints)

a) *by restricting market access to only standard-compliant, high-quality products; (wrong)*

b) *by enabling economies of scale, encouraging wider and fairer competition and facilitating trade thanks to the definition of widely shared practices; (right)*

c) *by freezing technological evolution, so as to allow producers and customers to get the best return from their past investments in established products. (wrong)*

9 - HOW DO STANDARDS BENEFIT INDUSTRIES?

(See Section 2.2 for hints)

a) *by facilitating the development of new technologies, by ensuring fair competition among industries and by enlarging products' market penetration opportunities; (right)*

b) *by ruling market access of new products, as they define a mandatory minimum set of requirements that new products must comply with; (wrong)*

c) *by pacing the technological evolution, so as to consolidate market positions of established industries. (wrong)*

10 - HOW DO STANDARDS BENEFIT SOCIETY AND INDIVIDUALS?

(See Section 2.2 for hints)

a) *by ruling the market introduction of innovative products, so as to guarantee safety and environmental sustainability; (wrong)*

b) *by establishing a minimum level of performances for any new product entering the market; (wrong)*

c) *by promoting innovation, a safer environment and a more competitive market. (right)*

11 - COMPLETE THE TABLE BELOW BY DEFINING THE CHARACTERISTICS OF THE LISTED SDOS ACCORDING TO THE CLASSIFICATION CRITERIA DEFINED IN THE FIRST ROW:

(See Section 2.3 for hints)

SDO	GEOGRAPHICAL COVERAGE	RECOGNIZED (Y/N)	MAIN TECHNICAL SCOPE
ISO	International	National SDOs	ICT
ITU	International	National and regional SDOs, Industries, Academia, Government bodies	Telecoms, ICT
ETSI	International	National SDOs, Industries, Research institutes, Government bodies	Telecoms, ICT
3GPP	International	SDOs, Industries, Research institutes, Government bodies	Mobile Telecommunications
IETF	International	Professionals	ICT
ECMA	International	Industries	ICT

12 - LIST THE MAIN PHASES OF THE GENERIC STANDARD LIFE CYCLE AND SUMMARIZE WHAT THEY ARE FOR:

(See Section 2.3 for hints)

PHASE NUMBER	PHASE NAME	WHAT IT IS FOR (SCOPE, MAIN ACTIVITIES INCLUDED IN THE PHASE)
1	Inception	Identification of needs for new standards
2	Conception	Start of standardization action; - Official submission to a SDO of the proposal for a new standardization work - Definition of objectives - Definition of action plan - Assignment of SDO's resources
3	Drafting	Standard development: • Document writing and internal reviewing • Request for the formal approval of stable documents
4	Approval	Stamp of approval for the new standards
5	Obsolescence	Standard withdrawn

13 - IDENTIFY THE TWO CHARACTERISTICS, FROM THOSE LISTED BELOW, THAT DO NOT DESCRIBE A NORMATIVE REQUIREMENT PART OF A STANDARD:

(See Section 2.4 for hints)

a) *clear, concise and unambiguous; (wrong)*

b) *widely explained by means of extended examples; (right)*

c) *expressed by means of specialized notations; (wrong)*

d) *defined by means of references to other standards; (wrong)*

e) *well justified by means of an extended technical dissertation; (right)*

f) *testable: the description has to be worded so as to provide all needed information to implement (possible) relevant tests. (wrong)*

14 - DESCRIBE THE TYPICAL CONTENT OF THE VARIOUS SECTIONS OF A GENERIC STANDARD LISTED BELOW:

(See Section 2.3 and 2.5 for hints)

SECTION	CONTENT
SCOPE / ABSTRACT	Brief description of the standard's content and objectives.
REFERENCES	List of reference documentation.
DEFINITIONS	List of definitions that are necessary for the understanding of certain terms used in the recommendation.
BODY OF THE DOCUMENT	It is the normative part of the standard.
ANNEXES	They detail some specific matters; they may be either informative or normative.

CHAPTER 3 - THE STANDARDS ECOSYSTEM - *P. 88*

1 - RECOGNIZED SDOS ARE:

(See Section 3.1 for hints)

a) *Organizations with a sole mission to publish standards that are referenced by regulation. (wrong)*

b) *Organizations that have been elected by the corresponding Parliament (e.g., National Parliament, European Parliament, etc.). (wrong)*

c) *Public organizations that have been created by treaties. (wrong)*

d) *Officially recognized by regulation systems as providers of standards. (right)*

2 - FORMAL STANDARDISATION:

(See Section 3.1 for hints)

a) *Is the process to produce de facto standards. (wrong)*

b) *Is undertaken by SDOs. (right)*

c) *Is only undertaken by officially recognized SDOs. (wrong)*

d) *Produces documents that companies and public organizations must comply with. (wrong)*

3 - NON-RECOGNIZED SDOS:

(See Section 3.1 for hints)

a) *May have well-established procedures to ensure the quality of their standards. (right)*

b) *Only produce private standardization documents. (wrong)*

c) *Produce standards that may later be published by recognized SDOs. (right)*

d) *Approve regulatory documents. (wrong)*

4 - DE FACTO STANDARDS:

(See Section 3.1 for hints)

a) *Cannot ever become formal standards. (wrong)*

b) *Have been previously approved by a public SDO. (wrong)*

c) *Are conventions that have achieved a dominant position. (right)*

d) *Usually have the characteristic of having been validated by the market. (right)*

5 - THE CONCEPT OF DOMINANT DESIGN:

(See Section 3.1 for hints)

a) *Is the main topic of an ISO Guide that addresses the coordination of SDOs. (wrong)*

b) *Is related to the key technological features that transform a document into a de jure standard. (wrong)*

c) *Is always based on the best user experience of technology. (wrong)*

d) *Is related to the key technological features that become a de facto standard. (right)*

6 - EXAMPLES OF DE FACTO STANDARDS ARE:

(See Section 3.1 for hints)

a) *PDF. (right)*

b) *Asynchronous communication. (wrong)*

c) *ISO 9001. (wrong)*

d) *HTML. (right)*

7 - REGARDING PUBLIC AND PRIVATE SDOS:

(See Section 3.1 for hints)

a) *Only public SDOs may adopt de facto standards as formal standards. (wrong)*

b) *Public SDOs are usually created by treaties. (right)*

c) *Generally speaking, private SDOs are commercial companies that publish private standards. (wrong)*

d) *Only public SDOs are eligible as recognized SDOs. (wrong)*

8 - WHAT IS THE PROCEDURE USED TO RELEASE AN INDUSTRIAL SPECIFICATION AS A FORMAL STANDARD?

(See Section 3.1 for hints)

a) *Adoption. (wrong)*

b) *Transposition. (wrong)*

c) *Publicly available specification. (right)*

d) *Regulation. (wrong)*

9 - REGARDING NORMATIVE AND INFORMATIVE STANDARDIZATION DOCUMENTS:

(See Section 3.2 for hints)

a) *Normative documents contain requirements, which must be met in order to claim compliance with the standard. (right)*

b) *Requirements in a standard are usually worded with the term "must". (wrong)*

c) *Informative documents contain information and requirements. (wrong)*

d) *The term "should" is used to include recommendations (right)*

10 - THE NAME ETSI ES 201 873-11 V4.7.1 (2017-06) GIVES THE READER THE FOLLOWING INFORMATION ABOUT THE STANDARDIZATION DOCUMENT:

(See Section 3.2 for hints)

a) *It is part of a family of standards. (right)*

b) *It is a European Standard. (wrong)*

c) *It needs to be revised before June 2019. (wrong)*

d) *It has been approved by ETSI. (right)*

11 - THE NAME NF EN ISO/IEC 15416 AUGUST 2003 GIVES THE READER THE FOLLOWING INFORMATION ABOUT THE STANDARDIZATION DOCUMENT:

(See Section 3.2 for hints)

a) *It has been previously approved by ISO/IEC. (right)*

b) *The document was originally approved as an International Standard, then as a European Standard, and then as a National Standard. (right)*

c) *It is document 416 within the 15000 family of standards. (wrong)*

d) *It was published in 2003. (right)*

12 - INDICATE WHICH OF THE FOLLOWING STATEMENTS ARE TRUE, REGARDING THE CLASSIFICATION OF ICT STANDARDS:

(See Section 3.2 for hints)

a) *The ITU-T Recommendation I.112. Vocabulary of terms for ISDNs belongs to the "terminology standards" category. (right)*

b) *The standard ISO/IEC 24800-4 File format for metadata embedded in image data (JPEG and JPEG 2000) belongs to the "System management standards" category. (wrong)*

c) *The UML specification belongs to the "Communication reference models" category. (wrong)*

d) *The 802.3 IEEE Standard for Ethernet belongs to the "software and networking" category. (right)*

13 - REGARDING VERTICAL AND HORIZONTAL STANDARDS:

(See Section 3.2 for hints)

a) *The ISO/IEC 27001 standards on information security management are vertical standards. (wrong)*

b) *The ETSI GSM family of standards are an example of horizontal standards. (right)*

c) *The smart grid standards belong to the category of vertical standards. (wrong)*

d) *The standards applicable to the food and drink industry are horizontal standards. (wrong)*

14 - REGARDING COORDINATION AMONG DIFFERENT LEVELS OF STANDARDIZATION:

(See Section 3.3 for hints)

a) *International standardization takes precedence over regional standardization. (right)*

b) *National standardization takes precedence over regional standardization. (wrong)*

c) *Regional standardization takes precedence over national standardization. (right)*

d) *Regional standardization takes precedence over international standardization. (wrong)*

15 - REGARDING COORDINATION AMONG DIFFERENT LEVELS OF STANDARDIZATION:

(See Section 3.3 for hints)

a) *Agreements among the corresponding SDOs make it possible for approved international standards to be adopted as regional standards, and then as national standards. (right)*

b) *Agreements tend to recognize that standardization at a narrower scope may have particular needs that need to be considered when adopting standards with a wider scope. (right)*

c) *Approved international standards are usually adopted as regional standards, and then as national standards. (right)*

d) *Approved national standards are simultaneously adopted as regional standards, and then as international standards. (wrong)*

16 - ABOUT THE STANDSTILL CONCEPT:

(See Section 3.3 for hints)

a) *It is a process through which national standards are approved as international standards. (wrong)*

b) *It is the process through which SDOs are officially recognized by the European Commission. (wrong)*

c) *It entails an obligation for national SDOs not to take any action that could prejudice European standard harmonization. (right)*

d) *It is a tool to support coordination between European and national standardization activities. (right)*

17 - REGARDING THE PROCESS OF COORDINATION AMONG EUROPEAN AND NATIONAL SDOS:

(See Section 3.3 for hints)

a) *Once a European standard is approved, conflicting national standards are withdrawn. (right)*

b) *First, national SDOs submit their contributions or national perspectives on the standard's topic and scope; these contributions inform the drafting of the first version of the European standard, which is undertaken by the European SDO. (wrong)*

c) *European SDOs translate the approved EN into the languages of all of the nations where the standard is adopted. (wrong)*

d) *First, a standardization group within a technical committee of a European SDO drafts the document, then national SDOs submit their votes and comments about the draft. (right)*

18 - THE VIENNA AGREEMENT:

(See Section 3.3 for hints)

a) *Establishes that international standards are simultaneously approved as European standards. (right)*

b) *Establishes that any pre-existing conflicting national standards must be withdrawn. (right)*

c) *Recognizes that the European Single Market may have particular needs. (right)*

d) *Was signed between ITU and ETSI, and underlines the fact that international standardization takes precedence over national standardization. (wrong)*

19 - AS A RESULT OF THE FRANKFURT AGREEMENT:

(See Section 3.3 for hints)

a) *Around 80% of all European electrotechnical standards are identical to or based on IEC International Standards. (right)*

b) *New electrical standards projects are jointly planned between CENELEC and IEC. (right)*

c) *All European electrotechnical standards are identical to or based on IEC International Standards. (wrong)*

d) *All European electrotechnical standards are identical to or based on ISO International Standards. (wrong)*

20 - WHAT IS THE AVERAGE PROPORTION OF EUROPEAN STANDARDS IN AN EU COUNTRY?

(See Section 3.3 for hints)

a) *Less than 10%. (wrong)*

b) *Between 10% and 50%. (wrong)*

c) *Between 50% and 90%. (wrong)*

d) *More than 90%. (right)*

21 - STANDARDIZATION REQUESTS FROM THE EUROPEAN COMMISSION:

(See Section 3.4 for hints)

a) *Are drafted by the European Commission after consulting social representatives. (right)*

b) *Can be refused by the European SDOs, but this situation is quite rare. (right)*

c) *Must be previously approved by each Member State. (wrong)*

d) *Need to be ratified by the European Parliament. (wrong)*

22 - STANDARDIZATION REQUESTS FROM THE EUROPEAN COMMISSION:

(See Section 3.4 for hints)

a) *Are translated into all the official languages of the European Union, and then approved as directives. (wrong)*

b) *Are requests to the European Standardization Organizations to develop standards. (right)*

c) *Are transformed into de facto standards by non-official SDOs. (wrong)*

d) *Are transformed into de facto standards once their adoption is universal. (wrong)*

CHAPTER 4 - THE PRODUCTION OF STANDARDS - *P. 140*

1 - WHICH PRINCIPLE BELOW IS NOT A FUNDAMENTAL PRINCIPLE OF THE STANDARDIZATION PROCESS?

(See Section 4.2 for hints)

a) *Openness (wrong)*

b) *Abstraction (right)*

c) *Transparency (wrong)*

d) *Impartiality (wrong)*

2 - WHAT IS THE NAME OF THE DEVELOPMENT PHASE TAKING PLACE AFTER CONCEPTION?

(See Section 4.2 for hints)

a) *Inception (wrong)*

b) *Approval (wrong)*

c) *Drafting (right)*

d) *Maintenance (wrong)*

3 - WHICH GROUP OF STAKEHOLDERS DOES NOT TAKE PART IN THE PROCESS OF DEVELOPING ICT STANDARDS?

(See Section 4.2 for hints)

a) *Biology faculty members (right)*

b) *Consulting company staff (wrong)*

c) *Certification laboratory engineers (wrong)*

d) *Users involved in environmental organizations (wrong)*

4 - DOES THE CHAIRMAN OF A TECHNICAL COMMITTEE BELONG TO THE SECRETARIAT OF THE SDO?

(See Section 4.3 for hints)

a) *Yes (wrong)*

b) *No (right)*

5 - WHICH OF THE FOLLOWING IS NOT A SOFT COMPETENCY?

(See Section 4.3 for hints)

a) *Active listening (wrong)*

b) *Fluency in English (wrong)*

c) *Problem solving (right)*

d) *Word processing proficiency (wrong)*

6 - IS MATHEMATICAL EXPERTISE REQUIRED TO BECOME A STANDARDIZATION EXPERT?

(See Section 4.3 for hints)

a) *Yes (wrong)*

b) *No (right)*

7 - THE STANDARDIZATION EXPERT ESTABLISHES THE COMPANY STANDARDS STRATEGY WITH:

(See Section 4.4 for hints)

a) *the marketing team (wrong)*

b) *management (right)*

c) *the product development leader (wrong)*

8 - THE STANDARDIZATION EXPERT HAS TO TRAVEL TO ATTEND ALL HIS MEETINGS

(See Section 4.4 for hints)

a) *True (wrong)*

b) *False (right)*

9 - NATIONAL DELEGATES REPRESENT THE POINTS OF VIEW OF THEIR COUNTRIES AS PRESCRIBED BY:

(See Section 4.4 for hints)

a) *the company CEO (wrong)*

b) *the network operators (wrong)*

c) *the national administration (wrong)*

d) *the national mirror committee (right)*

10 - THE IETF RFC PROCESS IS:

(See Section 4.2 for hints)

a) *a top-down process (wrong)*

b) *a bottom-up process (right)*

c) *an integrative design process (wrong)*

d) *a standardization technical committee (wrong)*

11 - A TYPICAL SDO IS GOVERNED ACCORDING TO:

(See Section 4.2 for hints)

a) *a cooperation agreement (wrong)*

b) *a hierarchical structure (right)*

c) *a horizontal model (wrong)*

12 - 3GPP IS:

(See Section 4.5 for hints)

a) *a national SDO (wrong)*

b) *a European SDO (wrong)*

c) *an international SDO (wrong)*

d) *a partnership project among telecommunications SDOs (right)*

CHAPTER 5 - STANDARDIZATION AND INNOVATION - *P. 170*

1 - WHAT IS INNOVATION?

(See Section 5.2.1 for hints)

a) *Innovation is a new invention. (wrong)*

b) *Innovation happens only at the product and service level. (wrong)*

c) *Innovation is the combination of invention and commercialization. (right)*

d) *Innovation is incremental when there is a considerable improvement of performance within a short period of time. (wrong)*

2 - AN ENTERPRISE RESOURCE PLANNING (ERP) SYSTEM THAT IS ALREADY USED BY OTHER COMPANIES IN A SECTOR, BUT ACTUALLY IMPLEMENTED FOR THE FIRST TIME BY A PARTICULAR COMPANY IS A …

(See Section 5.2.1 for hints)

a) *New-To-the-Market (NTM) innovation (wrong)*

b) *New-To-the-Firm (NTF) innovation (right)*

c) *New-To-the-World (NTW) innovation (wrong)*

d) *Disruptive innovation (wrong)*

3 - QWERTY IS…

(See Section 5.2.2 for hints)

a) *superior to DVORAK. (wrong)*

b) *a formal standard. (wrong)*

c) *a committee standard. (wrong)*

d) *a de facto standard. (right)*

4 - THE ANALOGY BETWEEN STANDARDIZATION AND TREE PRUNING ILLUSTRATES…

(See Section 5.2.2 for hints)

a) *the potential of standards in supporting innovation and growth. (right)*

b) *how standards inhibit innovation. (wrong)*

c) *that standards lead to a waste of innovation resources. (wrong)*

d) *the chaotic nature of the innovation process. (wrong)*

5 - AT WHICH PHASE IN THE TECHNOLOGY LIFE CYCLE DOES A DOMINANT DESIGN EMERGE?

(See Section 5.2.3 for hints)

a) *Introduction (wrong)*

b) *Growth (right)*

c) *Maturity (wrong)*

d) *Decline (wrong)*

6 - ANTICIPATORY STANDARDS…

(See Section 5.2.3 for hints)

a) *proceed in parallel with market growth and improvement of technology. (wrong)*

b) *are "forward-looking" answers to expected interoperability problems. (right)*

c) *are created at the end of technology development (wrong)*

d) *are not conducive to innovation, as they inhibit creativity. (wrong)*

7 - THE INNOVATION PROCESS CONSISTS OF…

(See Section 5.3.3 for hints)

a) *Pure basic research, oriented basic research, applied research, and experimental development (wrong)*

b) *Pure basic research, oriented basic research, applied research, and diffusion (wrong)*

c) *Pure basic research, oriented basic research, applied research, experimental development and diffusion (right)*

d) *Pure basic research, applied research, experimental development, and diffusion (wrong)*

8 - INNOVATION IS SUPPORTED…

(See Section 5.4 for hints)

a) *only by standards. (wrong)*

b) *neither by standards nor by standardization. (wrong)*

c) *only by the standardization process. (wrong)*

d) *by standards and by standardization. (right)*

9 - EXCEEDING THE REQUIREMENTS OF STANDARDS IS…

(See Section 5.4.3 for hints)

a) *an innovation potential, as it provides impulses for the improvement of products and technologies. (right)*

b) *a cost-increasing factor. (wrong)*

c) *not an innovation potential, as competitors will strive to do the same. (wrong)*

d) *not allowed because of regulations. (wrong)*

CHAPTER 6 - A STRATEGIC PERSPECTIVE ON STANDARDIZATION - *P. 190*

1 - WHEN IS AN ORGANIZATION PARTICIPATING IN STANDARDIZATION CONSIDERED A "LEADER"?

(See Section 6.2 for hints)

a) *When it develops more standards than others (wrong)*

b) *When other organizations use its ideas (wrong)*

c) *When standardization is business critical for the organization (right)*

d) *When it pays the highest membership fees (wrong)*

2 - WHAT IS THE FORMAL STATUS OF MOST STANDARDIZATION ORGANIZATIONS?

(See Section 6.2 for hints)

a) *They are part of the ministry of internal affairs (wrong)*

b) *They are part of the ministry for trade and foreign affairs (wrong)*

c) *They are, non-governmental organizations (NGOs) registered as legal entities, like non-profits (right)*

d) *They are part of United Nations organizations, like the IMF and WHO (wrong)*

3 - CAN AN ORGANIZATION BE A MEMBER OF BOTH CEN/CENELEC AND ETSI?

(See Section 6.2 for hints)

a) *No, CEN/CENELEC has national organizations as members, ETSI only accepts companies (wrong)*

b) *Yes, but only national standards organizations can be a member of both CEN/CENELEC and ETSI (right)*

c) *No, because ETSI only accepts commercial organizations that pay a membership fee (wrong)*

d) *Yes, because commercial organizations can be members of both CEN/CENELEC and ETSI (wrong)*

4 - WHICH STANDARDS ORGANIZATIONS HAVE A "ONE MAN, ONE VOTE" RULE?

(See Section 6.3 for hints)

a) *CEN/CENELEC, because each member organization can vote only once (wrong)*

b) *ETSI, as only one person can vote from each organization (wrong)*

c) *IEEE and the IETF, as votes are given to individuals with regular attendance (right)*

d) *ITU, as only the Director is allowed to vote (wrong)*

5 - IS IT EASIER TO OBTAIN A LARGE VOTING RIGHT IN ETSI THAN IN THE IETF?

(See Section 6.3 for hints)

a) *Yes, because you can "buy" votes by accumulating high membership fees (wrong)*

b) *No, because in the IETF an organization can send many people to a few meetings (wrong)*

c) *They are about the same, as both require resources: in the IETF an organization could send more people, in ETSI an organization would need a significant amount of revenue and fees (right)*

d) *Yes, because in the IETF an organization gets disqualified if it sends too many people (wrong)*

6 - WHAT MAKES A STANDARD PROPRIETARY?

(See Section 3.1 for hints)

a) *It is widely used (wrong)*

b) *An organization holds an essential patent limiting its use by others (wrong)*

c) *It is very comprehensive and comes with a complete test suite (wrong)*

d) *It has been developed in isolation by a single or a closed group of organizations (right)*

7 - WHO IS RESPONSIBLE FOR THE MAINTENANCE OF STANDARDS?

(See Section 4.2 for hints)

a) *In the EU, the European Commission (wrong)*

b) *ETSI and CEN/CENELEC (wrong)*

c) *Strictly speaking, nobody: there is a moral but no legal obligation for the organization that has developed and/or adopted and published a standard to maintain the standard (right)*

d) *The users, as they represent the biggest test environment (wrong)*

8 - TO TEST INTEROPERABILITY, IS ONE-TO-ONE TESTING SUCH AS "PLUGTEST" BETTER THAN CONFORMANCE AND INTEROPERABILITY TESTING?

(See Section 6.5 for hints)

a) *One-to-one testing, such as "plugtest", and interoperability testing are equivalent (wrong)*

b) *One-to-one testing, such as "plugtest", and interoperability are complementary (right)*

c) *One-to-one testing, such as "plugtest", is better because it tests two systems connected to each other (wrong)*

d) *Interoperability testing is better as it tests against a reference implementation (wrong)*

CHAPTER 7 - A BUSINESS PERSPECTIVE: IPR AND STANDARDIZATION - *P. 210*

1 - WHICH ONE OF THE FOLLOWING INSTRUMENTS IS NOT CONSIDERED A TYPE OF IPR?

(See Section 7.2.1 for hints)

a) *Patents (wrong)*
b) *Trademarks (wrong)*
c) *Standards (right)*
d) *Copyright (wrong)*

2 - WHICH TYPE OF INTELLECTUAL PROPERTY RIGHT COULD BE OBTAINED FOR A TEXT THAT IS CONTRIBUTED TO A STANDARD DEVELOPMENT ORGANISATION?

(See Section 7.2.1 for hints)

a) *Patents (wrong)*
b) *Trademarks (wrong)*
c) *Industrial design (wrong)*
d) *Copyright (right)*

3 - WHO TYPICALLY OWNERS THE COPYRIGHT ON THE TEXT OF THS STANDARD?

(See Section 7.3 for hints)

a) *The individual copyright owners who contributed text parts to the standard (wrong)*
b) *The government of the country the SDO is located in (wrong)*
c) *The government of the country designated in the SDO patent policy (wrong)*
d) *The SDO (right)*

4 - CAN A PATENT BE ESSENTIAL TO A TECHNICAL STANDARD?

(See Section 7.3 for hints)

a) *No (wrong)*
b) *Yes, but such a situation is rather rare (wrong)*
c) *Yes, and this is quite common (right)*

5 - CAN A COPYRIGHT BE ESSENTIAL TO A TECHNICAL STANDARD?

(See Section 7.3 for hints)

a) *No (wrong)*
b) *Yes, but such a situation is rather rare (right)*
c) *Yes, and this is quite common (wrong)*

6 - WHICH OF THE BELOW IS NOT A WAY TO OBTAIN A SEP?

(See Section 7.4.2 for hints)

a) *By applying for a patent for an invention that is required in order to implement an existing standard (right)*
b) *By actively promoting its own patented technologies for inclusion into the standard by making technical contributions (wrong)*
c) *By acquiring a SEP on the market (wrong)*
d) *Wait and hope that others establish an SDO standard that uses a technology that is covered by one of your patents (wrong)*

7 - A COMPANY OWNS A PATENT ON A MOBILE PHONE DESIGN WHERE THE PHONE IS MADE OF TWO PARTS CONNECTED BY A HINGE (POPULARLY KNOWN AS A CLAMPSHELL OF FLIP PHONE). CAN THAT PARTY REQUIRE MOBILE PHONE MAKERS TO TAKE A LICENSE ON THAT PATENT?

(See Section 7.4.1 for hints)

a) *No, because such a patent would be essential for the standard and therefor creates an exemption to obtain a license (wrong)*

b) *Yes, because such a patent would be essential for the standard and thus an implementer should obtain a license (wrong)*

c) *Only if the phone maker produces a phone with a hinge construction as protected by the patent (the patent is not essential) (right)*

8 - WHY IS A PATENT THAT IS DECLARED TO BE POTENTIALLY ESSENTIAL BY ITS OWNER NOT NECESARILLY ESSENTIAL?

(See Section 7.4.2 for hints)

a) *The precise content of the final standard is not yet known, and the technology in the declared patent may eventually not be included in the standard at all (wrong)*

b) *By the time of such declaration, the ultimate scope of the patent may not be yet known (wrong)*

c) *Both answers above are true (right)*

9 - IN WHICH OF THE BELOW SITUATIONS ARE YOU ALLOWED TO ASK FOR A MONETARY COMPENSATION WHEN LICENSING OUT A SEP?

(See Section 7.5 for hints)

a) *The SDO allows you to choose the type of commitment and you chose to submit a RF licensing commitment (wrong)*

b) *The SDO allows you to choose the type of commitment and you chose to submit a FRAND licensing commitment (right)*

c) *The SDO only allows for RF licensing commitment and you submitted a RF licensing commitment (wrong)*

d) *You earlier submitted an RF licensing commitment but later upgraded that to a FRAND (wrong)*

CHAPTER 8 - AN ECONOMIC PERSPECTIVE ON STANDARDIZATION - *P. 231*

1 - TO WHAT EXTENT DID STANDARDS CONTRIBUTE TO GERMANY'S GDP BETWEEN 2002 AND 2006?

(See Section 8.2.1 for hints)

a) *Between 0.07 and 0.08% (wrong)*

b) *There is no evidence that standards contributed to the GDP (wrong)*

c) *Between 0.7 and 0.8% (right)*

d) *Between 7 and 8% (wrong)*

2 - TOTAL FACTOR PRODUCTIVITY (TFP) IS AN ESSENTIAL PARAMETER THAT DETERMINES THE QUANTITY OF ECONOMIC OUTPUT PRODUCED IN A COUNTRY. IT PLAYS AN IMPORTANT ROLE IN ESTIMATING THE CONTRIBUTION OF STANDARDS TO THE GDP. ON WHICH FACTORS DOES THE TFP DEPEND?

(See Section 8.2.1 for hints)

a) *Technological knowledge generated in a country (number of patents), (right)*

b) *Technological knowledge imported from abroad (number of technological licence payments abroad) (right)*

c) *The level of diffusion of this technological knowledge (number of standards) (right)*

d) *Technological knowledge generated in a country (number of papers) (wrong)*

3 - WHO BEARS THE COSTS OF DEVELOPING, UPDATING AND DISTRIBUTING STANDARDS?

(See Section 8.2.2 for hints)

a) *Standardization is financed by governments as the resulting standards contribute to the economy as a whole (wrong)*

b) *The costs are generally incurred by companies, academia and other organizations by participating in the standard-setting process, or by purchasing standards (right)*

c) *50% of the costs are covered by the state and the remaining 50% are covered by companies participating in standard setting (wrong)*

d) *SDOs cover the costs via crowdfunding initiatives and voluntary donations (wrong)*

4 - VARIETY-REDUCING STANDARDS REDUCE THE VARIABILITY OF KEY PRODUCT CHARACTERISTICS. WHICH ECONOMIC EFFECTS ARE MAINLY ASSOCIATED WITH THIS TYPE OF STANDARD?

(See Section 8.3.3 for hints)

a) *They support economies of scale (right)*

b) *They support network effects (wrong)*

c) *They prevent lock-ins into old technologies (wrong)*

d) *They can prevent market fragmentation (right)*

5 - THE GLOBALIZATION OF THE COMPUTER INDUSTRY HAS ONLY BEEN POSSIBLE BECAUSE OF INTERNATIONALLY ACCEPTED COMPATIBILITY STANDARDS. HOW DO COMPATIBILITY STANDARDS SUPPORT THE DIVISION OF LABOUR IN THE COMPUTER INDUSTRY?

(See Section 8.3.1 for hints)

a) *They stipulate the exact tasks for all market players in the value chain (wrong)*

b) *Through predefined interfaces, the production of computer components can be outsourced to suppliers all over the world (right)*

c) *Suppliers can focus on small portions of the value chain to achieve economies of scale and sell computer components to an international market (right)*

d) *They describe which activity of the value chain should be conducted in a certain geographic area for environmental protection reasons (wrong)*

6 - MINIMUM QUALITY STANDARDS REFER TO THE MINIMUM ACCEPTABLE LEVEL OF REQUIREMENTS. WHAT ARE THE EFFECTS OF MINIMUM QUALITY STANDARDS FROM THE CUSTOMER/CONSUMER PERSPECTIVE?

(See Section 8.3.2 for hints)

a) *They make it easy to assess which product is best suited for their purposes (right)*

b) *They make it harder to distinguish between different product variants (wrong)*

c) *They help in assessing if a certain product is worth a certain price (right)*

d) *They foster information asymmetries between buyers and sellers (wrong)*

7 - WHICH STATEMENTS ARE TRUE?

(See Sections 8.3.1 and 8.3.2 for hints)

a) *Open standards attract producers of complementary products who want to avoid dependence on one company (right)*

b) *Open standards are especially attractive for enterprises seeking first-mover advantage (wrong)*

c) *Open standards make it more likely for the market to get locked-in in inferior technology (wrong)*

d) *Open standards enhance the market power of a single producer, leading to a monopoly (wrong)*

8 - HOW DO DIFFERENT TYPES OF STANDARDS POSITIVELY INFLUENCE TRADE?

(See Section 8.3 for hints)

a) *Minimum quality standards can foster trust between trading partners (right)*

b) *Information standards that provide codified knowledge can facilitate trade (right)*

c) *Minimum quality standards help reduce the level of risk felt by buyers (right)*

d) *Measurement standards can lead to lower transaction costs and less risk between trading partners (right)*

9 - WHY DO GOVERNMENTS REFER TO STANDARDS IN OPEN TENDERS?

(See Section 8.4 for hints)

a) *To limit the number of applications to a manageable number, as only companies complying with the standard can apply (wrong)*

b) *To improve the quality of public services and infrastructures (right)*

c) *So that they can diffuse innovations to the private sector (right)*

d) *They are legally obliged to refer to standards whenever possible (wrong)*

10 - WHAT IS THE MAJOR DEMAND-SIDE EFFECT ON INNOVATION OF COMPATIBILITY STANDARDS?

(See Section 8.3.5 for hints)

a) *Achievement of economies of scale (wrong)*

b) *Reduction of information asymmetries (wrong)*

c) *Generation of network effects (right)*

d) *Lowering uncertainty and risk (wrong)*

11 - HOW CAN A TECHNOLOGY ACHIEVE DOMINANCE IN THE MARKET?

(See Section 8.3.1 for hints)

a) *By natural selection (right)*

b) *By winning a standard race (right)*

c) *By being released by an SDO officially recognized by a government (wrong)*

d) *Only a technology defined in a patent can achieve dominance in a market (wrong)*

12 - WHAT ARE THE MAIN NEGATIVE EFFECTS OF MINIMUM QUALITY STANDARDS?

(See Section 8.3 for hints)

a) *Reduced choice (wrong)*

b) *Regulatory capture (right)*

c) *Raising rivals' costs (right)*

d) *Avoiding adverse selection (wrong)*

NOTES

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