Understanding ICT Standardization: Principles and Practice

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The latest version of these slides is available from: www.etsi.org/standardization-education

Contents

Contents (Slide Zoom)

General information

- Accompanying textbook:

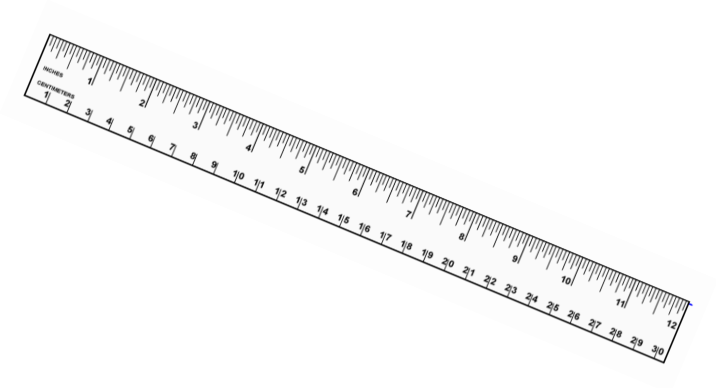
Understanding ICT Standardization: Principles and Practice (Published 2018)

  - Includes supporting material, e.g. quizzes to prove knowledge
  - More detailed information about the topics

1 Introduction

1 Introduction

- Standards support everyday life much more than people think
- Society recognized importance of standardized measurements thousands of years ago: e.g. weight, distance or length
- Development of a common reference system agreed upon people and institutions



Source pictures: pngall.com

1 Introduction

- Rapid technological progress → need for standardization grows
- Especially in the area of Information and Communications Technologies (ICT)
- Standardization and standards boost progress and create basis upon which technology can evolve

2 Introduction to Standards

Contents

2.1 Basics of standardization

What standards are (in a wide sense) and why they're needed

The most general definition for a «standard» may be

«a widely agreed way for doing something» .....

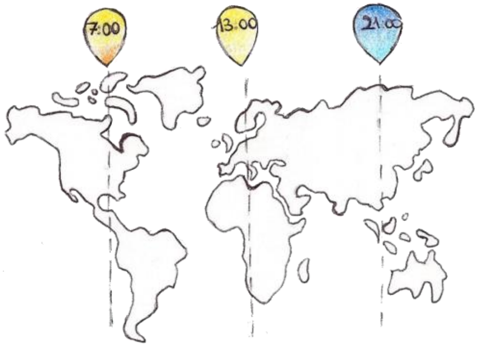
.... where, depending on the specific area of application, "doing something" may be replaced by, e.g., "designing a product", "building a process", "implementing a procedure" or "delivering a service".

«Standard» (i.e. agreed and common) ways of doing things bring lot of benefits; our technological world without «standards» simply **would not work (or, at least, it would be harder to make it work)**

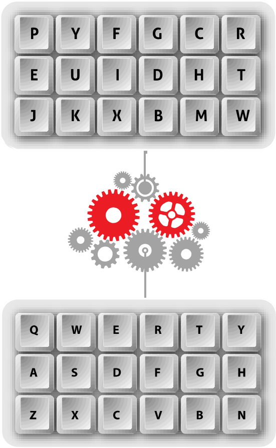
2.1 Basics of standardization

What standards are (in a wide sense) and why they're needed

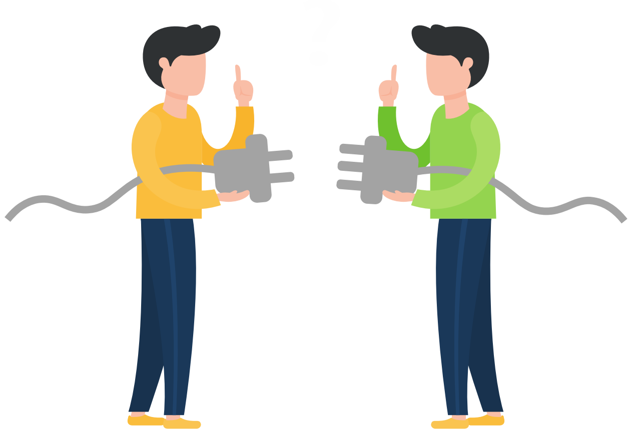
For instance, what if



we didn't have a common world-wide way to measure time and common procedures to manage air traffic



each computer had its own keyboard

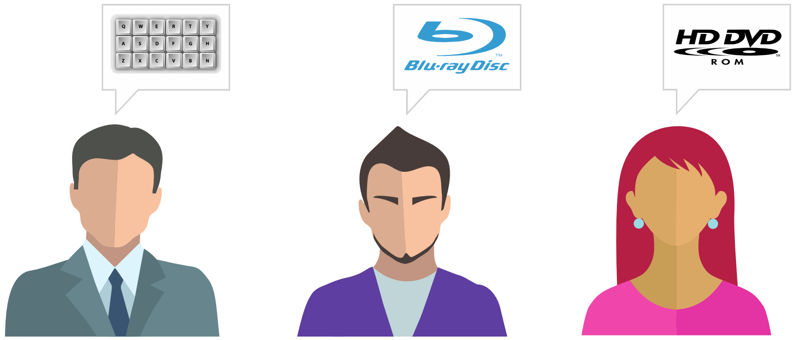


each smartphone and PC had its own specific set of connectors and charger (though some have by choice ... more on this in next slides)

2.1 Basics of standardization

Two main different types of “standards”

Different types of standards according to the development process



De facto standards, or standards in actuality, are adopted widely by an industry and its customers. These standards arise when a critical mass simply likes them well enough to collectively use them.

Formal standards are endorsed by a formal Standard Development Organization (SDO). SDOs ratify standards through official procedures and give the standard stamp of approval.
De facto standards can become formal standards if they are approved by a formal SDO. Examples : HTML PDF

2.1 Basics of standardization

Focus on "formal standards"

From here on, we will focus on "formal standards"; so, in the following and unless otherwise explicitly stated when referring to "standards" we will mean "formal standards"

2.1 Basics of standardization

What a (formal) Standard is: a more detailed definition

- A **standard** defines requirements, specifications, guidelines or characteristics for a determined material, product, process or service.

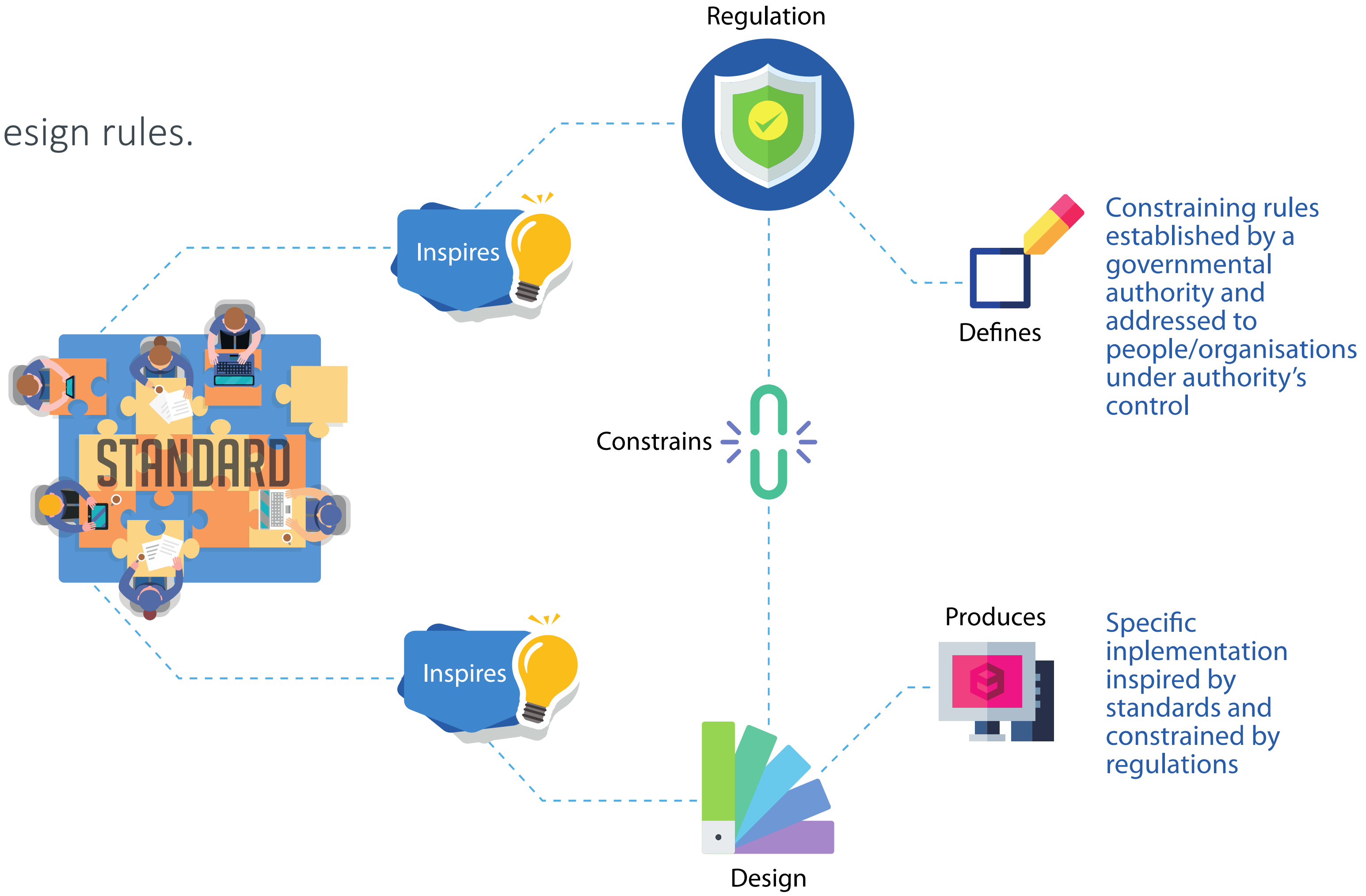
- Standards are defined by **Standard Development Organizations** (**SDOs**), which involve selected stakeholders in the standardized item (among e.g., manufacturers, providers, consumers and regulators, with possible contributions from academics and professionals)

- SDOs' put in place procedures to guarantee a **fair standard development process**, which is aimed at **building consensus among involved stakeholders** and guaranteeing the **quality** of the final deliverables.

2.1 Basics of standardization

What a (formal) Standard is NOT

- Standards are NOT regulations.
- Standards are NOT a set of thorough design rules.
- Yet, they may inspire both



2.1 Basics of standardization

What a (formal) Standard is NOT

- Standards are NOT regulations.
  - While conformity with standards is voluntary, regulations are compulsory; i.e.
    - An item (product, service, process, etc.) that doesn't fit regulations is not allowed in the territory/market where those regulations apply;
    - On the contrary, non-compliance to standards doesn't limit 'by law' the diffusion of an item (e.g. remember the case of some smartphones' proprietary connectors)
  - Standards are often (fully or partially) captured into regulations, as this simplifies and accelerates regulatory work thanks to the directions of established best practices defined in standards
- Standards are NOT regulations.
  - 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 (e.g., to guarantee a certain degree of interoperability or to define a minimum level of performance)
  - Many 'standard-compliant' implementations of the item are possible

2.1 Basics of standardization

We live in a ‘standardized’ world

Using a Smartphone (some of possibly involved standards):

Wireless area networks
IEEE standards for WiFi and Bluetooth standard

Mobile network and services
3GPP standards for mobile networks and services

Internet
W3C standards for hypertext protocols and language
IETF standards for internet protocols

Applications
ECMA and ISO standards for scripting language (Java)

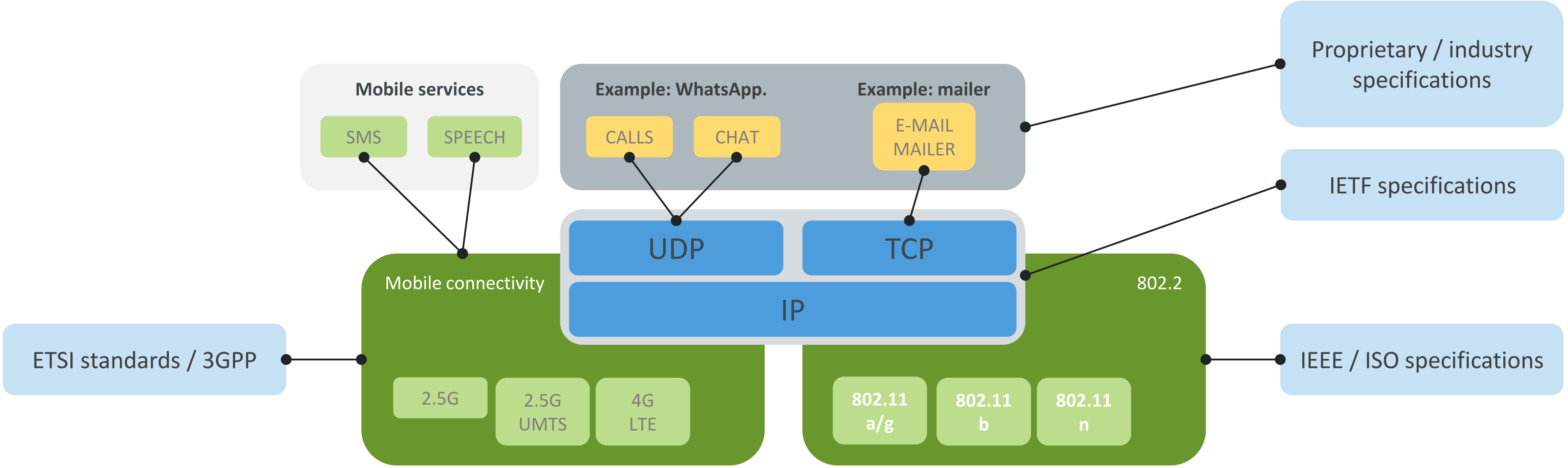
User terminal
ETSI standards for radio terminal equipment
ETSI and CEN/CENELEC standards for safety

2.1 Basics of standardization

We live in a 'standardized' world

Using a Smartphone (some of possibly involved standards)

A more detailed view



2.1 Basics of standardization

We live in a ‘standardized’ world

Using a Personal Computer (some of possibly involved standards)

2.1 Basics of standardization

We live in a ‘standardized’ world

Switching on lights (some of the standards involved)

CEN-CENELEC and ETSI standards for Smart Grids

IEC and CEN-CENELEC standards for **Generation System** (e.g. architectures, protocols and technologies for system monitoring and maintenance, power quality control, grid stability, balance demand and production)

IEC and CENELEC standards for electrical **Transmission and distribution** (e.g. architectures, protocols and technologies for monitoring and maintenance of assets, monitoring power flows and quality, system reconfiguration in case of faults, operate distributed energy sources)

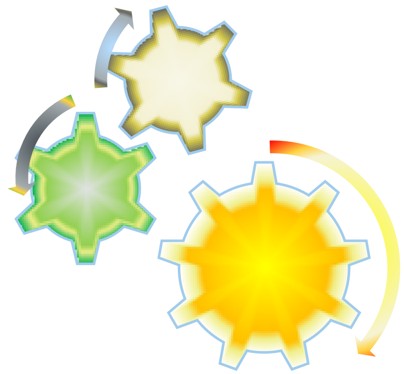
IEC standards for **electrical installations for buildings**; IEC and CENELEC standards for architectures, protocols and technologies for **metering and flexible management of customers** (demand/response)

2.2 Benefits and risks of standardization

Examples of benefits from Standards

As a consensus-built set of rules for doing something, a Standard benefits innovation, by

promoting the interoperability of products, services and processes

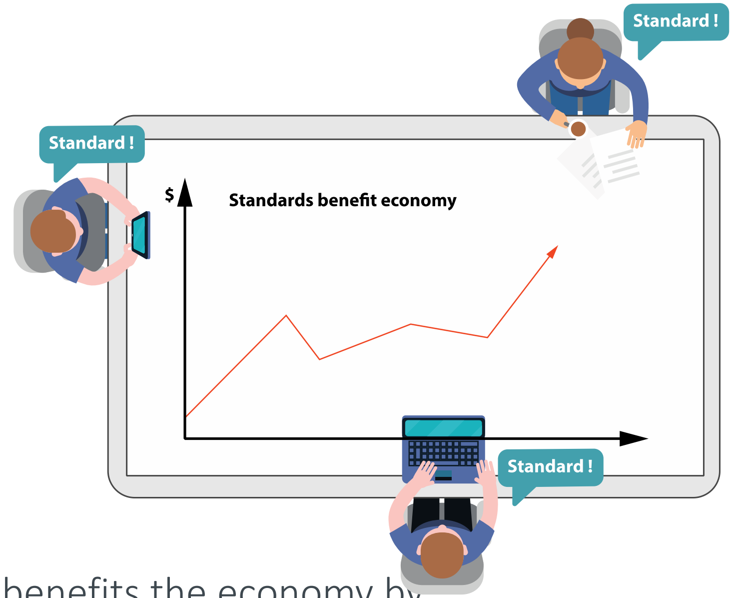


reducing development time, costs and risks, by steering designers' activity, which facilitates the uptake of innovation in the marketplace

2.2 Benefits and risks of standardization

Examples of benefits from Standards

As a consensus-built set of rules for doing something, a Standard



benefits the economy by

- incentivizing investments, as standards ensure the stability of the technology in a reasonable time frame
- enabling economy of scale
- encouraging larger and fairer competition
- facilitating trade thanks to common approaches among Countries

benefits the environment by

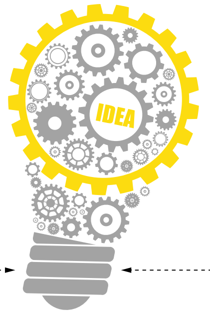
- enhancing the safety of products
- supporting environmental sustainability

2.2 Benefits and risks of standardization

Examples of benefits from Standards

Benefits of standards for industries (especially for newly established ones and SMEs)

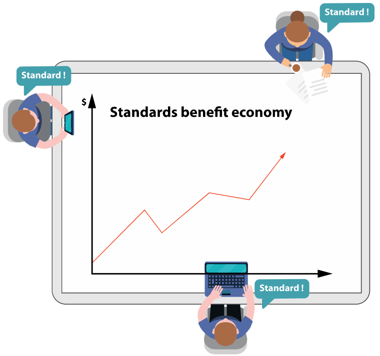
+ Innovation



STANDARD

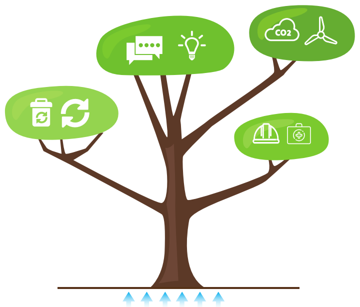
Ease new developments
(- risk, - investment,
+ opportunities)

+ Trade and competition



Enlarge potential market

+ Safety and sustainability



STANDARD

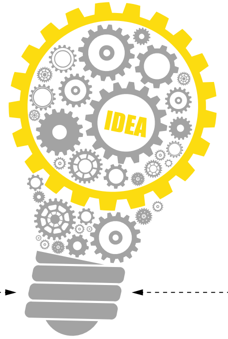
Fairer competition and less
risks of non-compliance
(widespread and shared
basic requirements)

2.2 Benefits and risks of standardization

Examples of benefits from Standards

Benefits of standards for communities and individuals

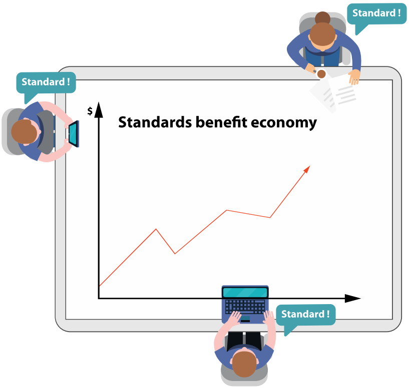
+ Innovation



STANDARD

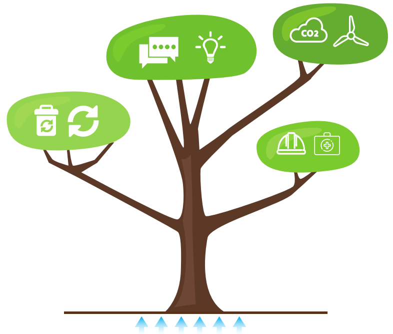
Satisfaction of tangible and intangible needs

+ Trade and competition



Best value for money

+ Safety and sustainability



STANDARD

Safer environment

2.2 Benefits and risks of standardization

Possible risks of Standards

Standards may jeopardize innovation, as:

- when established, standards may limit or delay the introduction of innovative (disruptive) solutions in the market

Measures SDOs put in place to minimize risks

- to involve academics and researchers in standard development;
- to establish open expert groups to explore innovation.

2.2 Benefits and risks of standardization

Possible risks of Standards

Standards may jeopardize fair competition among industries and Countries, as:

- SDOs may be politicized, or unduly influenced by special interests

Measures SDOs put in place to minimize risks

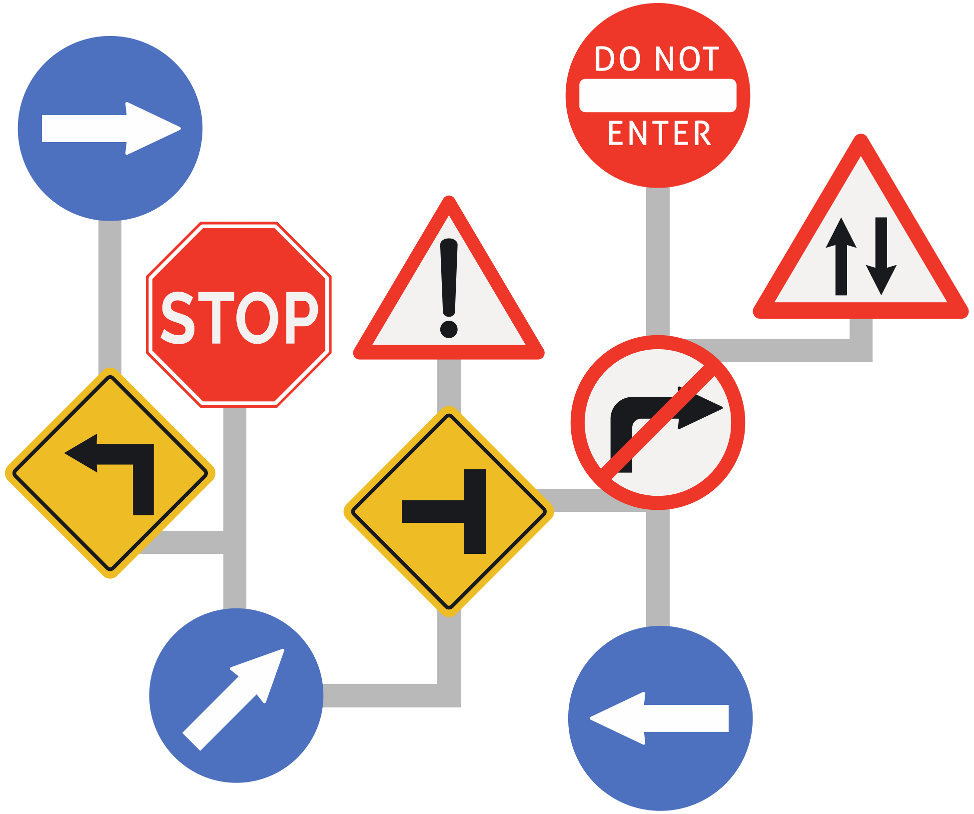
- to enlarge contributors base
- to involve all different stakeholders for the specific subject, each bringing its own special interest, so as to get to the best possible balance
- to implement a ruled and transparent development process

2.2 Benefits and risks of standardization

Possible risks of Standards

Varied standardization landscape may carry to inconsistencies, as:

- standards produced by different SDOs may be in competition or partially overlap; consequent production of inconsistent or, at least, redundant requirements may strongly jeopardize standardization benefits



Measures SDOs put in place to minimize risks

- to promote liaisons among SDOs and
- to increase collaborations and common actions

2.3 Standardization Landscape

Classification of SDOs

- Standardization landscape includes multiple SDOs that may differ in
  - Geographical coverage
  - Typology of affiliate organizations
  - Technical scope of activities (as per each SDO's statute)

- SDOs often establish liaisons or set up common working groups to generically coordinate their activities or to join efforts on specific items

2.3 Standardization Landscape

Classification of SDOs

- International SDOs

  They collect members worldwide, which mainly consist of national or international standard bodies.

- Regional SDOs

  SDOs often establish liaisons or set up common working groups to generically coordinate their activities or to join efforts on specific items

2.3 Standardization Landscape

Classification of SDOs - Geographical coverage

- National Standard Development Organizations (NSDO)

  They may be either public or private organizations, or combinations of the two, which issue country-specific standards and collaborate in international/regional SDOs as representatives of their countries.

  Some relevant NSDOs outside Europe are:

ANSI American National Standards Institute

JISC Japanese Industrial Standards Committee

भारतीय मानक ब्यूरो
Bureau of Indian Standards
The National Standards Body of India

ARIB

tsdsi

CCSA

Standards Council of Canada
Conseil canadien des normes

中国国家标准化管理委员会
STANDARDIZATION ADMINISTRATION OF THE PEOPLE'S REPUBLIC OF CHINA

TTA

atis

TTC Telecommunication Technology Committee

2.3 Standardization Landscape

Classification of SDOs - Affiliation

- Standard Initiatives

  They are built by standard bodies to coordinate standardization efforts on peculiar subjects

- Professional Organizations

  They collect independent professionals to promote best practices and innovation in specific areas

2.3 Standardization Landscape

Classification of SDOs - Affiliation

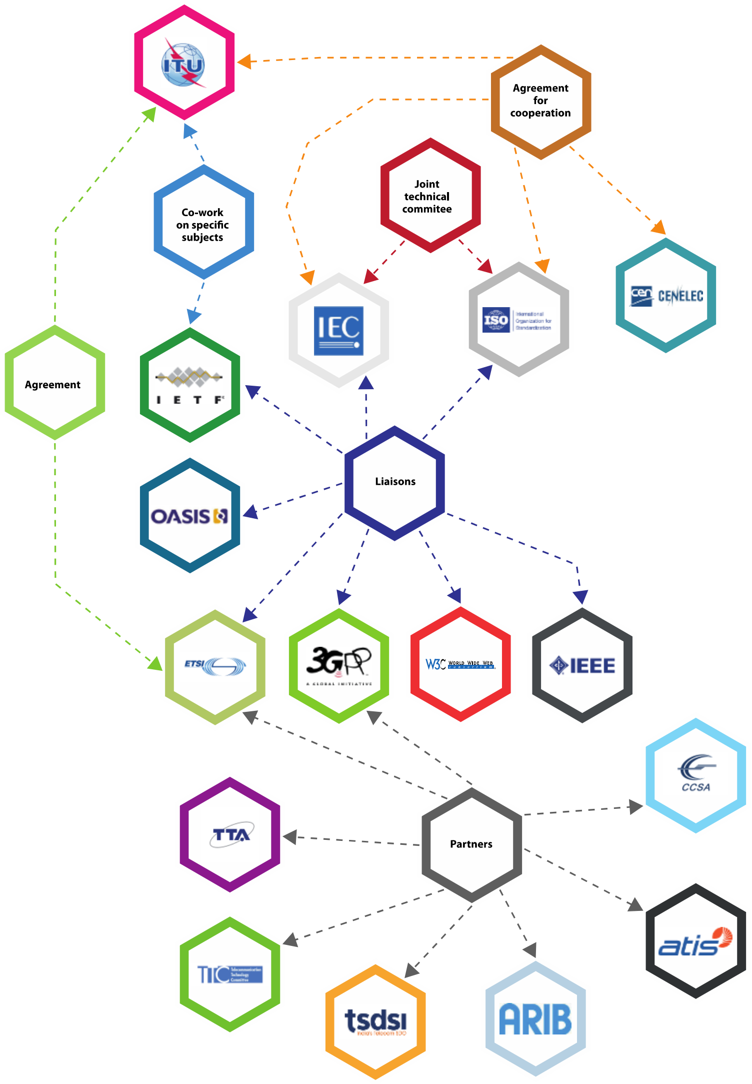
- Industrial Fora/ Consortia

  They are primarily established by industries that coordinate their efforts on specific subjects

2.3 Standardization Landscape

Classification of SDOs – Examples of liaisons among SDOs

A non exhaustive overview of the ICT ecosystem, where International, Regional and National SDOs, Professional Organizations and Industrial Consortia collaborate through liaisons and Standard Initiatives



2.3 Standardization Landscape

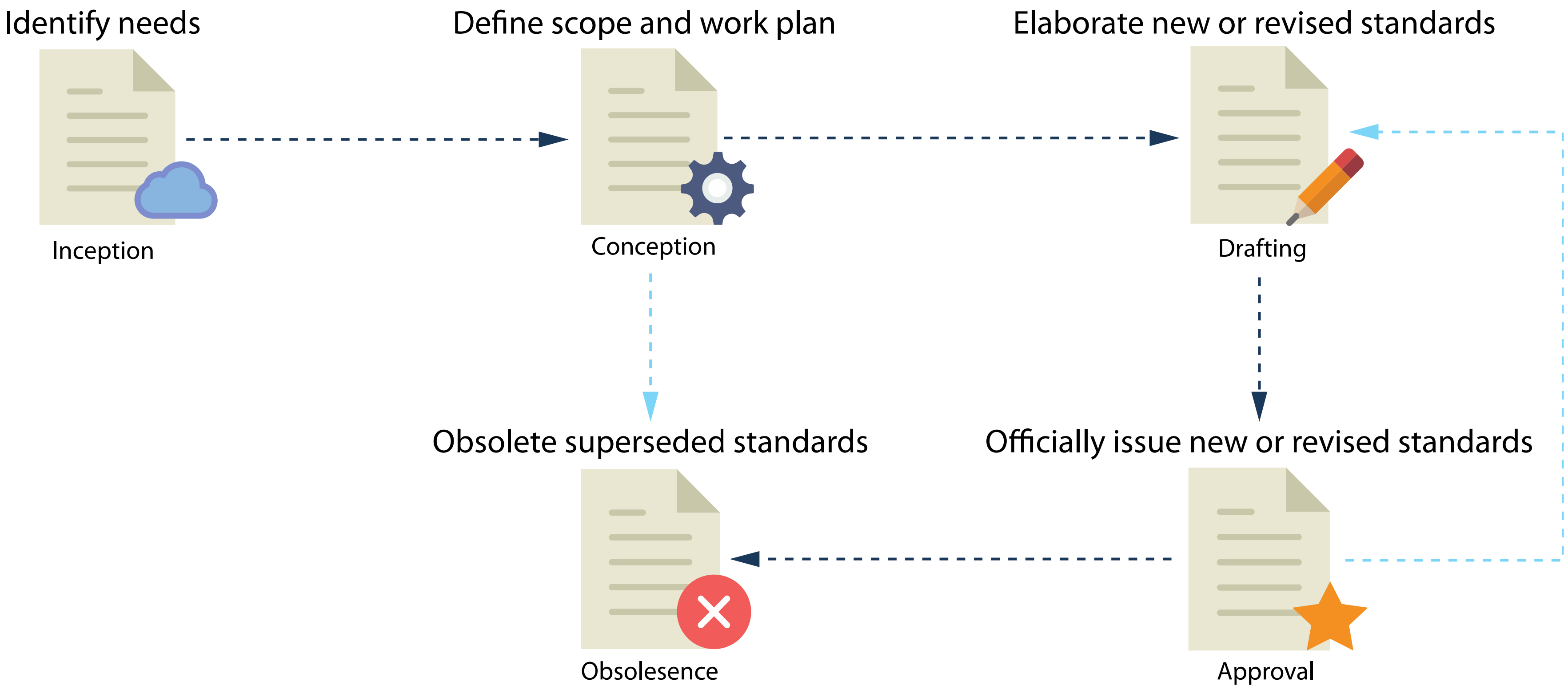
Classification of SDOs - Examples of scope of activities

A non exhaustive overview of the ICT ecosystem, where International, Regional and National SDOs, Professional Organizations and Industrial Consortia operate

Organization	Typical technical scope of activity
ITU	Interoperable telecom specifications incl. architecture, services, protocols, addressing / numbering plans
ISO	ICT architecture (OSI model) services, protocols incl. application protocols
IEC	Electrotechnical standards, incl. connectors, electrical safety and tests
ETSI	Interoperable telecom specifications incl. architecture, services
CEN	ICT architecture (OSI model) services, protocols incl. application protocols
CENELEC	Electrotechnical standards, incl. connectors, electrical safety and tests, ECM
IEEE	All LAN specifications: IEEE 802.xx, including cabled LANs, Token Ring and Bus, Wireless LANs WLAN, e.g. WiFi)
IETF	All internet related specifications including protocols, generic applications, addressing rules (IP, url)
ECMA	Media specifications, ICT specifications fed into ETSI, ISO/IEC, IEEE, etc.

2.4 The standardization process at a glance

Generic standard life cycle - Basic steps



2.4 The standardization process at a glance

What a standard is for

- Standards are addressed to expert technical audiences in order to define some characteristics for a set of products/services/processes

- Standards are not intended to fully specify products/services/processes, or to provide a throughout scientific-technical elaboration on a subject, but they're aimed to define the minimum requirements for the relevant items in order to meet certain well defined objectives (e.g., to guarantee a certain degree of interoperability or a minimum level of performance)

2.4 The standardization process at a glance

Standard document main characteristics

- It shall be clear and unambiguous
  - It shall help readers to clearly understand what is essential to ensure compliance
  - It shall include and clearly separate parts that are
    - Normative, i.e. which describe mandatory standard requirements, i.e. the individual characteristics that the item being standardized must implement if it is to fully comply with the standard
    - Informative, i.e. which help with conceptual understanding
- It shall be written in a plain language
  - Simple and short sentence
- It shall have well-defined objectives that meet real needs
  - It has NOT to be fruitlessly over-prescriptive

2.5 Using standards

How to find a standard

In order to identify standards related to a specific product/service:

- Select relevant SDOs
  - by geographical scope (which corresponds to the geographical market that the product/service is targeted for)
  - by technical scope (which corresponds to the market typology that the product/service is targeted for)
- Identify selected SDOs' relevant specification documents and their relevance
  - SDOs may produce different kinds of documents such as technology roadmaps, product/service requirements, product/service technical specifications, regulations produced on behalf of regulatory bodies and product/service test specifications.

2.5 Using standards

How to find a standard

First step : to identify relevant SDOs according to geographical scope and technical domain

Example

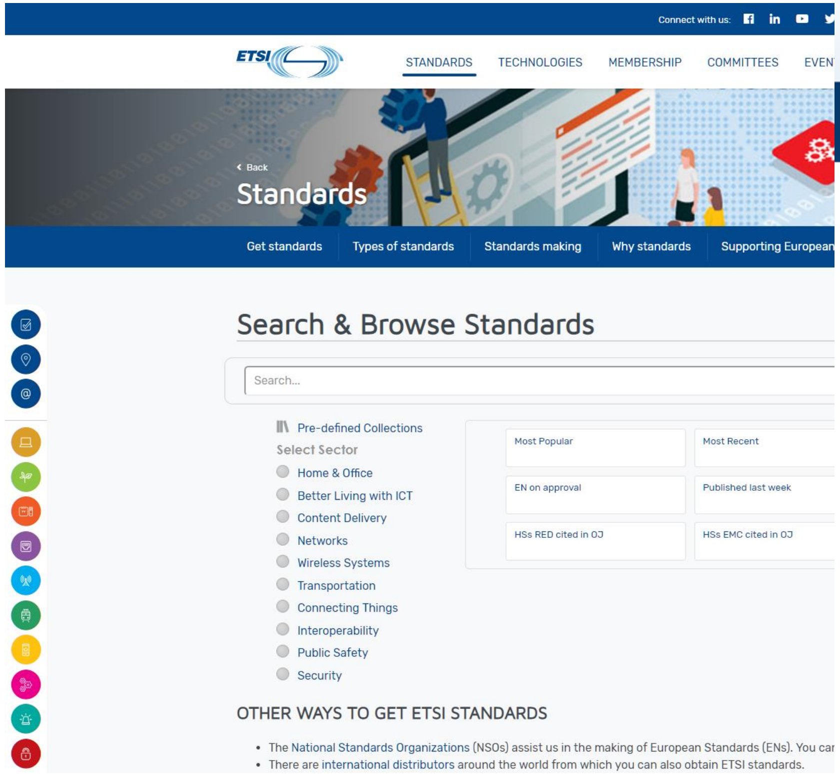
Organization	Headquarters	Geographical scope	Domain of activity	Affiliate organizations / members	Other SDOs it contributes to
ITU	Geneva (CH)	International	Telecom	National SDO / Industries	ISO
ISO	Geneva (CH)	International	ICT	National SDO	ITU
IEC	Geneva (CH)	International	Electrotechnical	National SDO	ITU
ETSI	Sophia Ant (FR)	Regional (Europe)	Telecom	National SDO / Industries / Research Institutes / Government bodies	ITU
CEN	Brussels (BE)	Regional (Europe)	ICT	National SDO	ISO
CENELEC	Brussels (BE)	Regional (Europe)	Electrotechnical	National SDO	IEC
IEEE	New York (US)	International	ICT Electrotechnical	Professionals	ISO
IETF	Fremont (US)	International	ICT	Professionals	ITU and ISO
ECMA	Geneva (CH)	International	ICT	Industrial Companies	ISO

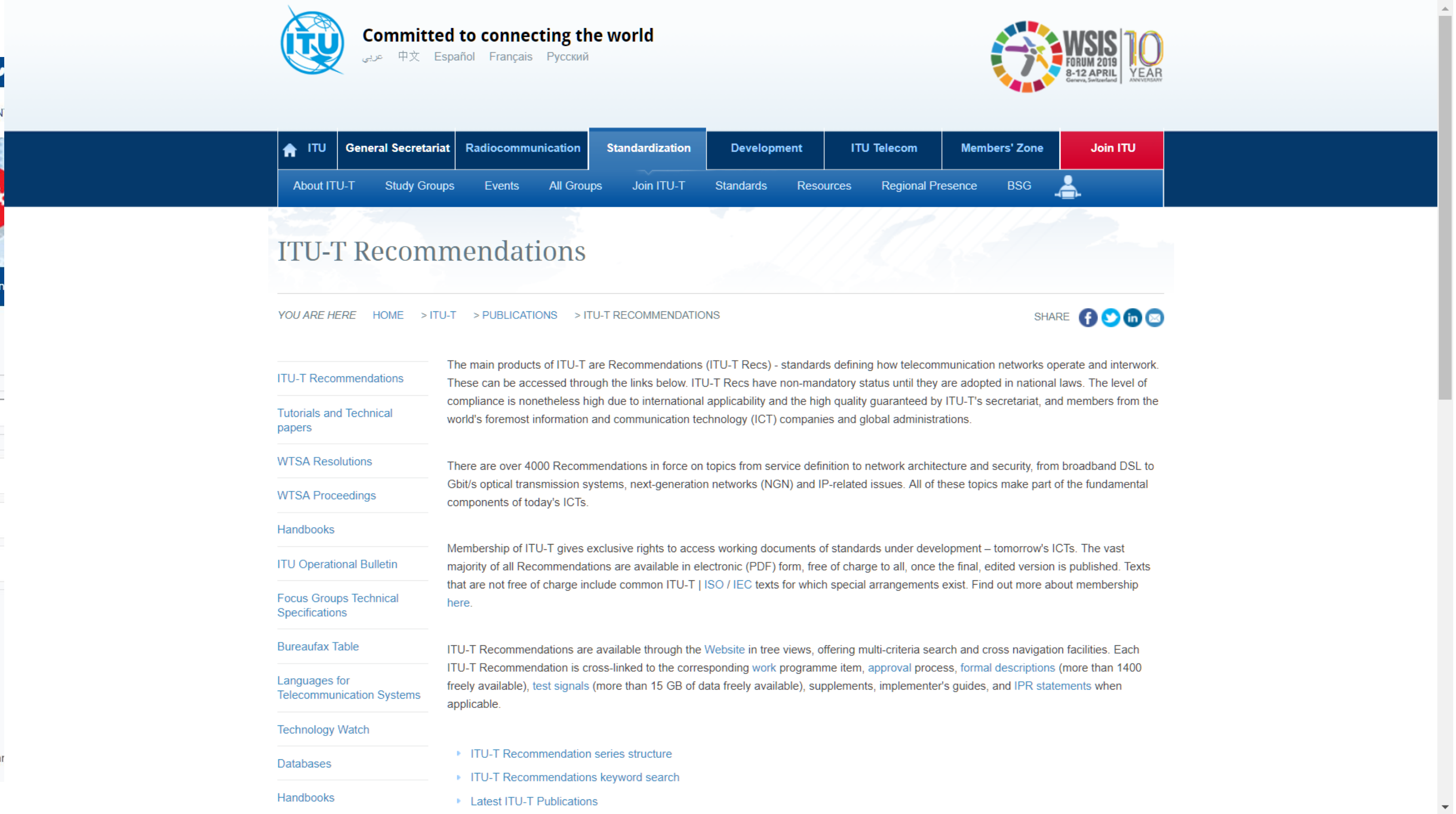
2.5 Using standards

How to find a standard

All SDOs make their documents available on line

Access may be restricted to authorized users





2.5 Using standards

How to find a standard

- Clearly identify standard document's scope and objectives

  Assigned standard document code may include information about document scope and applicability

Examples

ITU	ETSI	IETF
Publications from ITU Telecommunication standard sector (ITU-T) are coded with format X.nnn, where X describes document domain, such as, e.g.: A - Organization of the work 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 …… etcetera ..	ETSI produces a range of publications, each with its own particular purpose, which is encoded in the first two letters of 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 – 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 –the document contains explanatory material … etcetera ..	The IETF's official documents are named RFCs. "RFC" stands for Request for Comments, and this name expresses 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". IETF doesn't code documents' scope and objectives in RFC identifier, which is simply a progressive number.

Reference

- ETSI,Web Page «Different Types of ETSI Standards», http://www.etsi.org/standards/different-types-of-etsi-standards; accessed in 2017
- ITU, Web page «ITU-T Recom. series structure», http://www.itu.int/en/ITU-T/publications/Pages/structure.aspx; accessed in 2017
- IETF, Web page «Info for Newcomers», https://www.ietf.org/newcomers.html#officialdocs; accessed in 2017

2.5 Using standards

How to read standards

- Clearly identify standard document’s scope and objectives

  Standard documents explicitly claim scope and applicability, usually in introductory sections of the document

Examples

ITU

Recommendation ITU-T G.9963

Unified high-speed wireline-based home networking transceivers – Multiple input/multiple output specification

Summary

Recommendation ITU-T G.9963 specifies the basic characteristics of a multiple-input multiple-output (MIMO) high-speed home networking transceiver capable of operating over premises power-line wiring. This Recommendation includes the additions and modifications to Recommendations ITU-T G.9960 and ITU-T G.9961 that are required in order to fully define a MIMO home networking transceiver. MIMO transceivers are able to transmit over three power-line conductors (phase, neutral, and ground) in more than one Tx port and receive in more than one Rx port, thus providing an increased data rate and enhancing the connectivity (i.e., service coverage) of the home network. This Recommendation also specifies the means by which transceivers that

1 Scope

This Recommendation describes the modifications to Recommendations ITU-T G.9960 and ITU-T G.9961 that are needed to define MIMO home networking transceivers for operation over power-line wiring. More specifically, this Recommendation includes the following:

- the PHY functional models of the MIMO transceivers;
- detailed descriptions of the modifications (changes and additions) needed in the PHY and DLL sections relative to ITU-T G.9960 and ITU-T G.9961 Recommendations;
- the means by which transceivers that comply with ITU-T G.9960, ITU-T G.9961 and ITU-T G.9963 interoperate when operating on the same wires; and
- the means by which transmissions from ITU-T G.9963 transceivers do not degrade performance of transceivers that comply with ITU-T G.9960 and ITU-T G.9961 when operating on the same wires.

ETSI

ETSI EN 301 489-1 V1.9.2 (2011-09)

Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements

Foreword

This Harmonized European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document has been produced by ETSI in response to a mandate from the European Commission issued under Council Directive 98/34/EC [i.3] (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

The present document is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility ("the EMC Directive") (2004/108/EC [i.2] as amended) and Directive 1999/5/EC [i.1] of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity ("the R&TTE Directive").

1 Scope

The present document contains the common requirements for radio communications equipment and associated ancillary equipment, in respect of ElectroMagnetic Compatibility (EMC).

Product dependent arrangements necessary to perform the EMC tests on dedicated types of radio communications equipment, and the assessment of test results, are detailed in the appropriate product related parts of EN 301 489 series [i.13].

The present document, together with the product related part, specifies the applicable EMC tests, the methods of measurement, the limits and the performance criteria for radio equipment and associated ancillary equipment. In case of differences (for instance concerning special conditions, definitions, abbreviations) between part 1 of EN 301 489 series [i.13] and the relevant product related part of EN 301 489 series [i.13], the product related part takes precedence.

Technical specifications related to the antenna port of radio equipment and radiated emissions from the enclosure port of radio equipment and combinations of radio and associated ancillary equipment are not included in the present

IETF

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Network Working Group                                            S. Kent
Request for Comments: 4301                                        K. Seo
Obsoletes: 2401                                        BBN Technologies
Category: Standards Track                                  December 2005


            Security Architecture for the Internet Protocol

Status of This Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvement.  Please refer to the current edition of the "Internet
   Official Pro      ndards" (STD 1) for the standardization state
   and status of                                  memo is unlimited.

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   (November 1998).

1.  Introduction

1.1.  Summary of Contents of Document

   This document specifies the base architecture for IPsec-compliant
   systems.  It describes how to provide a set of security services for
   traffic at the IP layer, in both the IPv4 [Pos81a] and IPv6 [DH98]
   environments.  This document describes the requirements for systems
   that implement IPsec, the fundamental elements of such systems, and
   how the elements fit together and fit into the IP environment.  It
   also describes the security services offered by the IPsec protocols,
   and how these services can be employed in the IP environment.  This
   document does not address all aspects of the IPsec architecture.
   Other documents address additional architectural details in
   specialized environments, e.g., use of IPsec in Network Address
```

Only RFCs that open with words like "This document specifies an Internet standards track protocol" are normative documents approved by the IETF. Others are informative documents

2.5 Using standards
How to read standards

- **Identify the context of the standard document**

  Standard documents may have a very narrow scope as they can define only specific parts of a complex item; to get the actual relevance of the standard, it has to be correlated with provided other standard references (usually, they're explicitly quoted in the document itself)

ITU

Recommendation ITU-T G.9963

Unified high-speed wireline-based home networking transceivers – Multiple input/multiple output specification

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the

[ITU-T G.9960]	Recommendation ITU-T G.9960 (2011), *Unified high-speed wire-line based home networking transceivers – System architecture and physical layer specification.*
[ITU-T G.9961]	Recommendation ITU-T G.9961 (2010), *Unified high-speed wire-line based home networking transceivers – Data link layer specification.*
[ITU-T G.9964]	Recommendation ITU-T G.9964 (2011), *Unified high-speed wireline-based home networking transceivers – Power spectral density specification.*

ETSI

ETSI EN 301 489-1 V1.9.2 (2011-09)

Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

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[2] CENELEC EN 61000-4-2 (2009): "Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test".

[3] CENELEC EN 61000-4-3 (2006), A1 (2008) and A2 (2010): "Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test".

IETF

```
Network Working Group                                        S. Thomson
Request for Comments: 4862                                        Cisco
Obsoletes: 2462                                               T. Narten
Category: Standards Track                                           IBM
                                                              T. Jinmei
                                                                Toshiba
                                                         September 2007

                 IPv6 State

Status of

   This do
   Internet
   improvements.  Please                                    "Internet
   Official Protocol Standards" (STD 1) for the standardization state
```

Explicit list of obsoleted RFCs

```
8.1.  Normative References

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8.2.  Informative References

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```

- **Note**

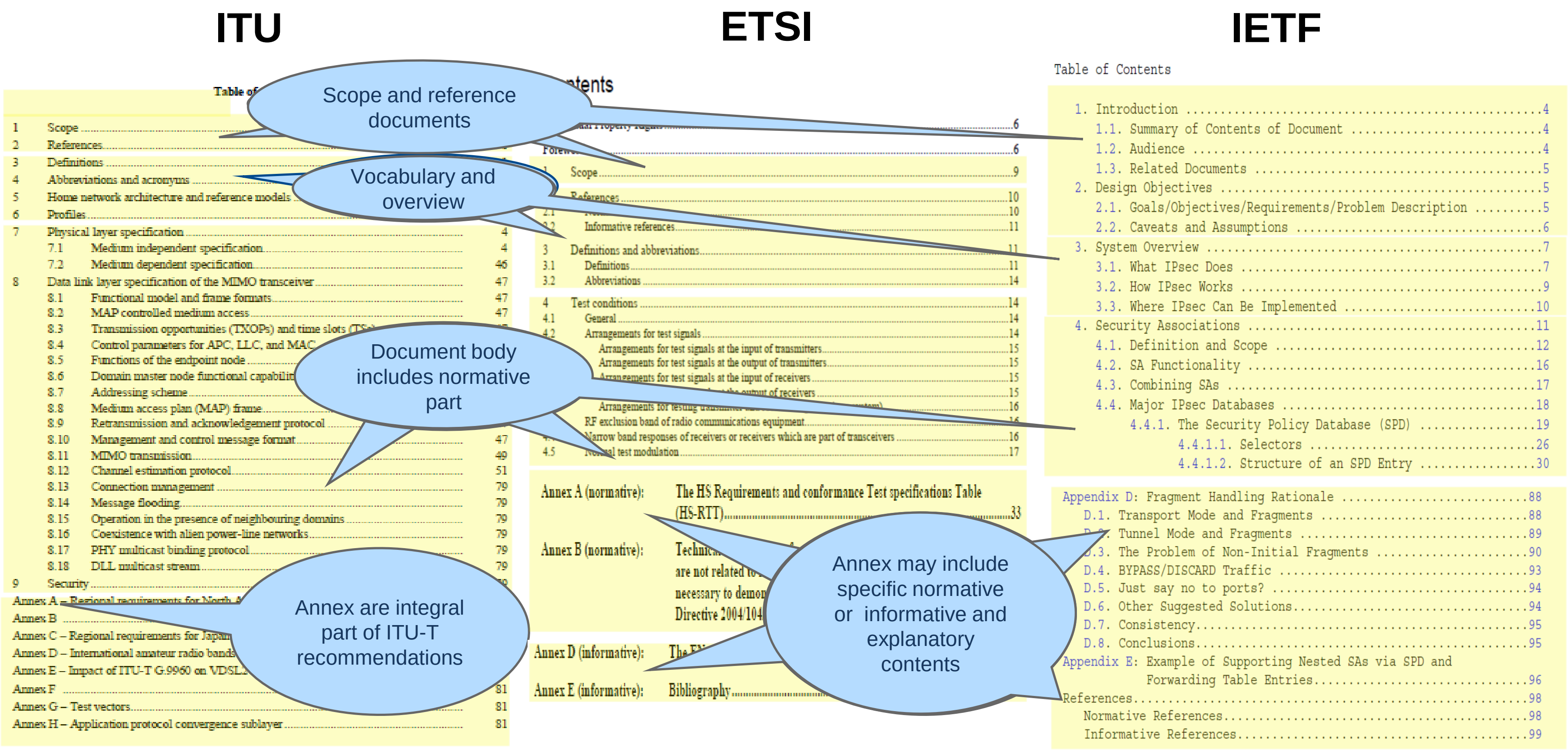
  To fully get the context of a standard document and build a comprehensive picture of the production of standards on a specific area, it may be useful referring to specific informational documents provided by SDOs and to additional documentation (such as, technical white papers, scientific journals and books)

2.5 Using standards

How to read standards

- Discriminate document sections and between normative and informative parts

    Examples



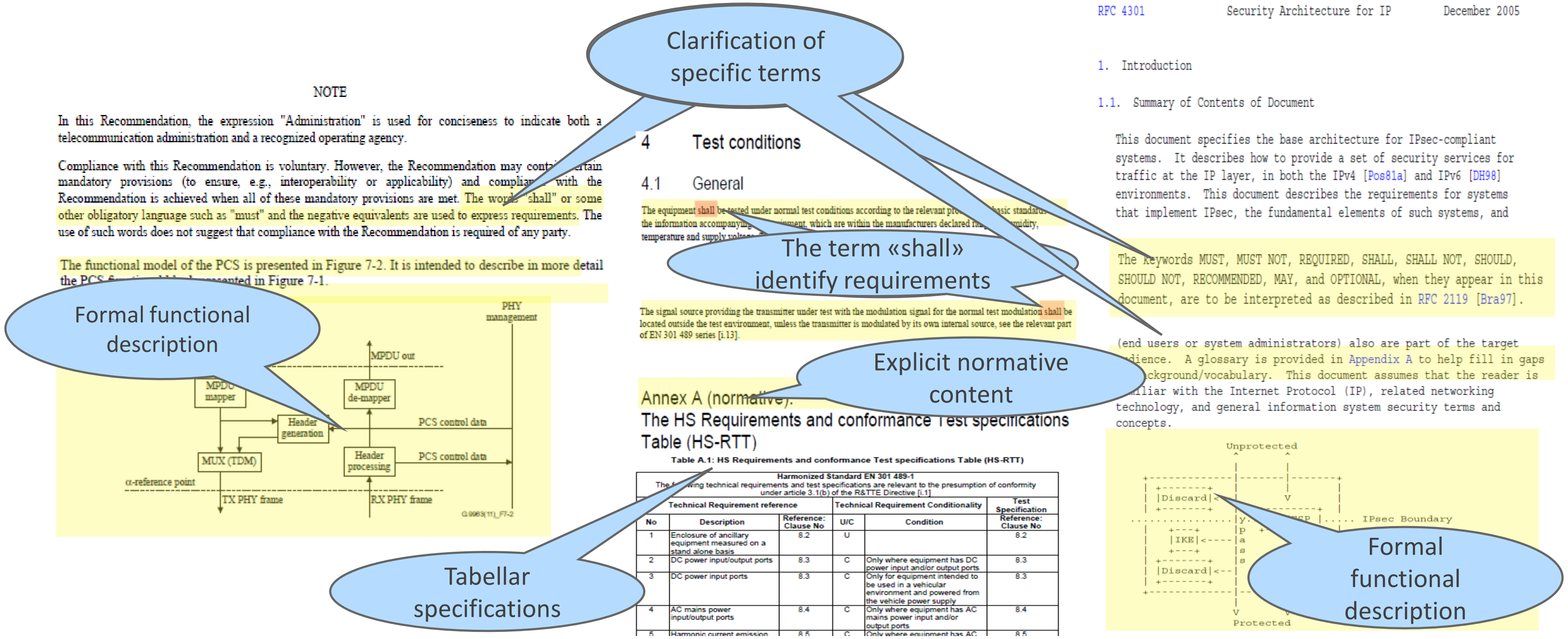
2.5 Using standards

How to read standards

- Capture standard specific ‘language’ and ‘formalisms’ to express requirements and clearly discriminate between normative and informative statements

Examples

ITU | ETSI | IETF



List of abbreviations: Chapter 2

- 3GPP : 3rd Generation Partnership Project
- AAP : Alternative Approval Process
- AD : Area Director
- ANSI : American National Standards Institute
- ARSO : African Organization for Standardization
- BGP : Border Gateway Protocol
- CEN : Comité européen de normalization - European Committee for Standardization
- CENELEC : Comité européen de normalization en électrotechnique - European Committee for Electrotechnical Standardization
- CERN : Centre Européen pour la Recherche Nucléaire - European Organization for Nuclear Research
- 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

List of abbreviations: Chapter 2

- 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
- IPsec : IP security
- HDMI : High Definition Multimedia Interface
- ICT : Information and Communication Technology
- LTE : Long Term Evolution
- M2M : Machine to Machine
- NSDO : National Standard Development Organization
- OSPF : Open Shortest Path First
- PASC : Pacific Area Standards Congress
- PDF : Portable Document Format
- SDO : Standard Development Organization
- TAP : Traditional Approval Process
- UMTS : Universal Mobile Telecommunications System
- VESA : Video Electronics Standards Association

List of abbreviations: Chapter 2

- W3C : World Wide Web Consortium
- WG : Working Group
- WI : Work Item
- XML : eXtensible Markup Language

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3 The Standards Ecosystem

Contents

3 The standards ecosystem

3 The standards ecosystem

- The learning objectives of this section are:
  - To understand and apply the different criteria for establishing the classifications of organizations and documents.
  - To understand the differences among National, Regional and International organizations, the benefits derived of their coordination, and to be aware of the main agreements and procedures supporting it.
  - To know about how specifications from industrial consortia are transposed into standards; to understand that marketing organizations produce specifications to validate conformance and interoperability; to be aware of regulations and their relationship with standards.
  - To get familiar with the naming conventions of different SDOs.
  - To understand the different types of documents.

3 The standards ecosystem

- As previously introduced, the standardization landscape is rich and complex, because of the variety in standard development organizations (SDOs) and the documents they produce…

3.1 Types of organizations and standards
Recognized organizations

- Some standards developing organizations (SDOs) are **officially recogniz**ed by regulation systems as providers of standards.
- They are known as **recognized organizations**.
- They publish standards when a specific **society need** is identified; sometimes the **authorities invite** them to address a topic in the need of standardization.
- Recognized SDOs have **robust and documented processes** for building consensus and approving standards.

3.1 Types of organizations and standards

Recognized organizations

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

3.1 Types of organizations and standards
Organizations that are not officially recognized

- Besides the officially recognized SDOs, there are well respected and long existing SDOs,
  - like **W3C, OASIS, IEEE, OMG**
- These are **not officially recognized** by the authorities, **but have well established procedures** to ensure the quality of their standards.

3.1 Types of organizations and standards
Organizations that are not officially recognized

- IEEE counts on a specific board (the IEEE-SA Standards Board) for coordinating 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 in society.
  - 802 standards deal with local area networks and metropolitan area networks.

3.1 Types of organizations and standards
Formal standards

- A **formal standard** is a document approved or adopted by a standards developing organizations (SDO).
- Some authors refer to them simply as **standards**.

3.1 Types of organizations and standards

Formal standards

- Sometimes experts take **formal standards into account** when putting together **regulation,**

- Sometimes, **governments invite recognized SDOs** to produce standards in support of specific policies or legislation.

3.1 Types of organizations and standards
Formal standards

- The European Commission invites the European Standardization Organizations (ESOs) to produce formal standards through **Standardization Requests** (a.k.a. Standardization mandates),
- About a **fifth of all European standards** are developed following a standardization request from the European Commission to the European Standardization Organizations (ESOs).

3.1 Types of organizations and standards
Formal standards

- In 2005 the European Commission sent a **standardization request**, called Mandate 376, to the ESOs (CEN, CENELEC and ETSI):
  - “To develop 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 was **standard** EN 301 549 “Accessibility requirements suitable for public procurement of ICT products and services in Europe”, published in 2015
- In 2016, the **Directive** (EU) 2016/2102 on the accessibility of the websites and mobile applications of public sector bodies was approved. It references EN 301 549:
  - “[..] content of websites that fulfils the relevant requirements of European standard EN 301 549 [..] shall be presumed to be in conformity with the accessibility requirements [..]”

3.1 Types of organizations and standards
Formal standards

- When regulation makes explicit reference to a specific standard. In those cases, the referred standard is called a **‘de jure’ standard**.
  - However, some authors use the term ‘de jure’ standard to refer generally to formal standards.

3.1 Types of organizations and standards
Formal standards and other standardization documents

- Some documents are produced with the aim of becoming **national or international standards**.
  - These documents will require the **highest level of exigency** in terms of maturity and consensus.
- In other cases, certain societal or industry topics may benefit from having a standardization document as a reference, even if that **topic has not raised the highest level of either maturity or consensus**.
  - These documents are produced by means of a **shorter and more flexible way** than the one a higher-level standard would demand.

3.1 Types of organizations and standards

De facto standards

- These **ICT-related items** have in common that they have had a **huge impact** in society…
  - PDF: a document format created by Adobe Systems.
  - HTML: a language for describing the structure of Web pages. It was originally created by Tim Berners-Lee, and it 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).
- … They are called "**de facto standards**". They are common practices adopted by the market, which are not the result of any standardization process.

3.1 Types of organizations and standards

De facto standards

- **A de facto standard** is a custom or convention that has achieved a dominant position by public acceptance or market forces, and that usually has the attractive characteristic of having been validated by market processes (Maxwell 2006)

- Abernathy and Utterback (1978) introduced the '**dominant design**' concept.

  - 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.

3.1 Types of organizations and standards
De facto standards

- De facto standards may be adopted as formal standards by recognized SDOs:
  - ISO/IEC 15445:2000 Information technology -- Document description and processing languages -- HyperText Markup Language (HTML)
  - ISO 32000-1:2008 Document management -- Portable document format -- Part 1: PDF

3.1 Types of organizations and standards

Public and private organizations

- Public organizations have been normally created by treaties. It is the case of ITU, which is an agency of the United Nations

- Other standards organizations are private, such as ISO, OMG, ETSI or ANSI.

3.1 Types of organizations and standards

Industrial consortia

- Some standards organizations were created as industrial consortia for producing standards
  - C2C-CC and W3C are industrial consortia created, respectively, by vehicle and web related companies

3.1 Types of organizations and standards
Open standards

- Openness of standards is not a precise concept.
- According to Openstand (2012), there are 5 involved principles:
  - Cooperation between standards organizations.
  - Adherence to: Due process; Broad consensus; Transparency; Balance; Openness.
  - Collective Empowerment.
  - Availability.
  - Voluntary Adoption.

3.1 Types of organizations and standards
Open standards

- Pros of openness:
  - the growth of Internet would not have been as rapid without universal availability of TCP/IP protocols or HTML.
  - According to the results of a survey by the European Commission (Galasso 2015), among the countermeasures to tackle the problem of ICT lock-in, the most used is "to define ICT strategies and architectures on open source and open standards".

3.1 Types of organizations and standards
Open standards

- Cons of openness:
  - It is difficult indeed to develop standards with no proprietary technology involved,
  - Hence, there are intense debates in SDOs about whether including proprietary technology, and how this should be done.

3.1 Types of organizations and standards

Types of ICT standards (modified from de Vries, 2006 and Hatto, 2013)

- Terminology standards
  - ITU-T E.800 Definitions of terms related to the quality of service.
- Measurements or test methods
  - IEEE Std 299-2006 IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures
- Specifications
  - EN 55 024 European immunity requirements for information technology equipment

3.1 Types of organizations and standards

Types of ICT standards (modified from de Vries, 2006 and Hatto, 2013)

- System architecture
  - ISO/IEC/IEEE 42010:2011, Systems and software engineering — Architecture description.
- Reference models
  - ISO/IEC 7498:1994 Preview. Information technology -- Open Systems Interconnection,
  - W3C Recommendation 15 December 2004 - the Architecture of the World Wide Web, Volume One

3.1 Types of organizations and standards

Types of ICT standards (modified from de Vries, 2006 and Hatto, 2013)

- Software and networking
  - 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. Wifi IEEE standards),
  - file information and formats (e.g. RFC 8259 JSON).
- Reference models
  - IEEE 730-2014 –Software Quality Assurance Processes

3.1 Types of organizations and standards

Types of ICT standards (modified from de Vries, 2006 and Hatto, 2013)

- The above classification is **not strict!** One document may be allocated to more than one category, for example:
  - Requirements standards may include testing procedures to assess whether the requirements are met,
  - Documents where systems or reference models are described may include the involved vocabulary,
  - Software standards may include requirements.

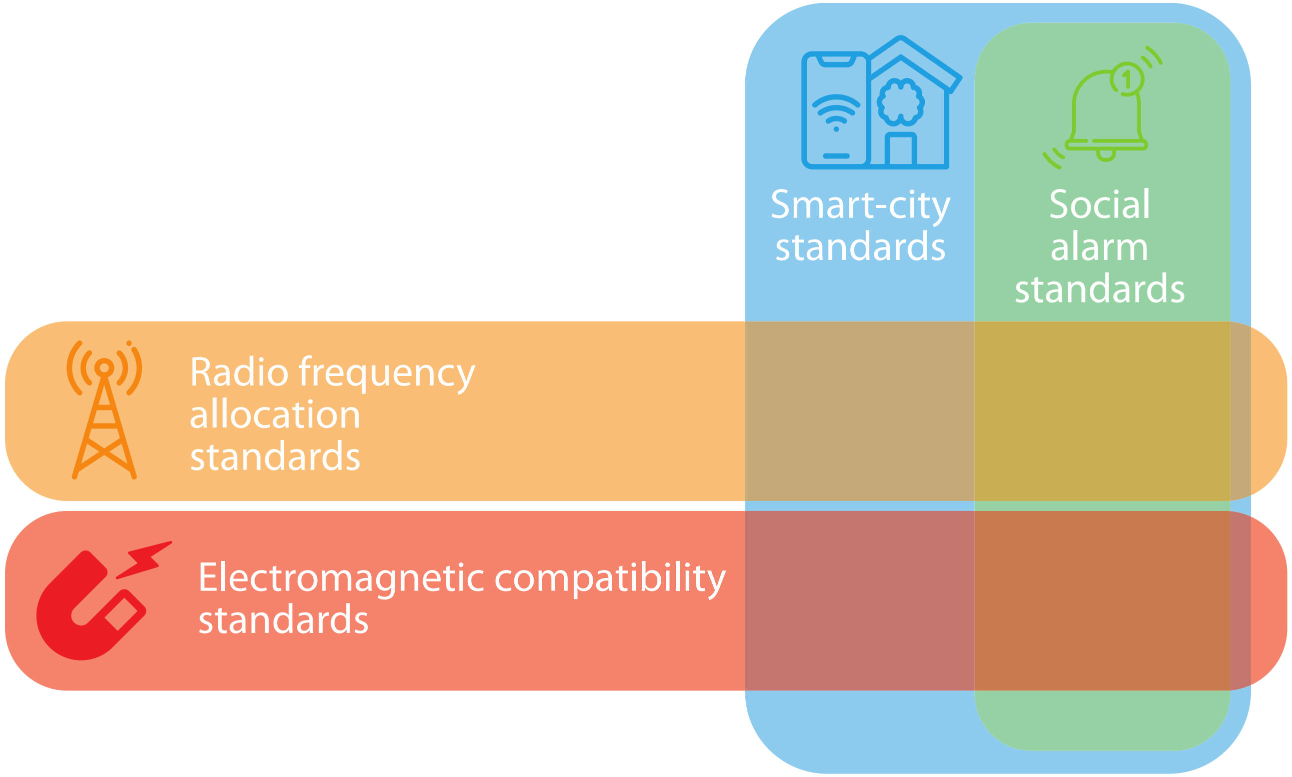
3.1 Types of organizations and standards

Vertical and horizontal standards (de Vries,2006)

- **Horizontal** standards are applicable across multiple industries or entities:
  - E.g., the EMC standards which are applicable in all electrical/electronic equipment, like the EN 61000, Electromagnetic compatibility (EMC) family of standards
- **Vertical** standards apply to a particular industry or entity,
  - e.g. the CENELEC family of standards about social alarm systems (EN 50134) includes direct or indirect references to the EN 61000 standards.

3.1 Types of organizations and standards

Vertical and horizontal standards



3.2 National, Regional and International standardization
Geographical scope of organizations and standards

- Recognized SDOs have **national, regional or international geographical** scope, and so do the formal standards they produce:
  - ISO, IEC and ITU are official **international** standard organizations, with a worldwide scope.
  - CEN, CENELEC and ETSI are officially recognized as **European** bodies for standardization.
  - PASC is a regional SDO the **Pacific** area.
  - DIN, UNE, ANSI, and BIS are national SDOs in, respectively, **Germany, Spain, USA, and India.**

3.2 National, Regional and International standardization

Geographical scope of organizations and standards

Standardisation Structures

	National level e.g. Germany	Regional level e.g. Europe	International
General	DIN	cen	ISO
Electrotechnology	DKE VDE DIN	CENELEC	IEC
Telecommunications	DKE VDE DIN	ETSI	ITU

3.2 National, Regional and International standardization
Geographical scope of organizations and standards

- Sometimes, SDOs produce standards with a **scope that goes beyond** their alleged **geographical adscription**.

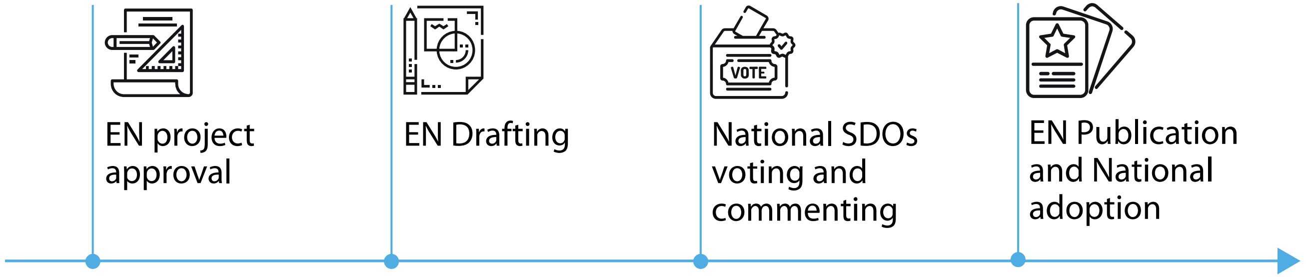
    - For instance, ETSI is an official SDO within the European Union, but the **ETSI family of GSM standards** for mobile communications was adopted **globally**.

3.2 National, Regional and International standardization
Co-operation and co-ordination

- **International** standardization usually takes **precedence** over **regional** standardization, which again takes precedence over **national** standardization

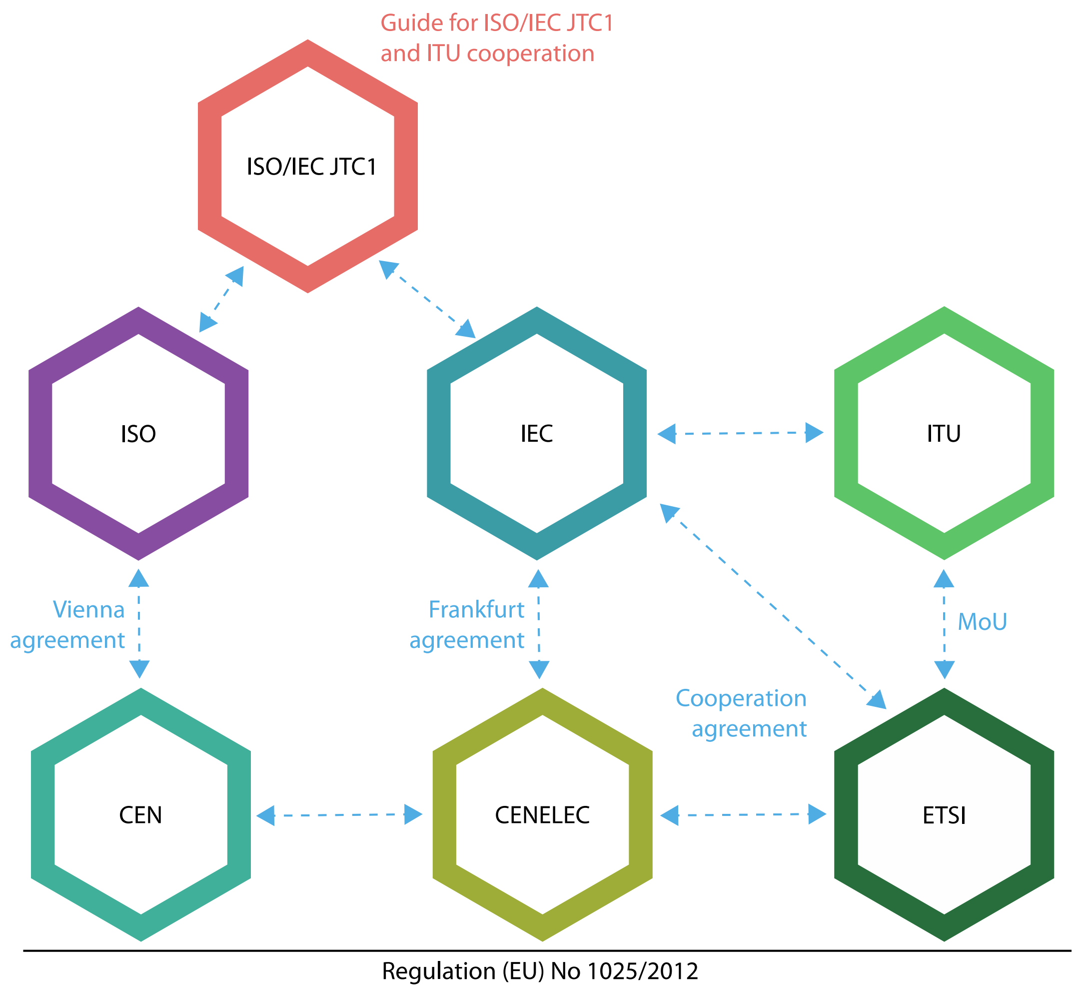
3.2 National, Regional and International standardization
Co-operation and co-ordination

- Coordination among European and National standardization activities.
  - European and their national member SDOs publish periodically their work programmes and the list of approved/adopted standards.
  - “standstill”: obligation for the National SDOs not to take any action, neither during the preparation of a European Standard (EN) nor after its approval.
  - The generic process of co-ordination between European and National standardization can be described as follows:



3.2 National, Regional and International standardization
Co-operation and co-ordination

- There exist co-operation and co-ordination agreements between European and international SDOs (modified from Jakobs, 2008)



3.2 National, Regional and International standardization
Co-operation and co-ordination

- The **Vienna agreement** provides rules for the collaboration between ISO and CEN:
  - by regular **exchange of information** between the two organizations,
  - by the adoption of existing international (ISO) standards as European (CEN) standards,
    - EN ISO 9001:2015 Quality management systems – Requirements
  - through the **transfer of work from CEN to ISO**, although this route is not automatic,
  - through **working by correspondence**,
  - through **(mutual) representation** at meetings of technical entities.

3.2 National, Regional and International standardization
Co-operation and co-ordination

- The **Frankfurt agreement** provides rules for the collaboration between IEC/CENELEC:
  - Around **80%** of all European electrotechnical standards are identical to or based on IEC International Standards.
  - New electrical **standards projects are jointly planned** between CENELEC and IEC, and where possible most are carried out at international level.
    - E.g., IEC 62236-3-2:2008 Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus is based on EN 50121-3-2:2006

3.2 National, Regional and International standardization
Co-operation and co-ordination

- **ISO/IEC Guide 21** provides guidance on Regional or National adoption of International Standards and other International Deliverables:
  - It provides methods for the **adoption of International** Standards (and other international deliverables) **as regional or national standards**.
  - It defines a system for **indicating the degree of correspondence** between International Standards and their national or regional adoptions.

3.2 National, Regional and International standardization
Co-operation and co-ordination

- **ITU and ETSI** have established a Memorandum of Understanding (MoU)
- **ISO and IEC** formed ISO/IEC JTC 1 to avoid duplicative or possibly incompatible standards.
- A guide contains a set of procedures for cooperation between **ITU-T and ISO/IEC JTC 1**

3.2 National, Regional and International standardization
Co-operation and co-ordination

- The 3rd Generation Partnership Project (3GPP)
  - provides their members with a **stable environment** to produce reports and specifications about **mobile** communication technologies, a field in constant evolution.
  - SDOs participating in 3GPP **transpose an identical text of 3GPP** deliverables as the corresponding deliverables

3.3 Adoption/Transposition of standards

- In which situation may a standard be transposed or adopted by a committee different from the one that produced it in the first place?

- Such a document may be
  - A de facto or industrial consortium standard, published and endorsed by a recognized SDO
  - A testing specification written by a marketing organization to promote the market adoption of a standard
  - A regulation referencing its technical content

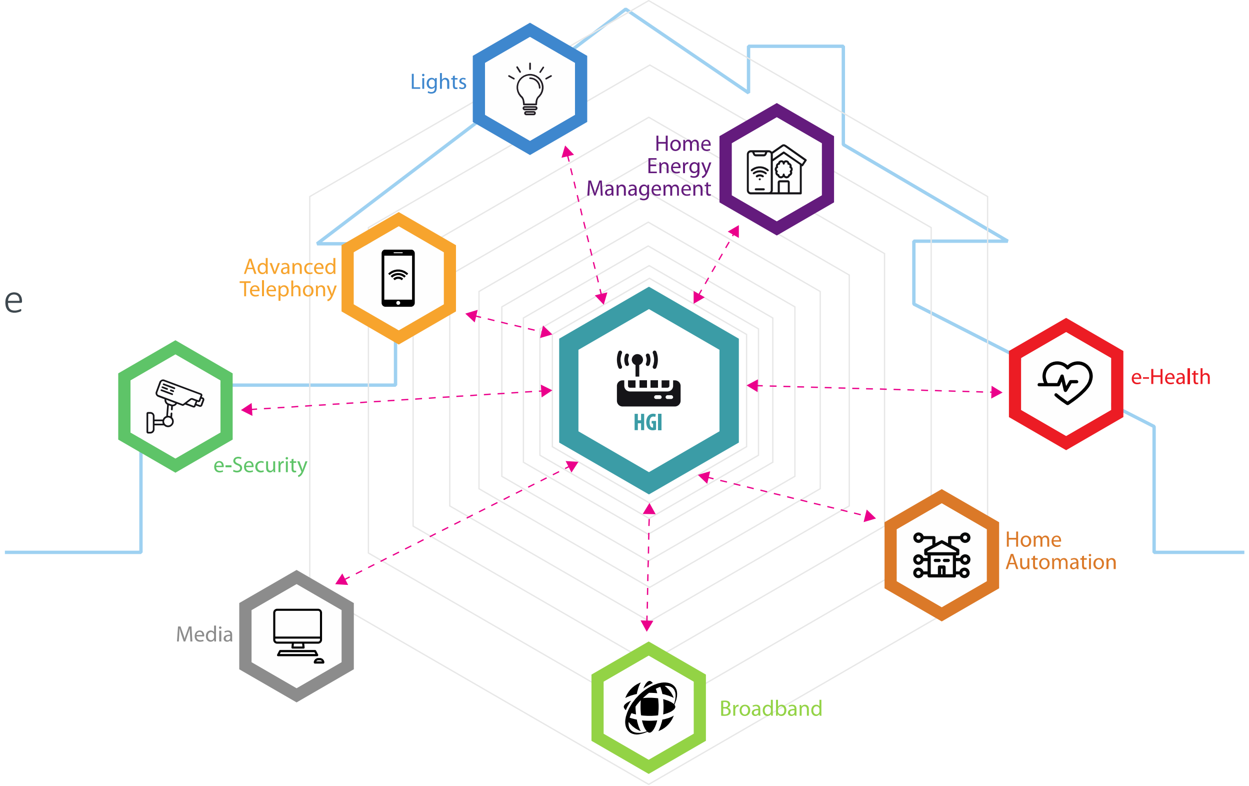
3.3 Adoption/Transposition of standards
Adoption of an industrial consortium standard

- Consortia specifications written by a group of stakeholders (e.g. an industrial consortium) are transferred into standards referenced by a recognized SDO

- Benefits
  - Ensure that the specification complies with the SDO standardization quality rules and fundamental principles
  - Provide more confidence and ensure a wider adoption by the market
  - The new standard is recognized at regional / international standardization level
  - Developing further versions because of technological evolution is possible when needed and subject to discussion with an larger group of stakeholders

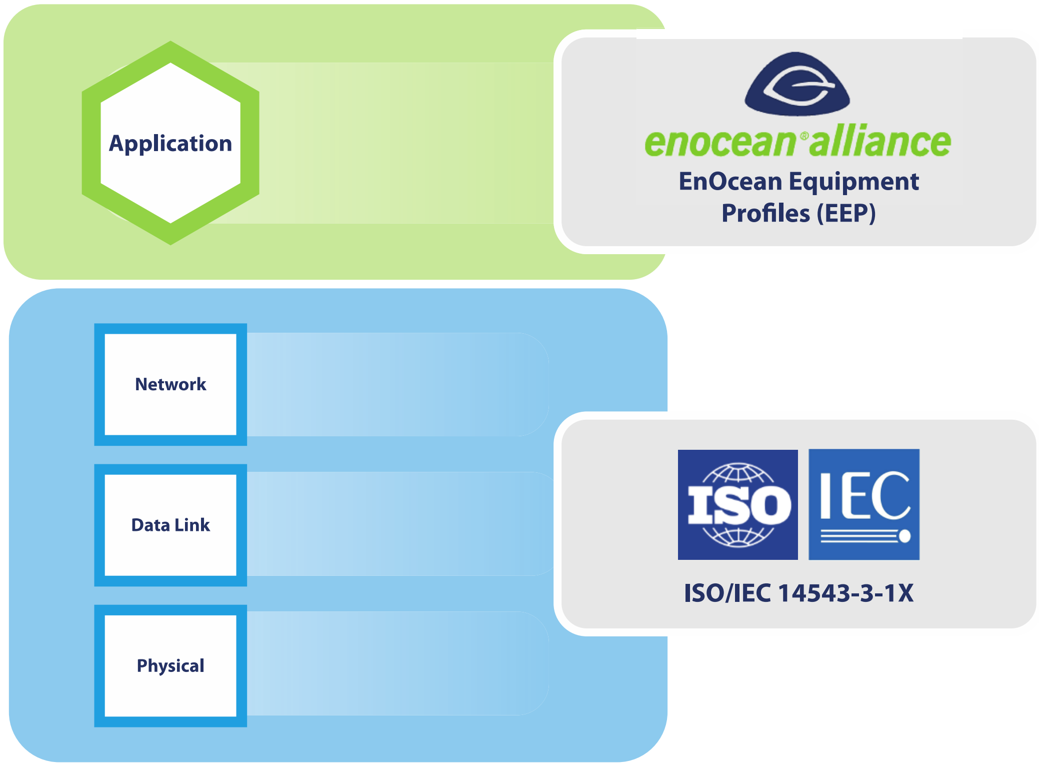
3.3 Adoption/Transposition of standards
Examples of applications of the PAS process

- Example: Specifications from industrial alliances become formal standards
  - ETSI PAS process :
    - HGI specifications were transposed by TC SmartM2M into ETSI specifications
    - The Car Connectivity Consortium (CCC) defined the MirrorLink open standard for smartphone-car connectivity that has been adopted by TC ITS committee



3.3 Adoption/Transposition of standards
Examples of applications of the PAS process

- ISO PAS process
  - EnOcean Alliance develops specifications for sustainable buildings
  - Wireless Short-Packet (WSP) protocol developed by EnOcean ratified as standard ISO/IEC 14543-3-10.
  - EnOcean Alliance complements this standard with dedicated equipment and generic profiles

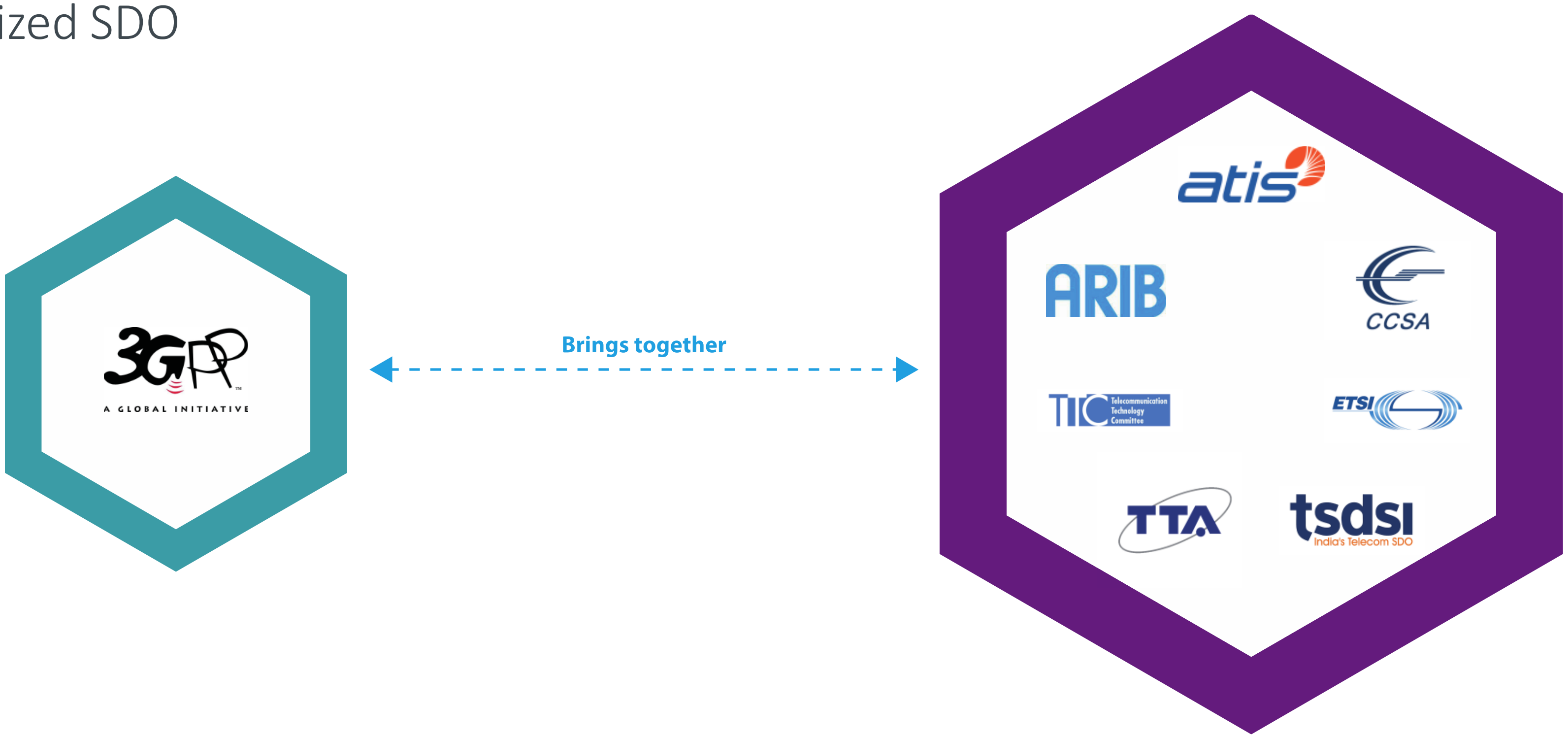


3.3 Adoption/Transposition of standards
Definition of the PAS process

- What is the **Publicly Available Specification** (PAS) process?
  - A means to transpose a specification more rapidly into an international standard published by a recognized SDO
- The document to be published in a PAS process is
  - a publication already developed at a quasi-final stage
  - approved by consensus at the consortium level
- The PAS process involves
  - benefiting from the SDO's reputation as a provider of standards for global use
  - subsequent maintenance and possible evolution by the SDO that applied the procedure
  - faster availability to the market and in a lighter way than with the full regular SDO process

3.3 Adoption/Transposition of standards
The Mirror process

- Example: Specifications from SDOs partnership projects are published as standards at regional level. This is the **Mirror** process.
  - A means to transpose a specification more rapidly into an international standard published by a recognized SDO



3.3 Adoption/Transposition of standards
Extension of standards by marketing organizations

- Extension of standards by marketing organizations
  - Standards are referenced by industrial alliances to build test suite specifications and promote the technology
  - Conformity assessment activities act as an essential intermediary between standards and the products themselves.
  - Example: IEEE 802.11 standard was adopted by the Wi-Fi Alliance to develop the requirements and profiles for certification.
    - The Wi-Fi Test Suite is a software platform designed to support certification program development and device certification
  - Example: GSMA Association writes guidelines and specifications to help implementers use the ETSI standards developed by 3GPP.
    - RCC 14 v5.0 – Service Provider Device Configuration, June 28, 2017
    - TS.11 Device Field and Lab Test Guidelines v19.0, April 11, 2017
    - IG.16 – Smarter Traffic Management, March 14, 2017

3.3 Adoption/Transposition of standards
Adoption into / from regulations

- A strong link exists between regulations, legislation and policies defined by local authorities at regional level, and standards
  - A regulation is a constraining legal act
  - A standard's application is voluntary
- Standards can be referenced in the regulations to simplify their content, facilitate or reduce certain controls, and better enact laws.

- The reference to a standard can be
  - implicit or explicit mention,
  - with the title and with / without date, and
  - with an optional, privileged or binding reference.
- A standard made compulsory becomes part of the regulation.

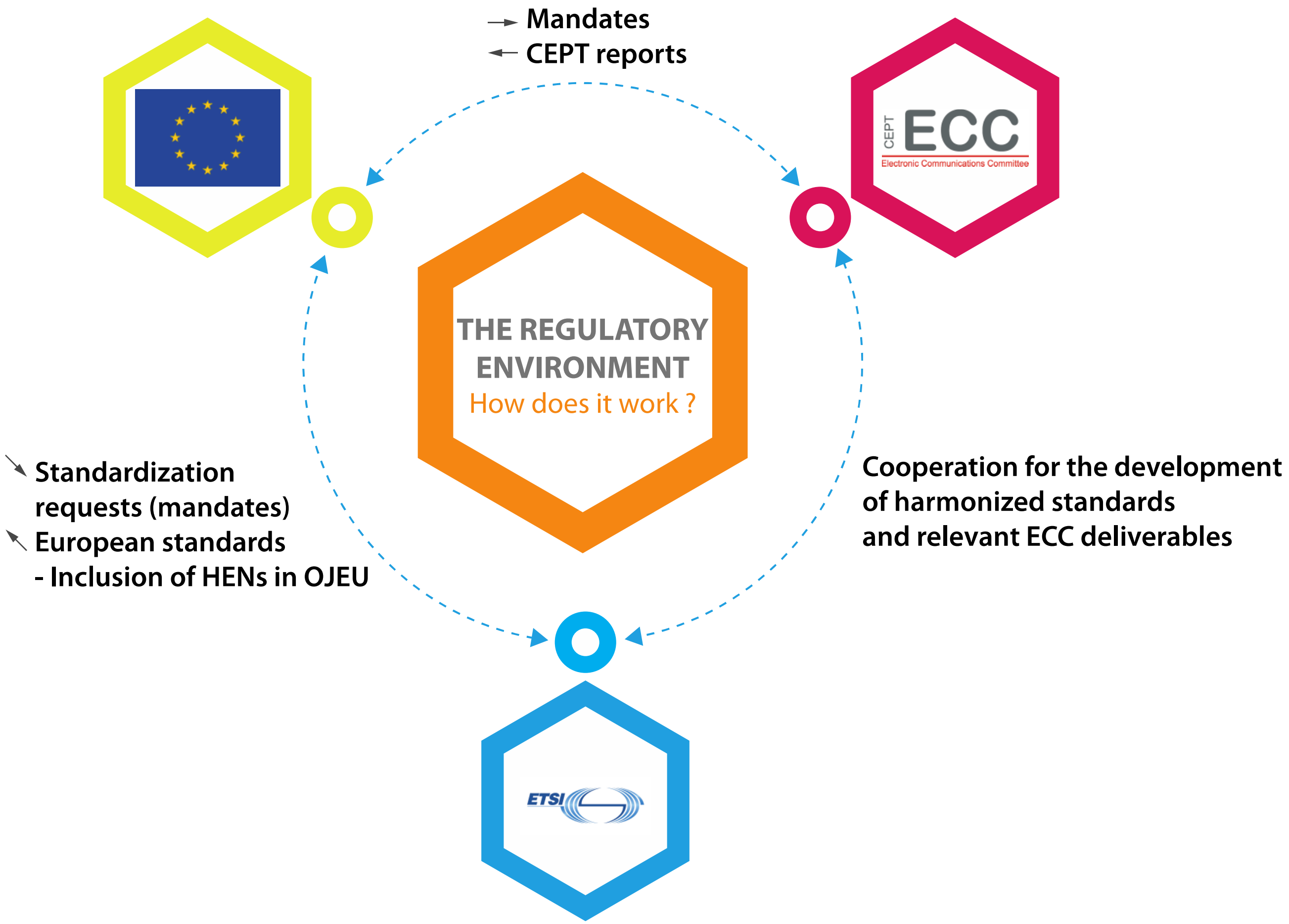
3.3 Adoption/Transposition of standards
Example of Harmonized standards

- In Europe, Harmonized Standards, essentially published by CEN, CENELEC and ETSI, allow manufacturers to place their products on the market with a presumption of conformity. This process requires that the Harmonized Standards are published in the Official Journal of the European Union (OJEU)

- Example : Radio Equipment Directive (RED), applicable from 13 June 2016
  - Any provider that wants to place a transmitting or receiving radio equipment on the European market and operate it by using the radio spectrum must meet the requirements of the relevant directives and regulations

- Example : the CE marking
  - Identifies a product as complying with the health and safety requirements contained in European legislation

3.3 Adoption/Transposition of standards
Example : the European Radio regulatory framework



3.4 Types of documents produced by SDOs

- There are **different types of documents** produced by SDOs.
- **Different organizations** may produce different types of **documents**.
- The **definition/purpose** of each type of document may differ across organizations.
- Different types of documents may differ in:
  - Their **scope** and addressed **stakeholders**.
  - The **process** leading to their approval/publication.
  - Not all organizations are **suitable** to produce every type of document.

3.4 Types of documents produced by SDOs
Normative and informative documents (Hatto, 2013)

- **Informative** documents, **do not contain any requirements** and it is therefore not possible for compliance claims to be certified.
- **Normative** documents **contain requirements** that must be met in order for claims of compliance with the standard;
    - **Requirements** in a standard are usually worded with the term "**should**"
    - **Recommendations** in a standard are usually worded with the term "**shall**"
    - In order to avoid confusion or contradiction, **informative elements** (even in normative documents) **cannot contain requirements**

3.4 Types of documents produced by official SDOs
Normative documents (1/2)

- Standard:
  - A document containing requirements or recommendations that have reached **wide consensus**.
  - Normally, approval of standards requires to go through the **most comprehensive and rigorous procedures** of organizations publishing them.
  - E.g., EN 301 893 5 GHz RLAN; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

3.4 Types of documents produced by official SDOs
Normative documents (2/2)

- Specification:
  - A document that has **not reached as much consensus as a standard**, but whose **availability is relevant** for a certain domain.
  - E.g., ISO/IEC TS 19841:2015 Technical Specification for C++ Extensions for Transactional Memory

3.4 Types of documents produced by official SDOs
Informative documents

- Technical report:
  - A document with **explanatory material** about a topic.
  - E.g., ETSI TR 103 234 Power Line Telecommunications; Powerline recommendations for very high bitrate services.
- Guide:
  - Documents **used by standards organizations for guidance** for how to handle specific technical standardization activities.
  - E.g., ISO/IEC Guide 71:2014 - Guide for addressing accessibility in standards, guides standardizers on how to address accessibility when either producing new standards or revising existing ones
  - E.g., CEN-CENELEC and ISO-IEC Guide 17 – Guides standardizers to take into account SME needs, e.g. making "simple and understandable" standards

3.4 Types of documents produced by official SDOs

- Some **documents are particular** to certain organizations:
  - ETSI Standard (ES)
  - CEN Workshop Agreement (CWA)
  - ISO Workshop Agreement (IWA)
  - ISO Publicly Available Specifications (PAS)

3.5 Naming conventions for standardization documents
Information provided by a document's name (1/2)

- The **SDO** (or SDOs, in case it is a joint publication) that has published it.
- **Other SDOs** that might have **adopted** the standard after it was originally published.
- The **type of document**, e.g., whether it is an International, European or National standard, a specification, technical report, etc.
- Whether the document belongs to a **family** of standards.

3.5 Naming conventions for standardization documents
Information provided by a document's name (2/2)

- Whether it is a **harmonised** standard.
- The **version** number of the standard, indicating whether it is a draft or final version, as well as informing of major, technical or editorial changes.
- The **year** of publication of the document.
- The **title** of the standard.

3.5 Naming conventions for standardization documents
Examples (1/3)

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

3.5 Naming conventions for standardization documents Examples (2/3)

- ETSI TS 102 412 V12.0.0 (2015-02) “Smart Cards; Smart Card Platform Requirements Stage 1” (Release 12)
  - The “ETSI” prefix indicates that this standard has been published by ETSI.
  - The “TS” prefix indicates that it is a technical specification.
  - The code of the standard is 102 412.
  - This is the version 12.0.0 of the standard (which is confirmed by the “release 12” in the title). ETSI uses three numbers (x.y.z) for indicating its document versions. The first final version of a document will be Version 1.1.1. Subsequent final documents will increase the first number "1.x.x" of the version number (1.x.x, 2.x.x, etc.). While the document is under review, subsequent draft versions will increase "x.1.1", e.g., 1.2.0, 1.3.0, etc.
  - It was published in February, 2015.
  - The document is part of the “Smart cards” family of standards.

3.5 Naming conventions for standardization documents
Examples (3/3)

- BS EN ISO/IEC 27002:2005 Information technology. Security techniques. Code of practice for information security management
  - The “BS EN ISO/IEC” prefix indicates that this standard was first published by ISO/IEC,
  - then adopted as an European Standard (EN), and then as a British standard (BS)

List of abbreviations: Chapter 3

- 3GPP: 3rd Generation Partnership Project
- ANSI: American National Standards Institute
- API: Application Programming Interface
- BIS: Bureau of Indian Standards
- C2C-CC: Car to Car- Communication Consortium
- CCC: Car Connectivity Consortium
- CE : (Marking) Conformité Européenne (European Conformity)
- CEN: Comité Européen de Normalization (European Committee for Standardization)
- CENELEC: European Committee for Electrotechnical Standardization
- CEPT: Conférence Européenne des Postes et des Télécommunications
- CWA: CEN Workshop Agreements
- DIN: German Institute for Standardization
- EC: European Commission
- ECC: Electronic Communications Committee

List of abbreviations: Chapter 3

- EMC: Electromagnetic compatibility
- EN: European Standard
- ES: ETSI Standard
- ESO: European Standards Organizations
- ETSI: European Telecommunication Standards Institute
- GSMA: Global System for Mobile Communications (GSM) Association
- HEN: Harmonized European Norms
- HGI: Home Gateway Initiative
- HTML: HyperText Markup Language
- ICT: Information and Communication Technology
- IEC: International Electrotechnical Commission
- IEEE: Institute of Electrical and Electronics Engineers
- ISO: International Organization for Standardization
- ITS: Intelligent Transport System
- ITU: International Telecommunication Union
- IWA: ISO Workshop Agreement

List of abbreviations: Chapter 3

- OASIS: Not-for-profit consortium, the acronym stands for Advancing Open Standards for the Information Society
- OJEU: Official Journal of the European Union
- OMG: Object Management Group
- PAS: Publicly Available Specification
- PASC: Pacific Area Standardization Conference.
- PDF: Portable document format
- RED : Radio Equipment Directive
- RFC: Request for Comments
- SDO: Standards Developing Organization
- TC: Technical Committee
- TCP/IP: Transmission Control Protocol/Internet Protocol
- TS: Technical Specification
- UNE: Spanish Association for Standardization
- W3C: World Wide Web Consortium
- WSP: Wireless Short-Packet

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4 The Production of Standards

Contents

4.1 The production of standards

- Producing formal standards of high quality requires
  - understanding the code of good practice that lies behind the formal standardization
  - satisfying a set of criteria relative to the requirements contained in the standard
  - the involvement of different types of standardization experts
- Production of standards is closely linked
  - to the organization of SDOs that are responsible to provide a suitable environment
  - to the organizations participating in the SDO activities and technical committees

4.2 The standardization scene
Conditions to make a good and fair standards

- The standard development process is the procedure applied towards the production of a standard document
- What is needed to make a good and fair standard ?
  - Some code of good practice with basic principles should be observed
    - Openness, transparency, impartiality, equity, consensus, effectiveness, relevance, development, coherence
    - In addition to clarity of the content
  - Different steps allow a comprehensive standardization of a technology, a function or a system and are usually documented either in dedicated or in more integrated documents
    - Ranging from feasibility studies to testing requirement specifications
  - The production of a standard follows a well-defined procedure , that may vary depending on the SDO policies
    - Ranging from inception to publication and maintenance
  - SDOs are organizations with a well-defined structure
    - Becoming the member of an SDO follows a set of rules
    - Knowledge of an SDO governance is essential for success in standardization.

4.2 The standardization scene
Fundamental principles: openness and transparency

- A set of fundamental principles and mechanisms foster the production of fair standards:
  - Openness
    - The standardization process is easily accessible to any interested stakeholder at all stages, from policy development and draft submission, to adoption and dissemination of the standards
    - However, industry fora / consortia may disregard this principle and have closed meetings and membership restricted only to companies with a specific industry interest
  - Transparency
    - the draft standard is made available to the all the working group members along its development steps with a sufficient time to provide them with the possibility to submit comments
    - However, a standard may be proposed for approval at a very short notice, with little information to peer working group members, who are deprived from the possibility to read and carefully analyse the document before its approval

4.2 The standardization scene
Fundamental principles: impartiality and equity

- A set of fundamental principles and mechanisms foster the production of fair standards:
  - Impartiality
    - The process is managed by a group of diverse stakeholders with varied interests and avoids being influenced, e.g., by funding or by one interest group
    - IPRs are a very sensitive topic and recognized SDOs often mandate that known IPRs be declared as early as possible
    - However, it might happen that a standard is proposed to meet the interest of a particular supplier or governmental entity. A major player dominating the market may be reluctant to have any standard at all and tries to slow down the process by adopting a difficult and demanding attitude
  - Equity
    - all representatives are allowed to express their position and comments and every representative opinion is considered
    - However, it might happen that the valid opinion of a participant is noted and not further considered, because it hampers the objectives of a specific group of interest

4.2 The standardization scene
Fundamental principles: consensus and effectiveness

- A set of fundamental principles and mechanisms foster the production of fair standards:
  - Consensus
    - 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
    - Consensus does not necessarily mean unanimity. Consensus may be achieved for example through a voting process (depends on the SDO procedures)
    - However, it might happen that actions are taken to silence the objections of one or a group of stakeholders, for example by providing the final version of a document with a very short notice
  - Effectiveness
    - Standards are developed only when it has been proven that implementation is feasible and appropriate, based on existing existing technological capabilities
    - Standards are revised when they become obsolete or have been identified as ineffective. They can also be deactivated
    - However, some standards may be developed to describe an emergent technology which is not yet mature, but whose supporters want to reach the market early and prevent the development of other competing technologies

4.2 The standardization scene

Fundamental principles: relevance to market needs and development

- A set of fundamental principles and mechanisms foster the production of fair standards:
  - Relevance to market needs
    - The standard responds to regulatory and market needs and does not try to distort the global market
    - Fair standards enable implementation by different providers and enable competition in the market. IPR policies ensure transparent procedure
    - However, it might happen that a stakeholder tries to develop a standard to consolidate its position in the market
  - Development
    - The standardization process is open to all interested parties and encourages the participation of developing countries
    - The standards are neutral and do not favour characteristics of specific countries or regions when different needs exist in other parts of the world
    - However, it might happen in practice that technical regulations and standards are published to protect domestic industries

4.2 The standardization scene
Fundamental principles: coherence and viability

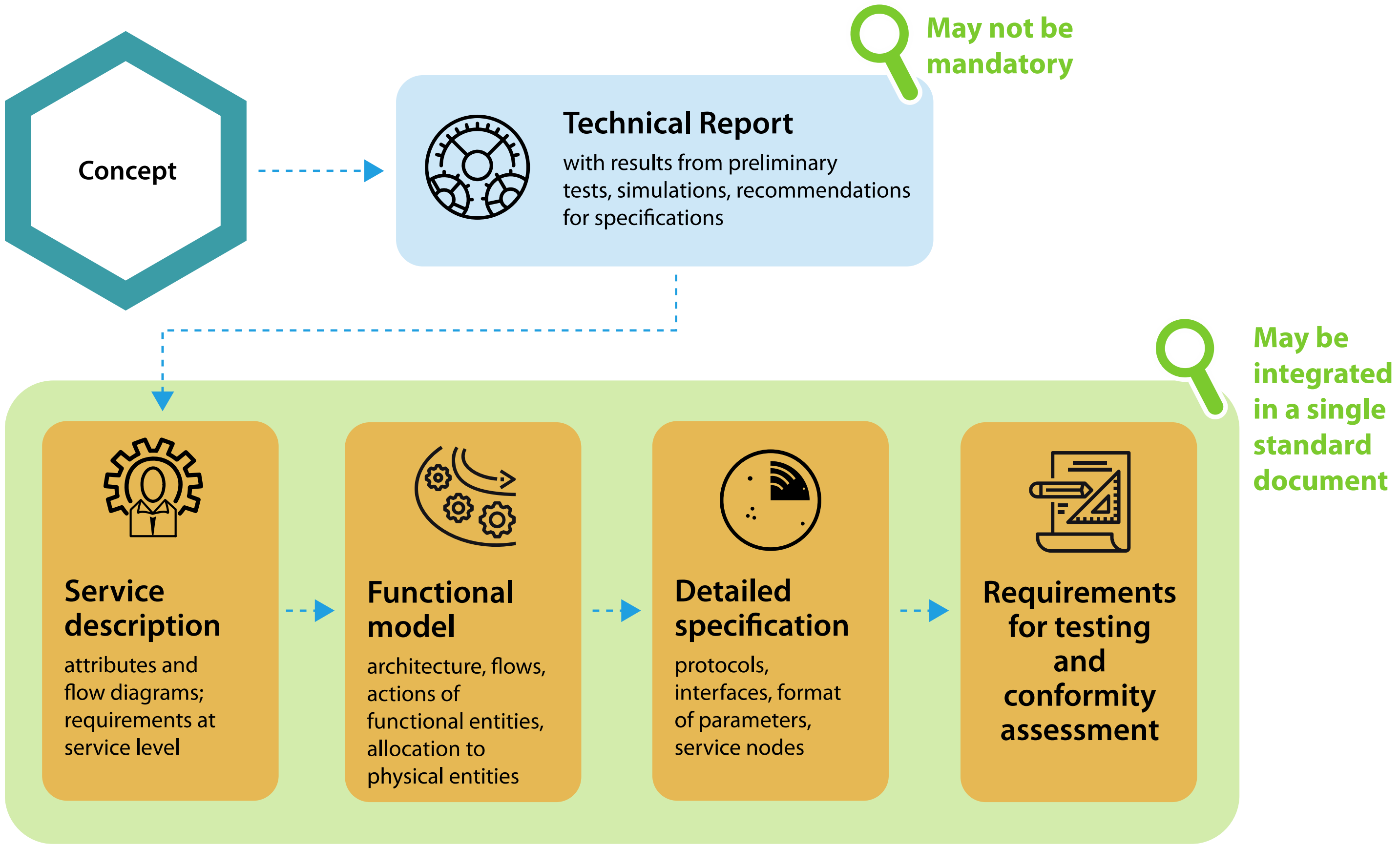
- A set of fundamental principles and mechanisms foster the production of fair standards:
  - Coherence
    - The standard contributes to the coherence of the market and avoids introducing a solution that conflicts or overlaps with the standards developed in another SDO
    - Collaboration and cooperation rather than competition with other SDOs is essential
    - For example, the Global Standards Collaboration (GSC) group annually brings together the world's leading telecommunications and radio standards organizations to share information in a number of important technical areas.
    - However, it might happen in practice that several SDOs work in parallel towards standards for technologies targeting the same market. They fragment the market and hinder its development
  - Viability and stability
    - Major SDOs must guarantee viability and stability of the standardization process and of their IT infrastructure in the long run, even at times of budget restrictions

4.2 The standardization scene
Quality of the requirements

- The requirements in a standard specification should be:
  - Necessary: they specify only what is required to meet the standard's objectives, and not to impose a particular approach to implementation
  - Unambiguous: it is impossible to interpret the normative parts of the standard in more than one way
  - Comprehensive and accurate (inclusiveness): they contain all the information necessary to understand the sense of the requirements, either directly or by reference to other documents
  - Precise: they are expressed clearly and exactly, without unnecessary detail that might confuse readers
  - Well-structured: the individual elements of the requirement are all included in an appropriate manner, easy to read and to understand
  - Consistent: there is no contradiction between the different requirements within the standard, nor with other related standards
  - Validated and testable: there are clear and obvious means of demonstrating that an implementation complies with the requirements
  - Open: standards are made available to the general public and are developed, approved and maintained via a collaborative and consensus driven process
  - Up-to-date: maintenance, evolution or withdrawal needs are regularly assessed

4.2 The standardization scene
Standardization steps of an ICT system

- The typical methodology for the exhaustive standardization of an ICT system includes several stages (ITU Recommendation I.130)

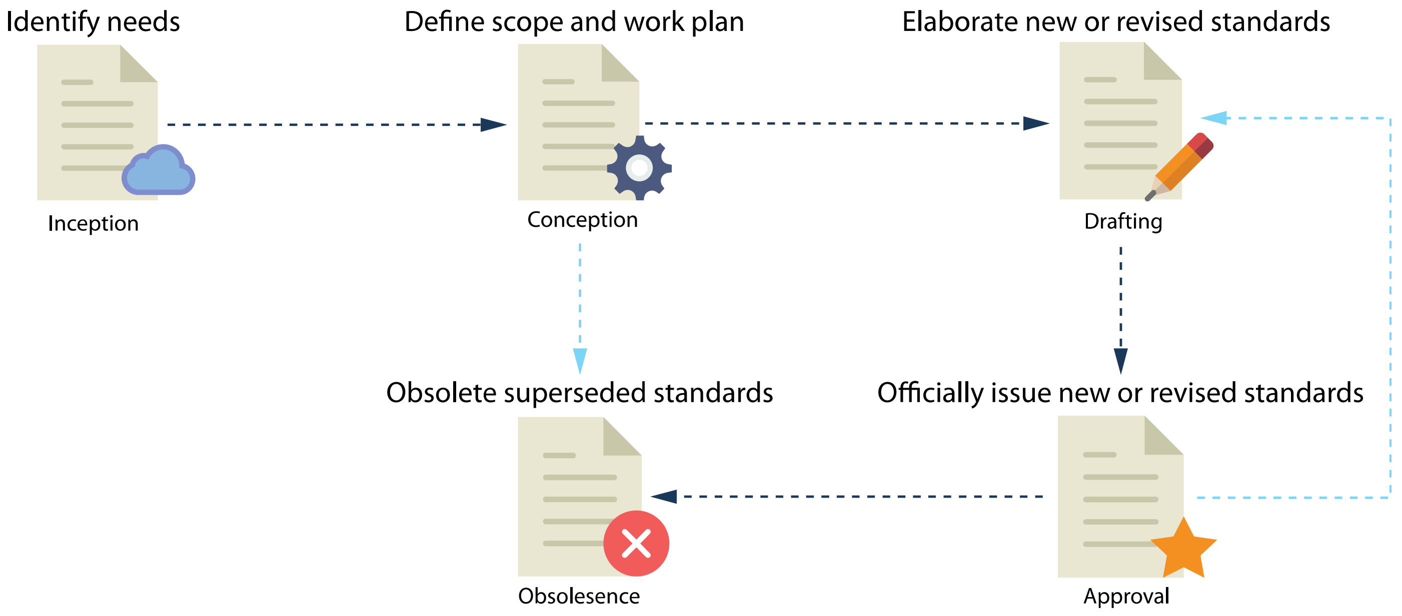


4.2 The standardization scene
Example: methodology of 3GPP standardization

- Example : 3GPP follows a three-stage methodology as defined in ITU-T Recommendation I.130.
- It is defined in 3GPP TR 21.900 clause 4.1.
  - Stage 1 is an overall service description from the user's perspective
  - Stage 2 is a functional model to meet those objectives. It identifies the architecture and functional capabilities
  - Stage 3 develops a specification of the detailed implementation requirements
  - It is a common practice to follow stage 3 with the production of test specifications or conformance test suites – a stage 4.
  - It is often appropriate to perform a feasibility study prior to formal specification work. This is sometimes referred to as "stage 0".

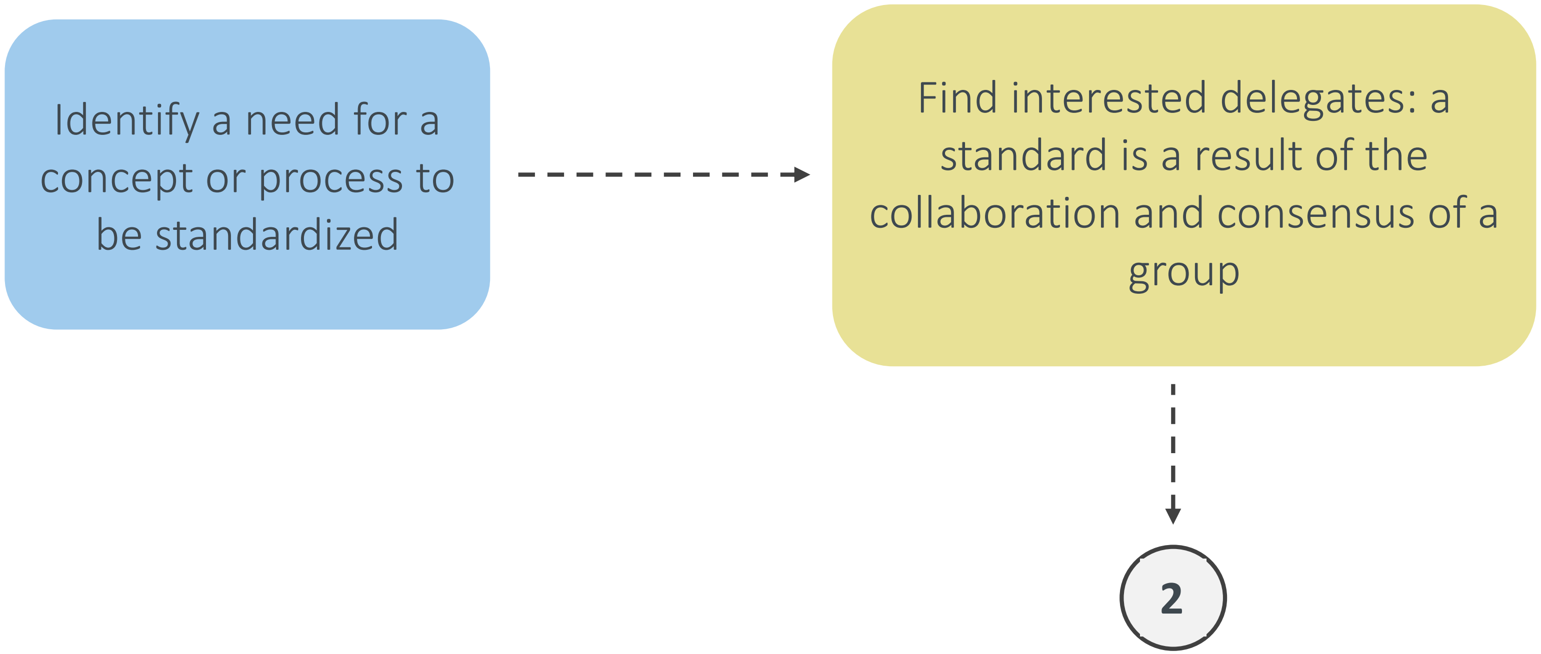
4.2 The standardization scene
The process for producing standards

- The preparation of a standard document follows a well-defined procedure, that may
    - differ according to the SDO
    - be more or less formal depending on the type of organization: a standard from an industrial alliance is often developed faster than a standard from a recognized SDO
- The preparation of a standard document follows a well-defined procedure, that may



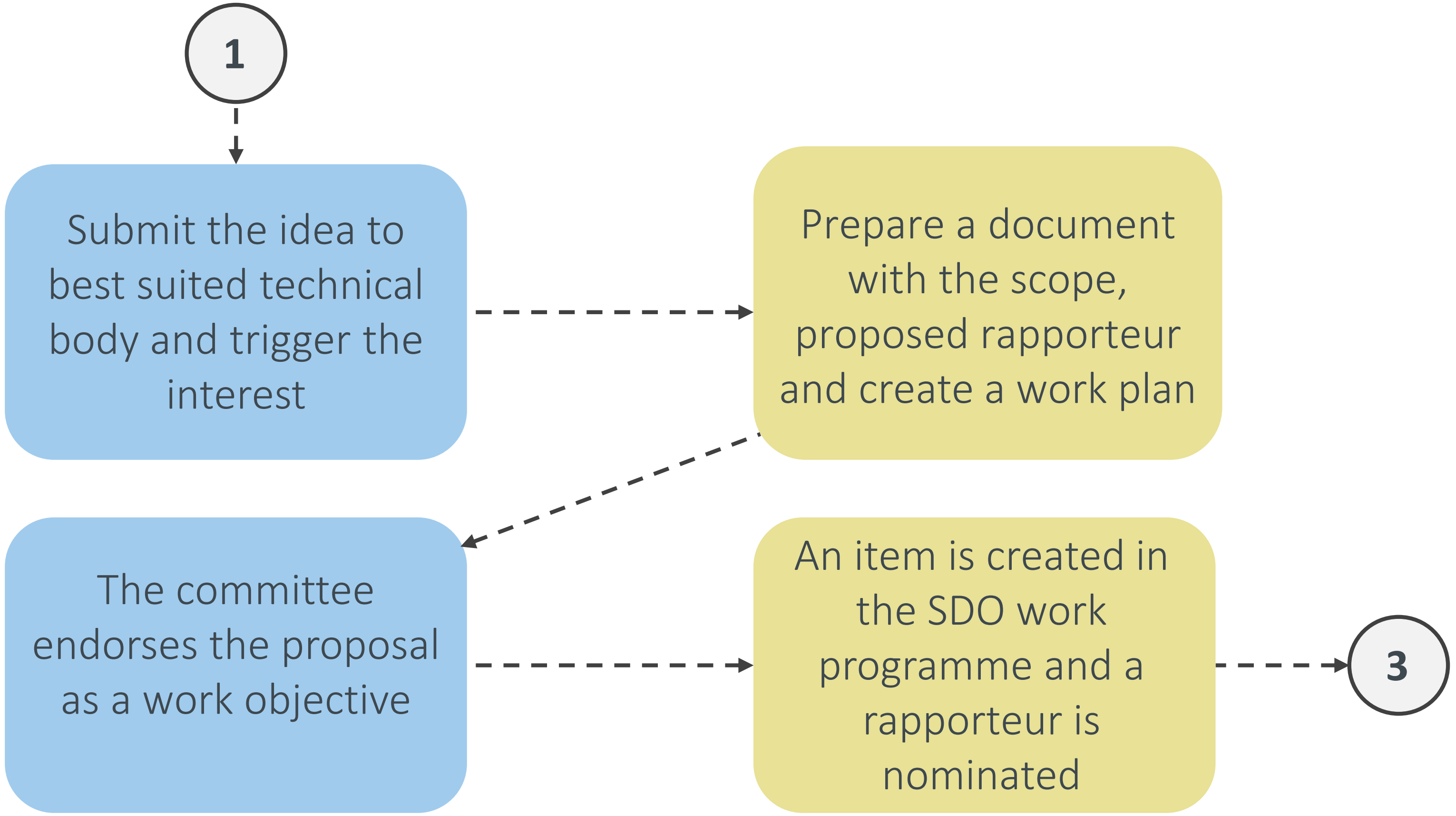
4.2 The standardization scene
The process for producing standards: step 1 - Inception

1 - Inception: Identify needs



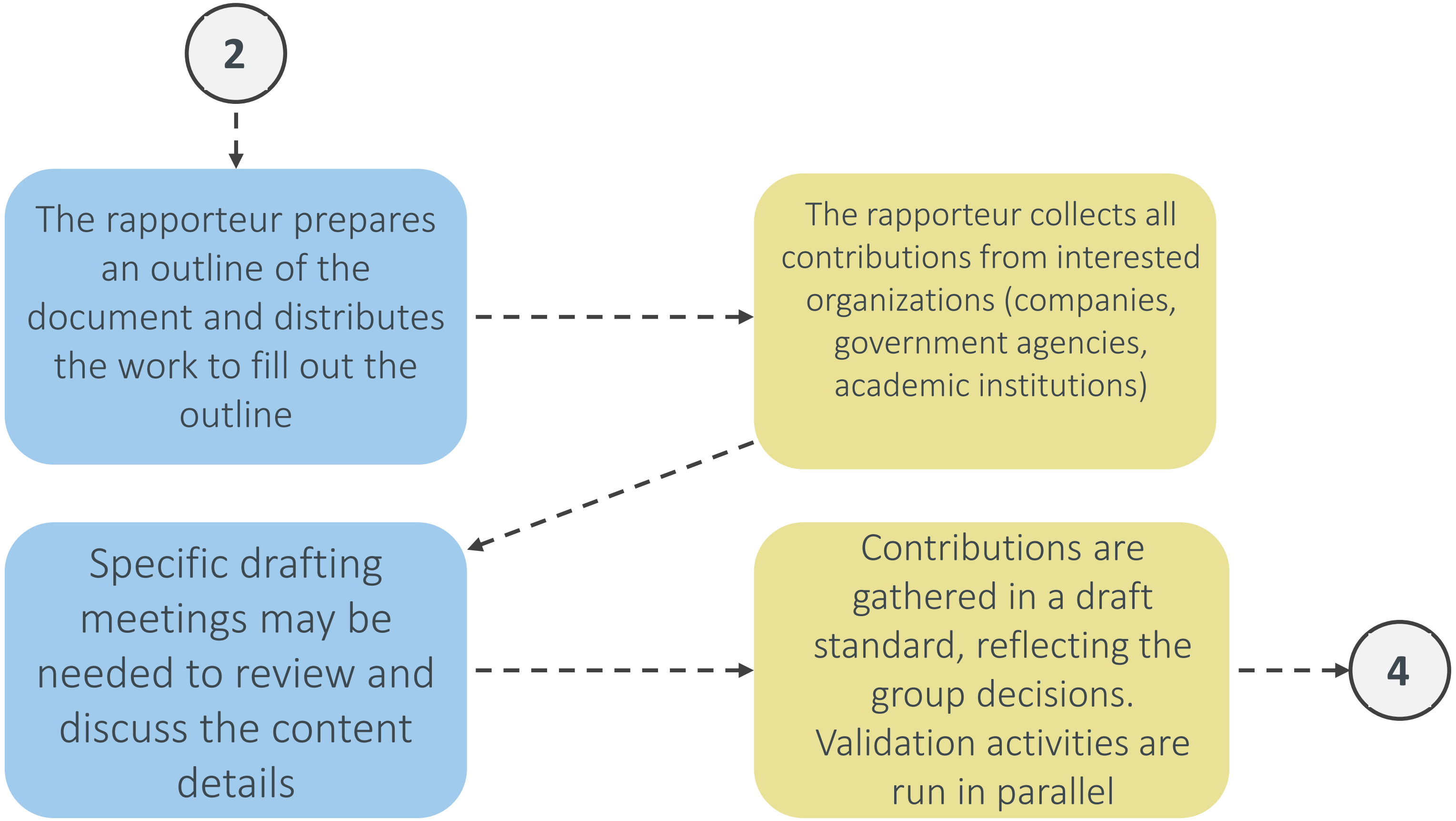
4.2 The standardization scene
The process for producing standards: step 2 - Conception

2 – Conception: define scope and work plan



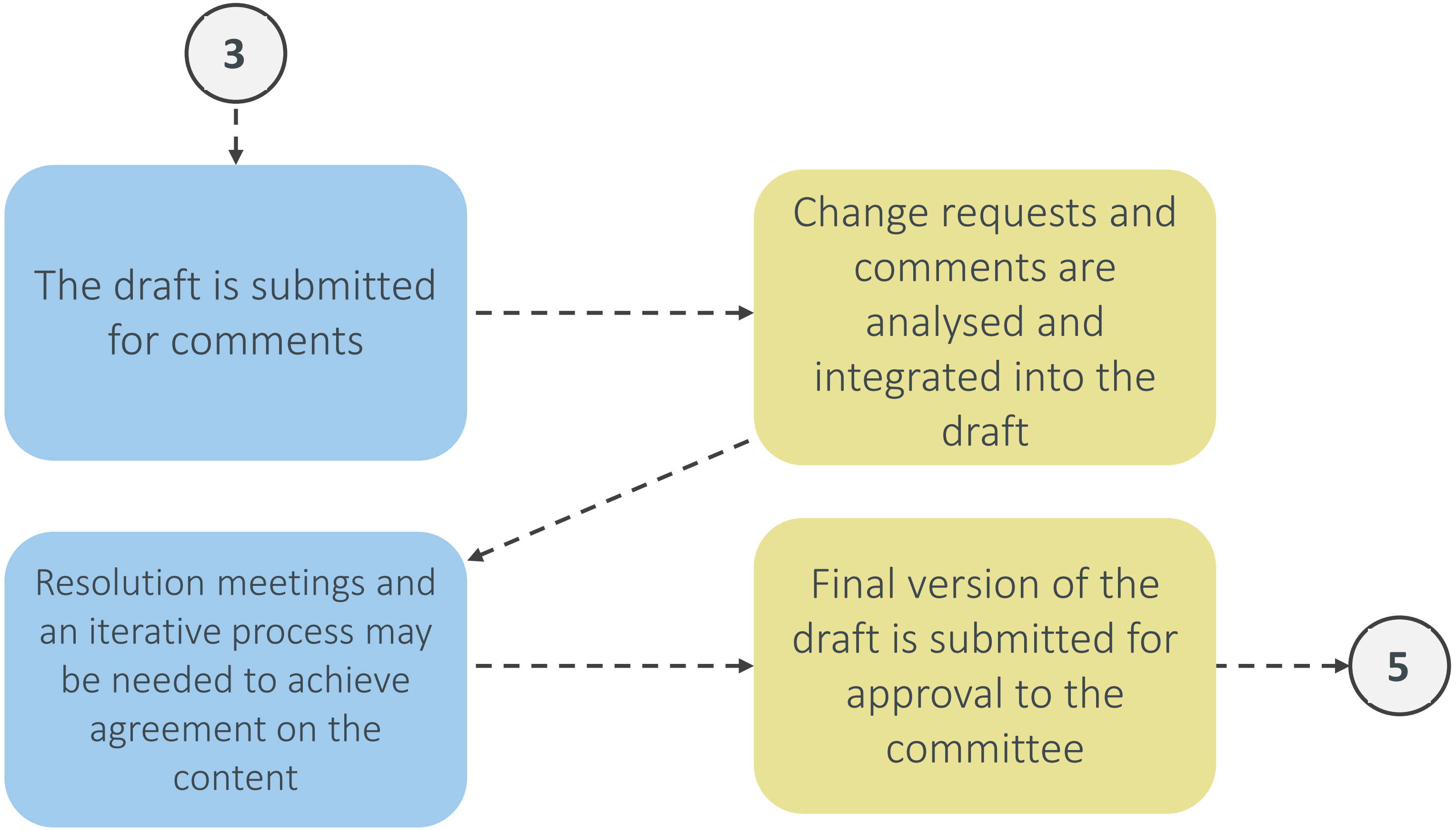
4.2 The standardization scene
The process for producing standards: step 3 - Drafting

3 – Drafting: elaborate new or revised standard



4.2 The standardization scene
The process for producing standards: step 4 - Approval

4 – Approval: achieve consensus on the draft standard

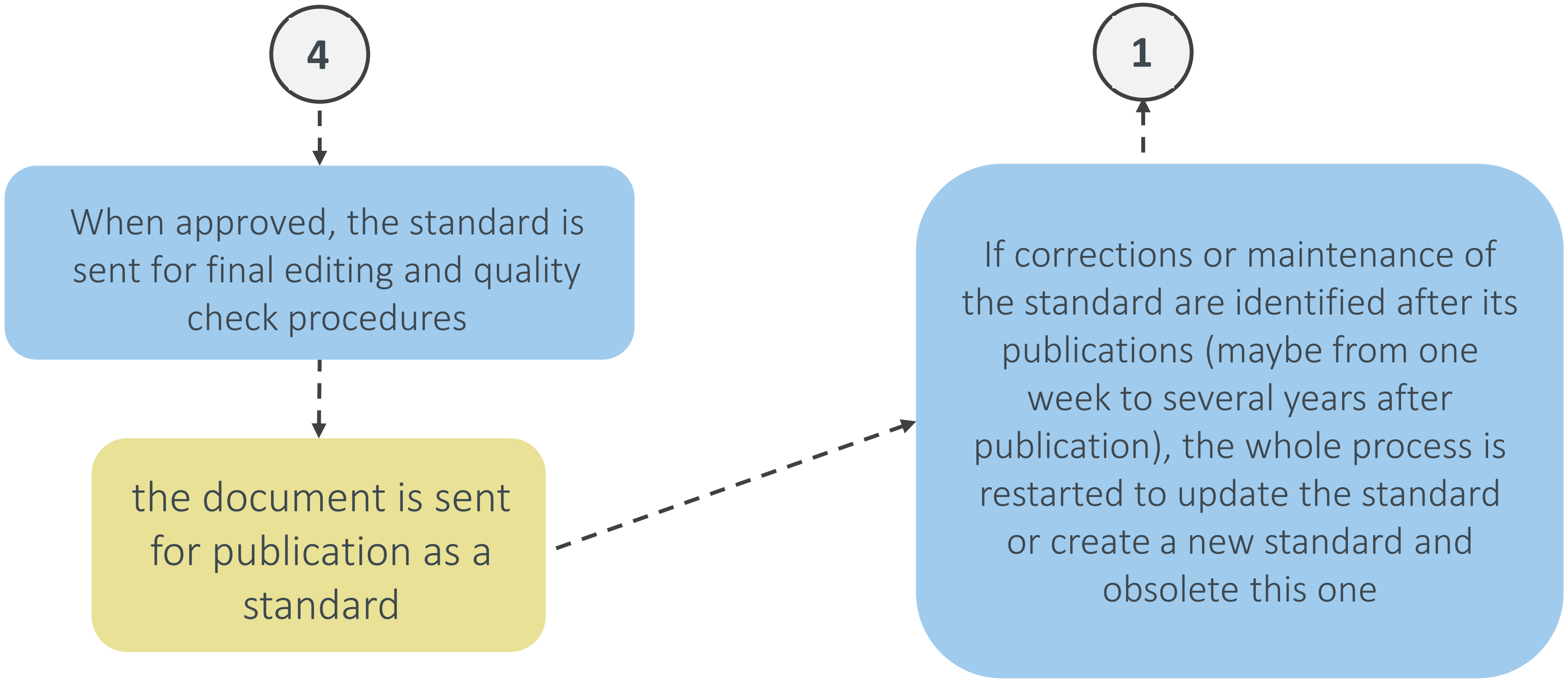


4.2 The standardization scene

The process for producing standards: step 5 – Publication and step 6 - Maintenance

5 – Publication: officially issue the new or revised standard

6 – Standard maintenance: maintain, evolve or withdraw the standard content



4.2 The standardization scene
Example of the CEN/CENELEC standardization process

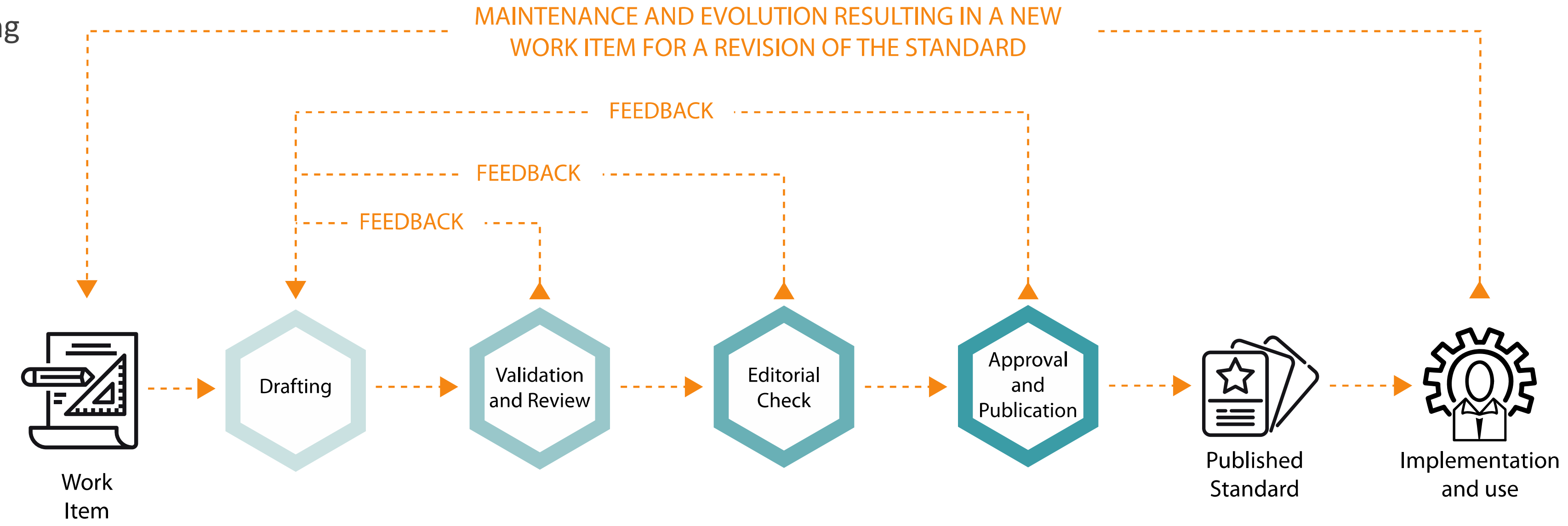
- Top-down approach

1. Proposal - evaluation and decision
2. Drafting and consensus building
3. Public enquiry
4. Consideration of comments
5. Approval of the standard
6. Publication

4.2 The standardization scene
Example of the CEN/CENELEC standardization process

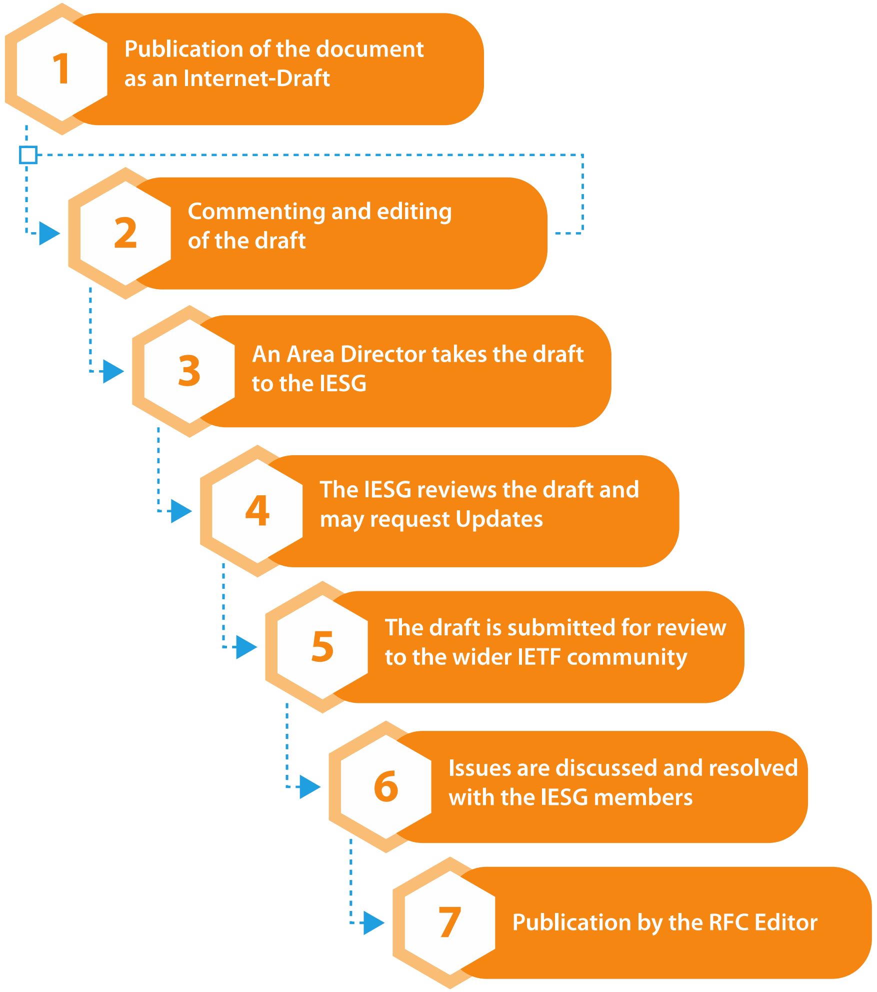
The key stages of the standards development process are to:

1. Create the Work Item
2. Develop the draft standard
3. Validate the draft
4. Submit the draft for editorial checking
5. Approve and publish the standard
6. Maintain and evolve the standard



4.2 The standardization scene
Example of the IETF development process

- Getting an RFC published
  - bottom-up process



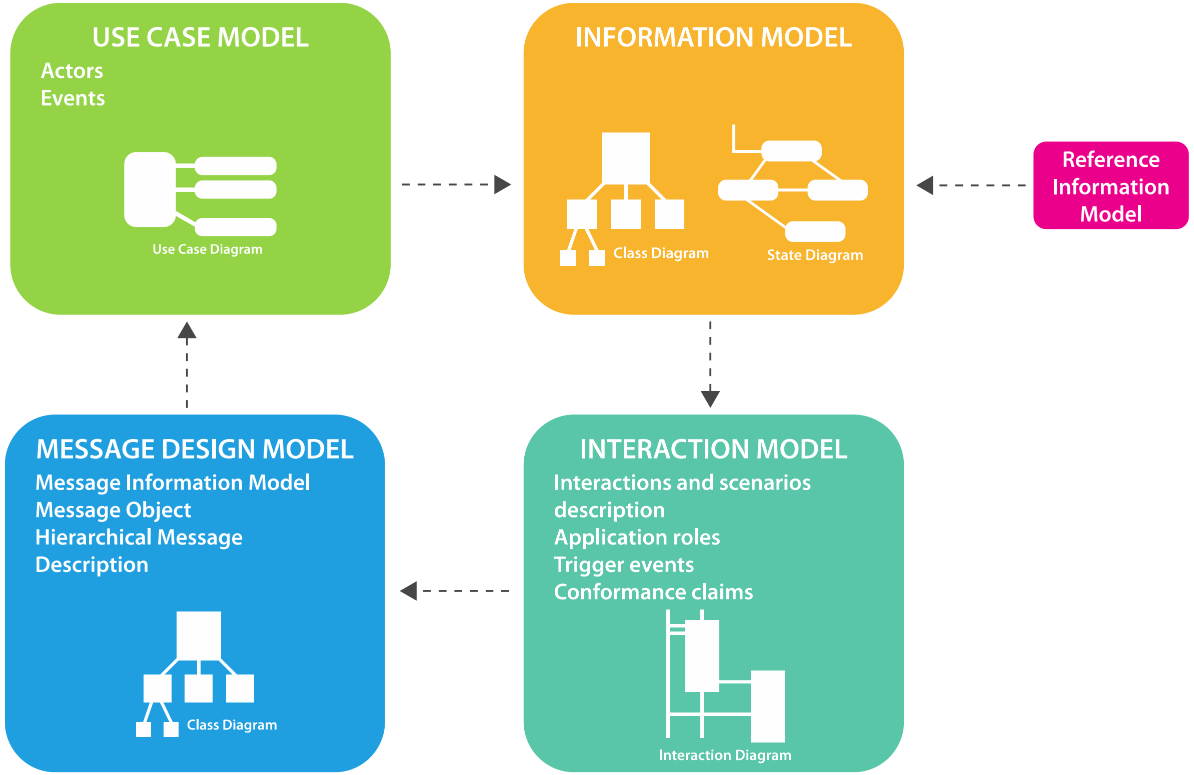
An IETF standard is published as an RFC ("Request for Comments").

An RFC starts out as an Internet-Draft (often called an "I-D" or just "draft").

IESG: Internet Engineering Steering Group

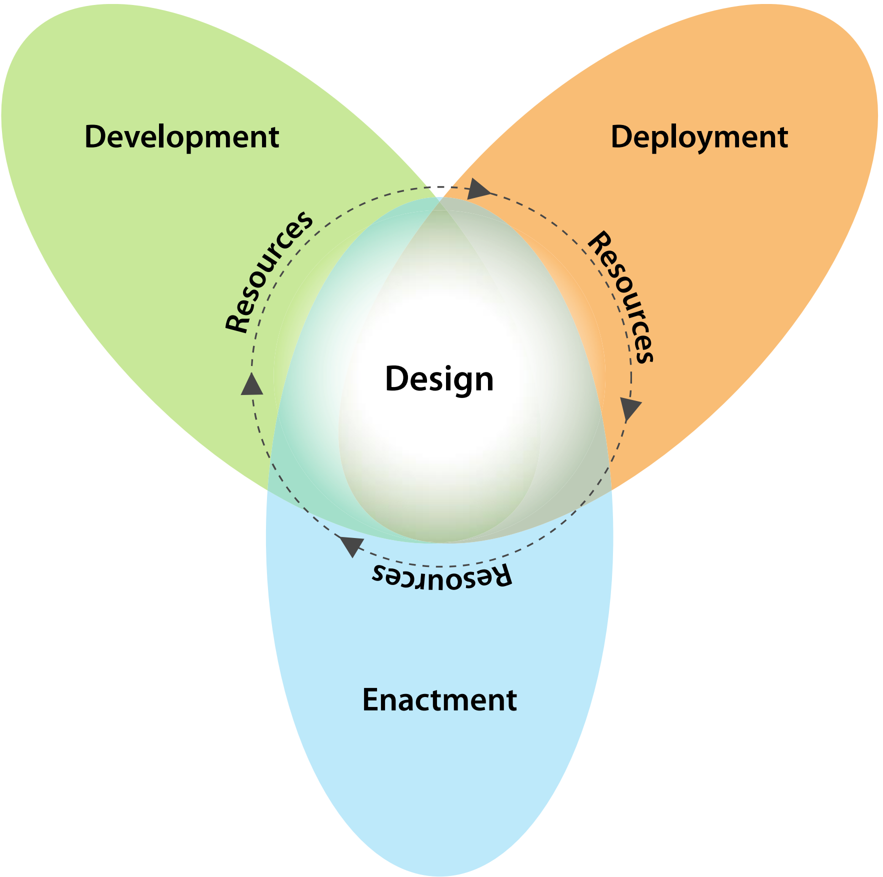
4.2 The standardization scene
Example of the HL7 methodology

- Example of another process based on models and an object-oriented methodology:
  - Health Level Seven (HL7) Version 3 Message Development Framework (Beeler, 1998)
  - Diagram of the message development framework: starting from a Use Case Model, leading to an Information Model, triggering an Interaction Model and derived in a Message Design Model



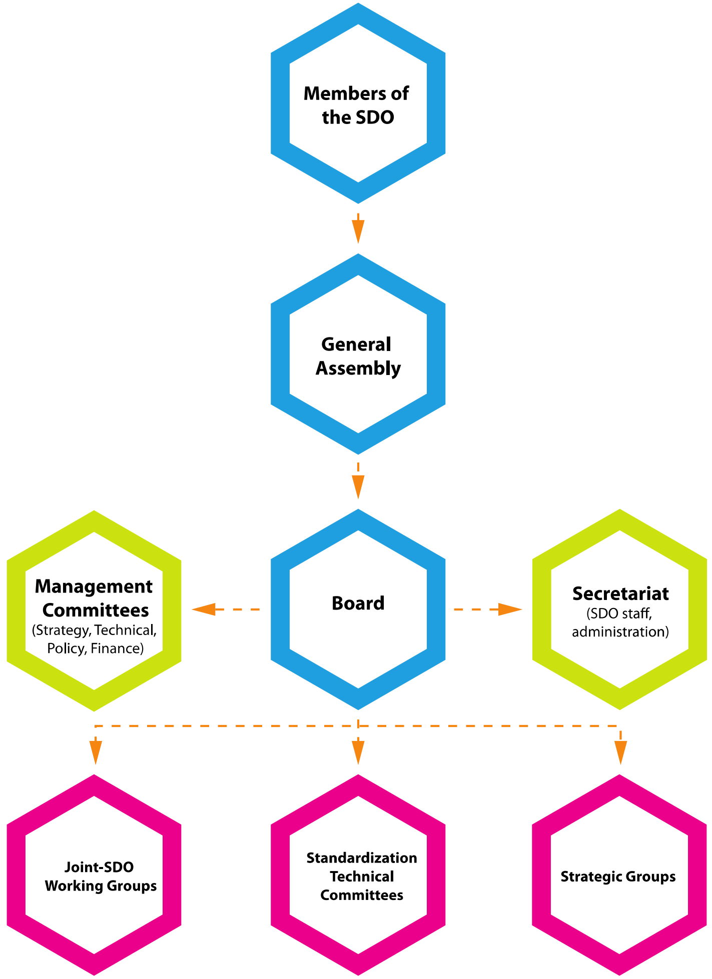
4.2 The standardization scene
Example of the Integrative Design Model methodology

- Integrative Design Model: based on the experience of implementation
  - The cycle of standards development is shown as a three-phase model (development, deployment and enactment) where design activities occur throughout all three phases (Millerand & Baker, 2010)



4.2 The standardization scene
Organization of an SDO

- SDO governance usually adopts a hierarchical structure

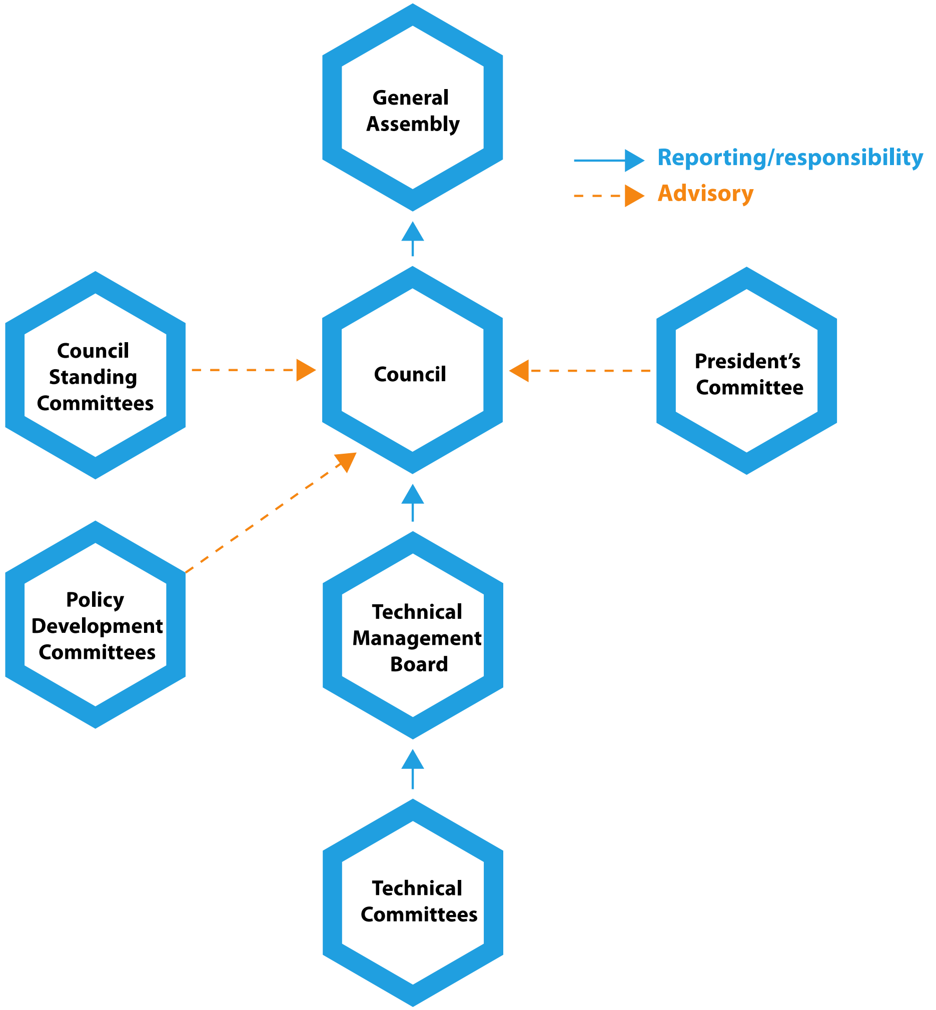


4.2 The standardization scene
Organization of an SDO: funding

- Financial options are important to guarantee the impartiality of the standards development process
- Financing should be capable of covering all the 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 implementing
- Funding may come from different sources, such as direct funding from governing authorities, membership fees, income from the sales of standards, and income from certification activities and their operations

4.2 The standardization scene
Organization of an SDO: example - ISO governance structure

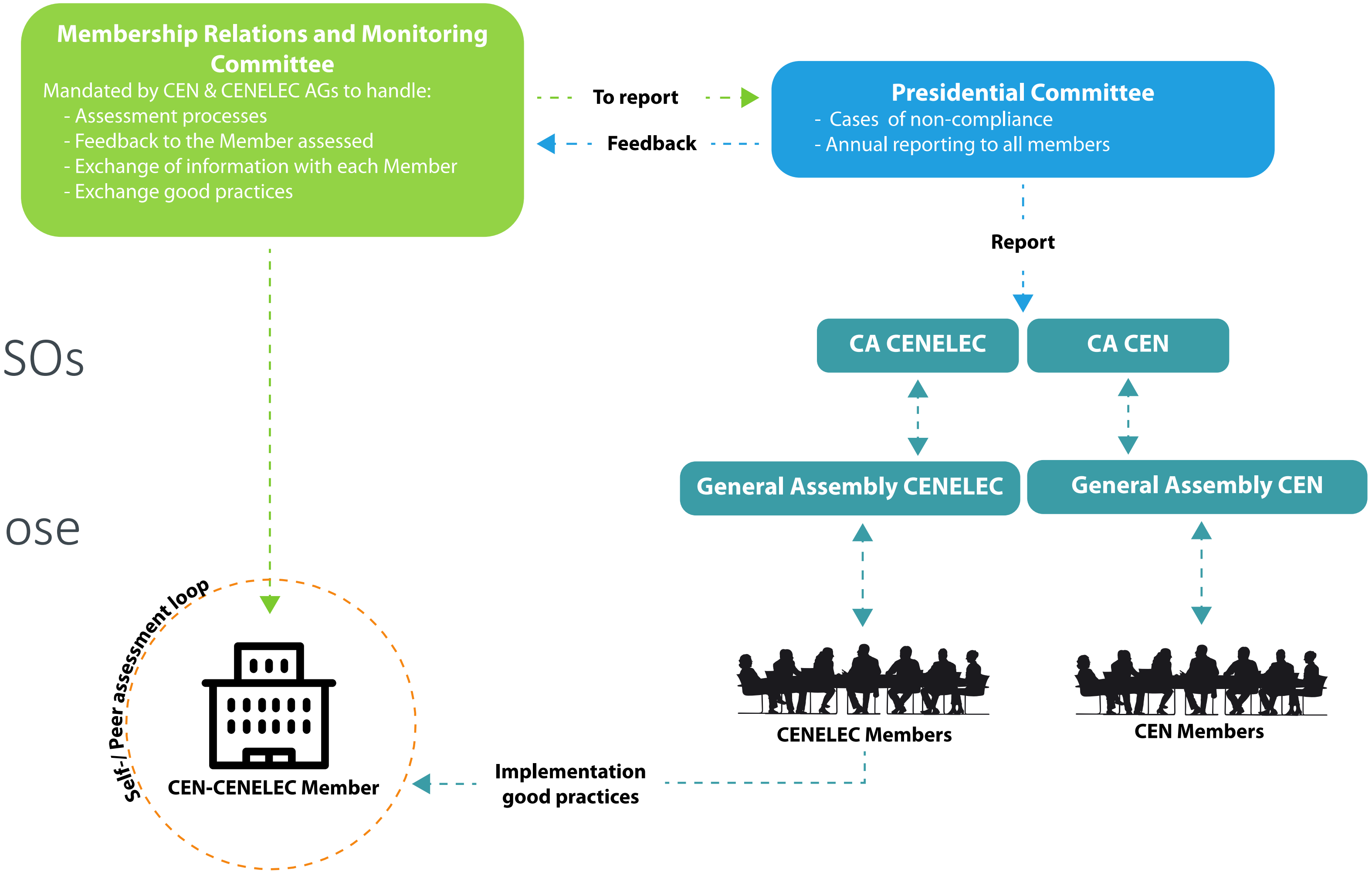
- The ISO Central Secretariat – ISO/CS – is responsible for supporting the governance and policy, advisory structure, and the operations of ISO. It assists the development process and publishes the standards



4.2 The standardization scene

Organization of an SDO: example - CEN-CENELEC cooperation model

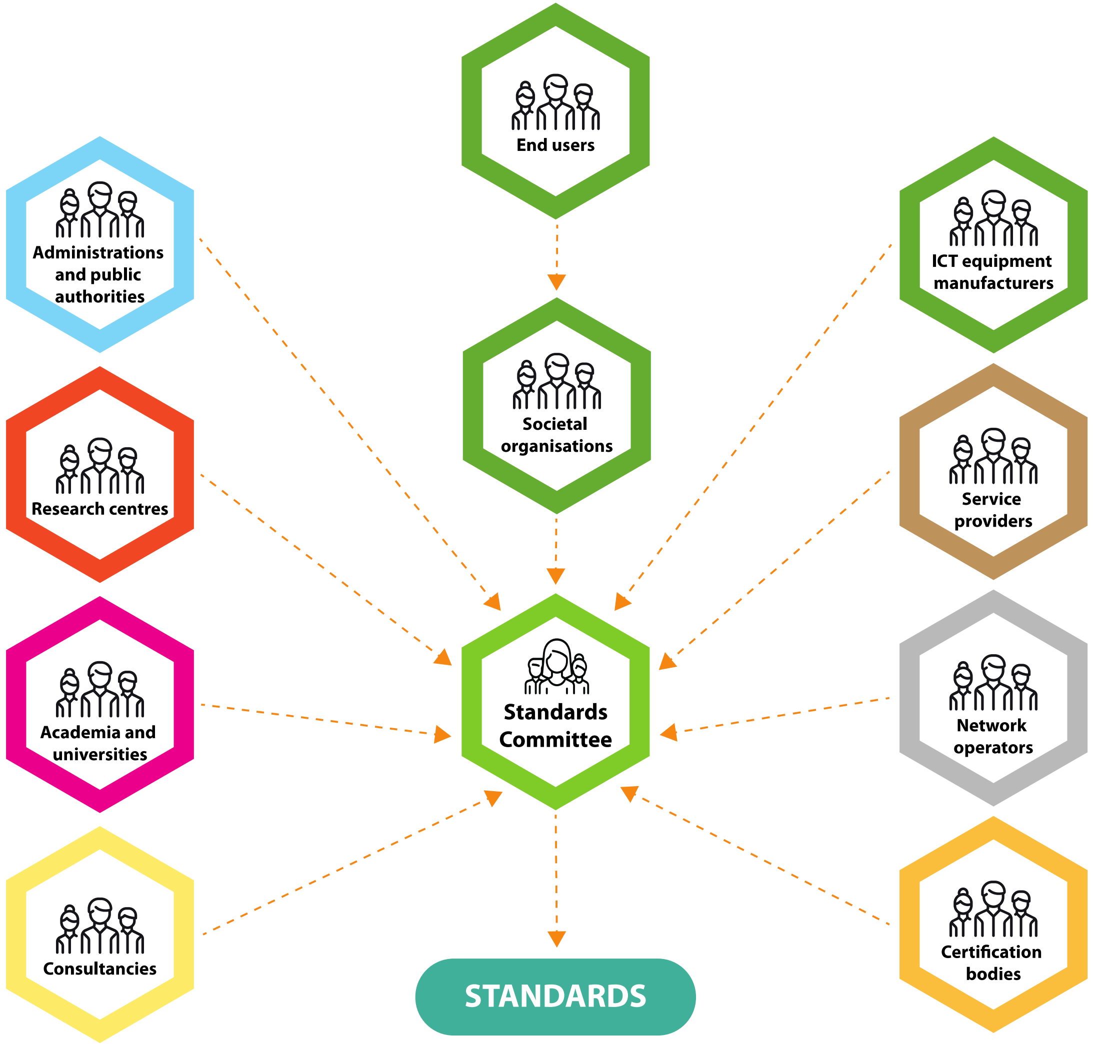
- CEN and CENELEC are two ESOs complementing each other.
- They have implemented a close cooperation agreement



4.2 The standardization scene
Organization of an SDO: example - IETF governance structure

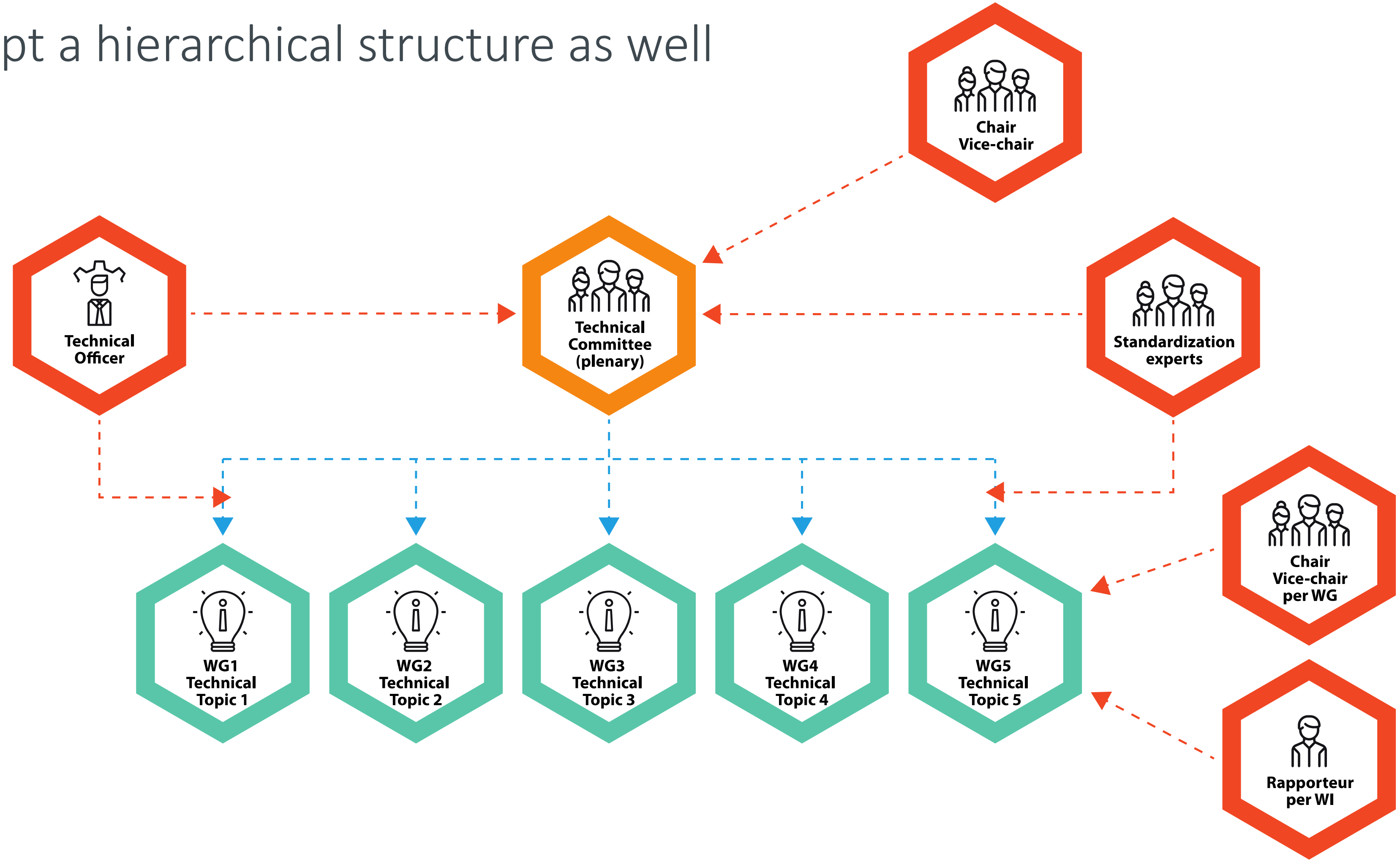
4.2 The standardization scene
Organization of an SDO: membership

- Who are the members of an SDO?
  - All stakeholders interested in the development of standards
- User groups hardly ever participate in standards development
  - Even if they are the final users and beneficiaries of the products and processes normalized
  - They suffer from a lack of technical background
  - So most often, they are represented by corporate users or societal organizations

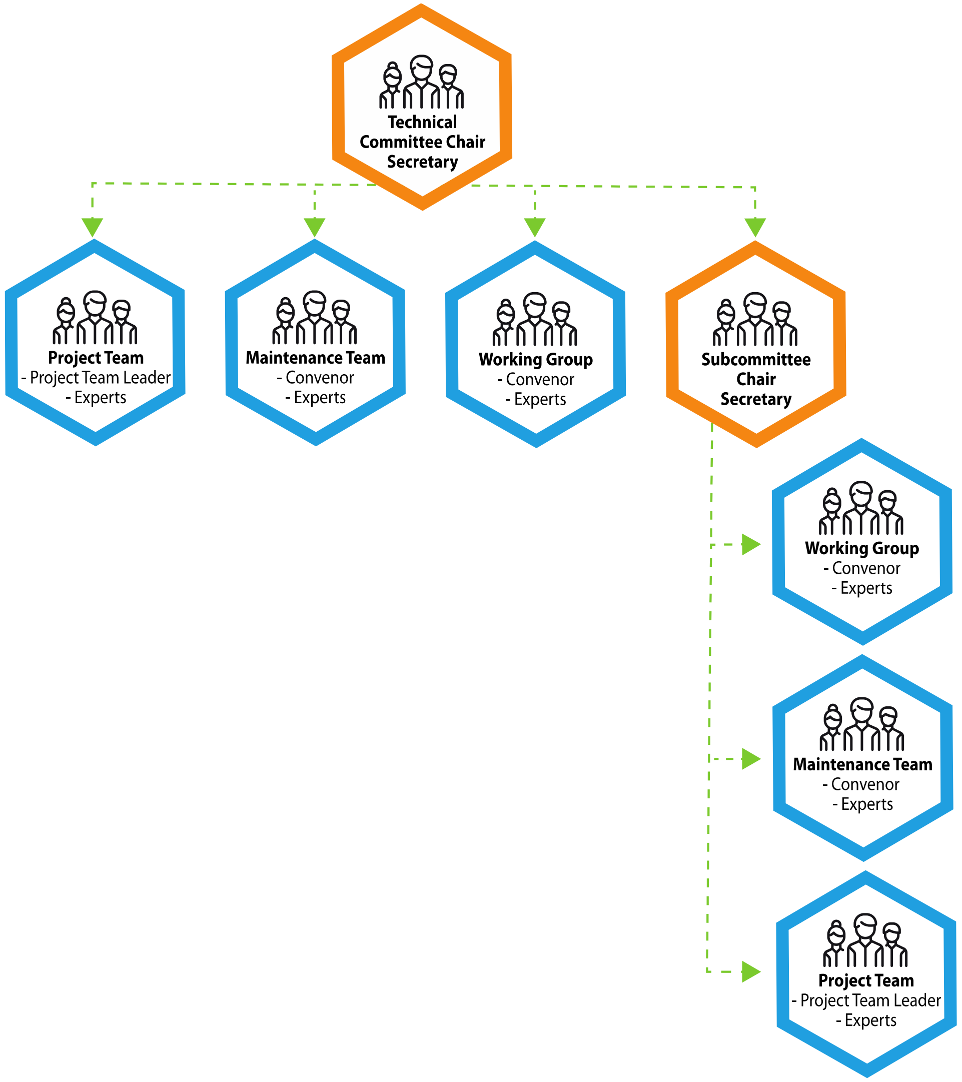


4.2 The standardization scene
Organization of an SDO: committees organization

- Similarly, Committees adopt a hierarchical structure as well
  - Large enough committees establish sub-committees (or Working Groups) to focus on specific tasks and topics. The number of sub-committees depends on the size of the parent committee
  - Small committees may not have sub-committees (flat structure)



4.2 The standardization scene
Example: Organization of an IEC Committee



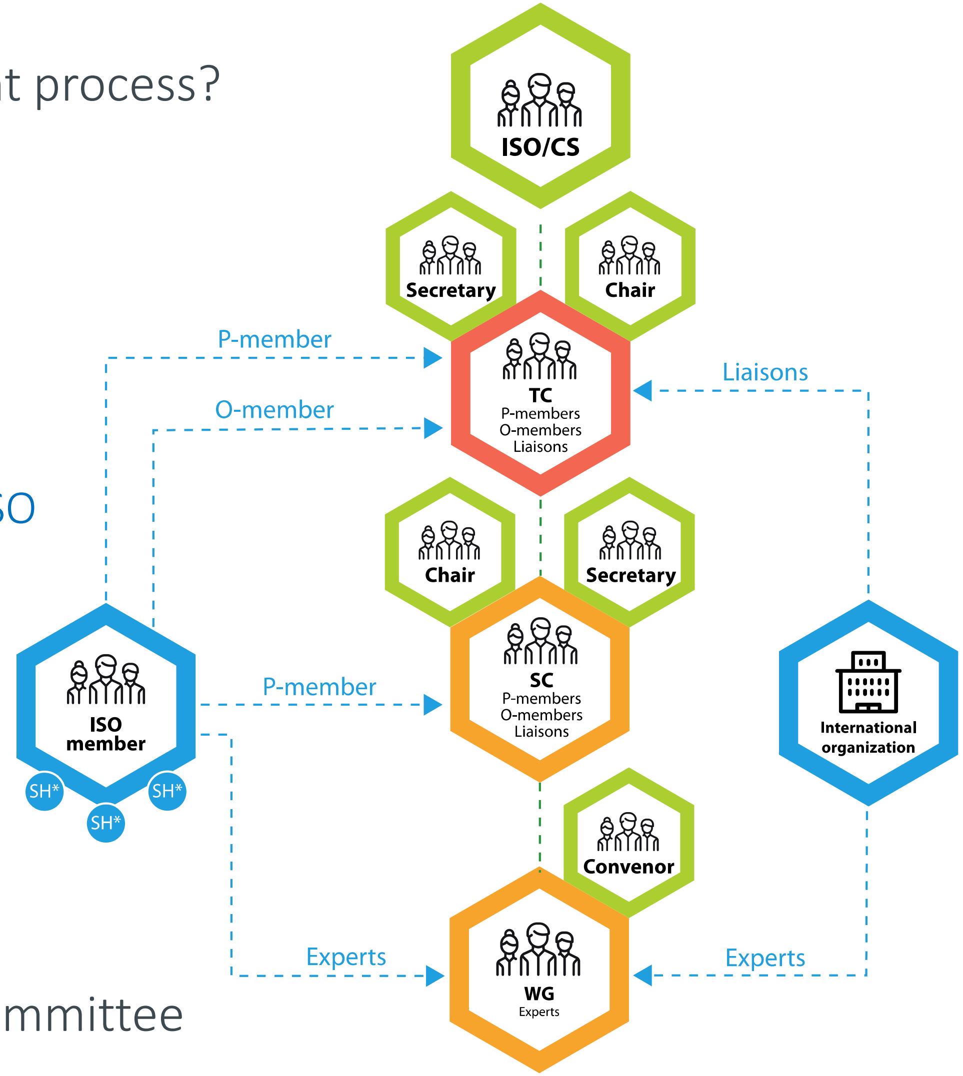
4.3 Roles and competences of the standardization expert

- Who and what is the standardization expert?
  - The *standardization expert* in a corporate organization, often in industry, national administration, research or academic organization, consumer or professional association, or as a staff member of an SDO
  - S/he is nominated to represent her/his organization in an SDO committee
  - S/he needs not be graduated as an engineer, but needs to be knowledgeable about the technical matters to be standardized
  - S/he assumes but also often coordinates most of the tasks and activities to be performed in the standardization process, with the help of the other experts and her/his company staff

4.3 Roles and competences of the standardization expert
Professionals involved in the standard development process

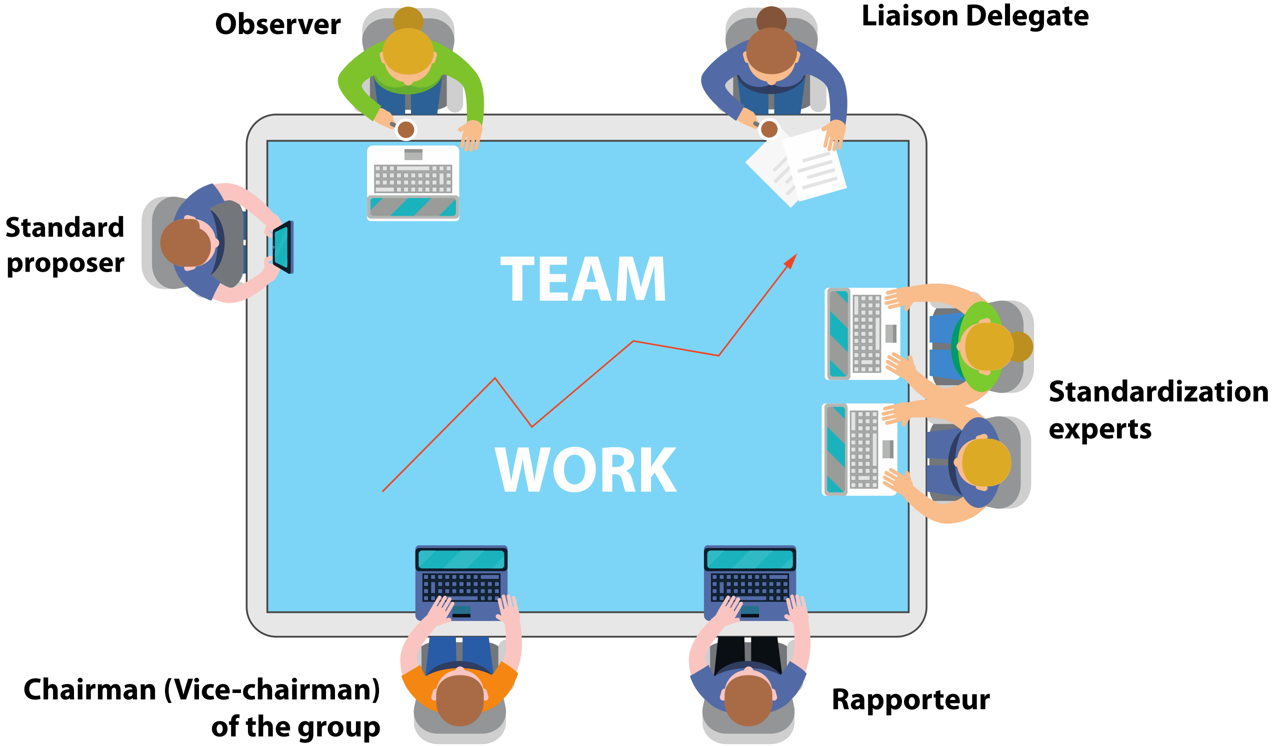
- Who are the professionals involved in the standard development process?
  - in the committee / working group
    - Chairman (vice-chairman) of the group
    - Standardization experts
    - Standard proposer
    - Rapporteur
    - Liaison representative
  - in the SDO permanent staff
    - Technical Officer
    - Final editor
- Experts are affiliated by their respective member organizations
- Tasks and responsibilities depend on the role they play in the committee

Example from ISO



4.3 Roles and competences of the standardization expert
The chairman (vice-chairman)

- Professionals involved in standard development process and their responsibilities
  - in the committee / working group



Chairman (vice-chairman)

of the group:

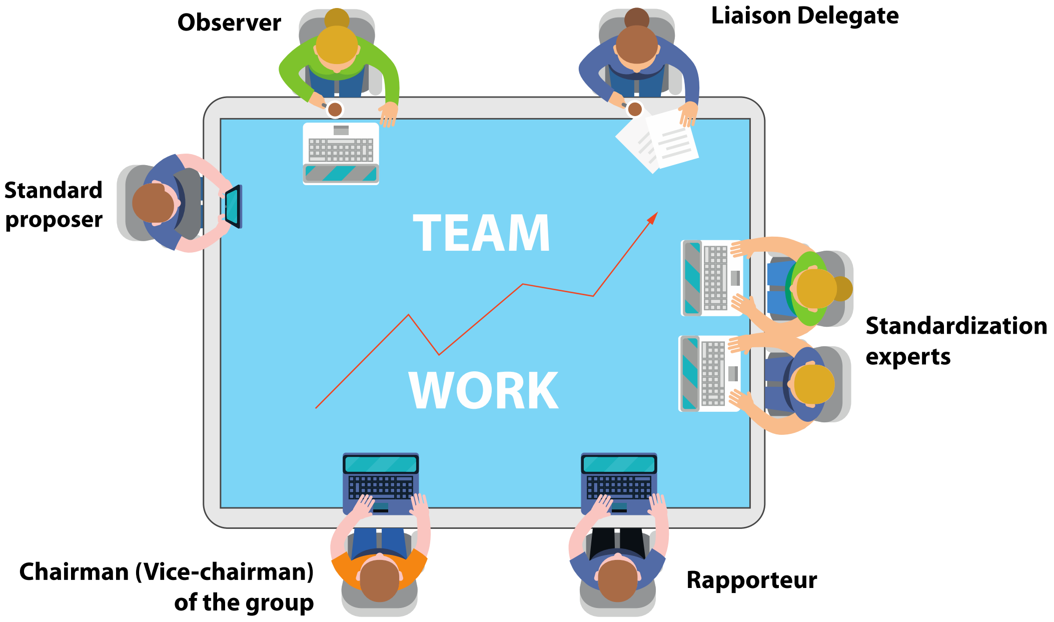
- leads the activities of the group manages the standardization meetings and takes appropriate actions and decisions
- ensures that the work programme of the SDO is realized in due time
- provides guidance to the SDO secretariat
- represents the WG at external meetings

4.3 Roles and competences of the standardization expert
The experts and liaison delegates

- Professionals involved in standard development process and their responsibilities
  - in the committee / working group

Standardization experts

- provide technical expertise and knowledge in the technology
- submit contributions and change requests
- discuss the content of the drafts and make technical decisions



Liaison delegates

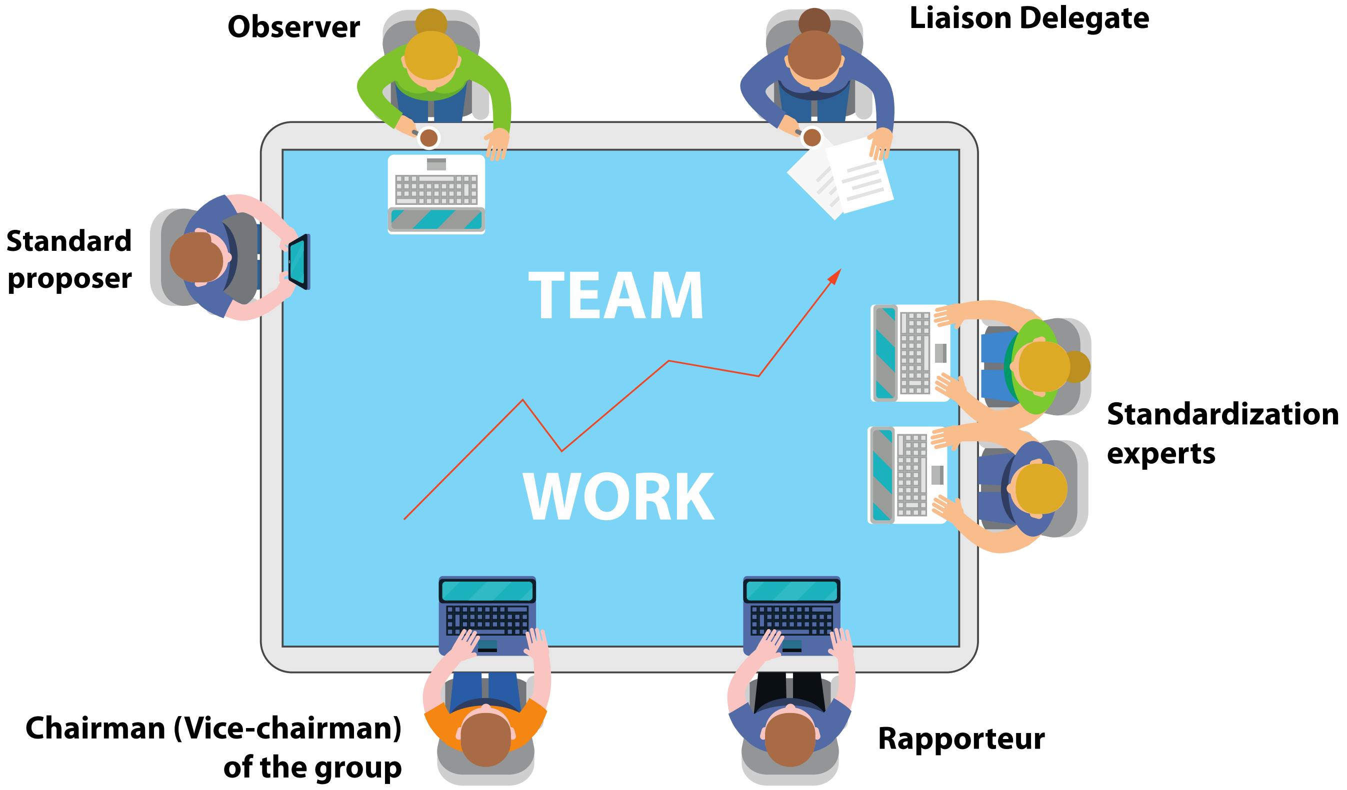
- serve as a link between two TCs or WGs
- report to each WG about the activities and standards of the other group

4.3 Roles and competences of the standardization expert
How to propose a new standard

- Professionals involved in standard development process and their responsibilities
  - in the committee / working group

Standard proposer

- detects the market need for a new standard based on the information received from her/his own organization
- submits a proposal to the committee, with the target topic and timeline and triggers the discussion during a meeting
- receives support and interest from other members

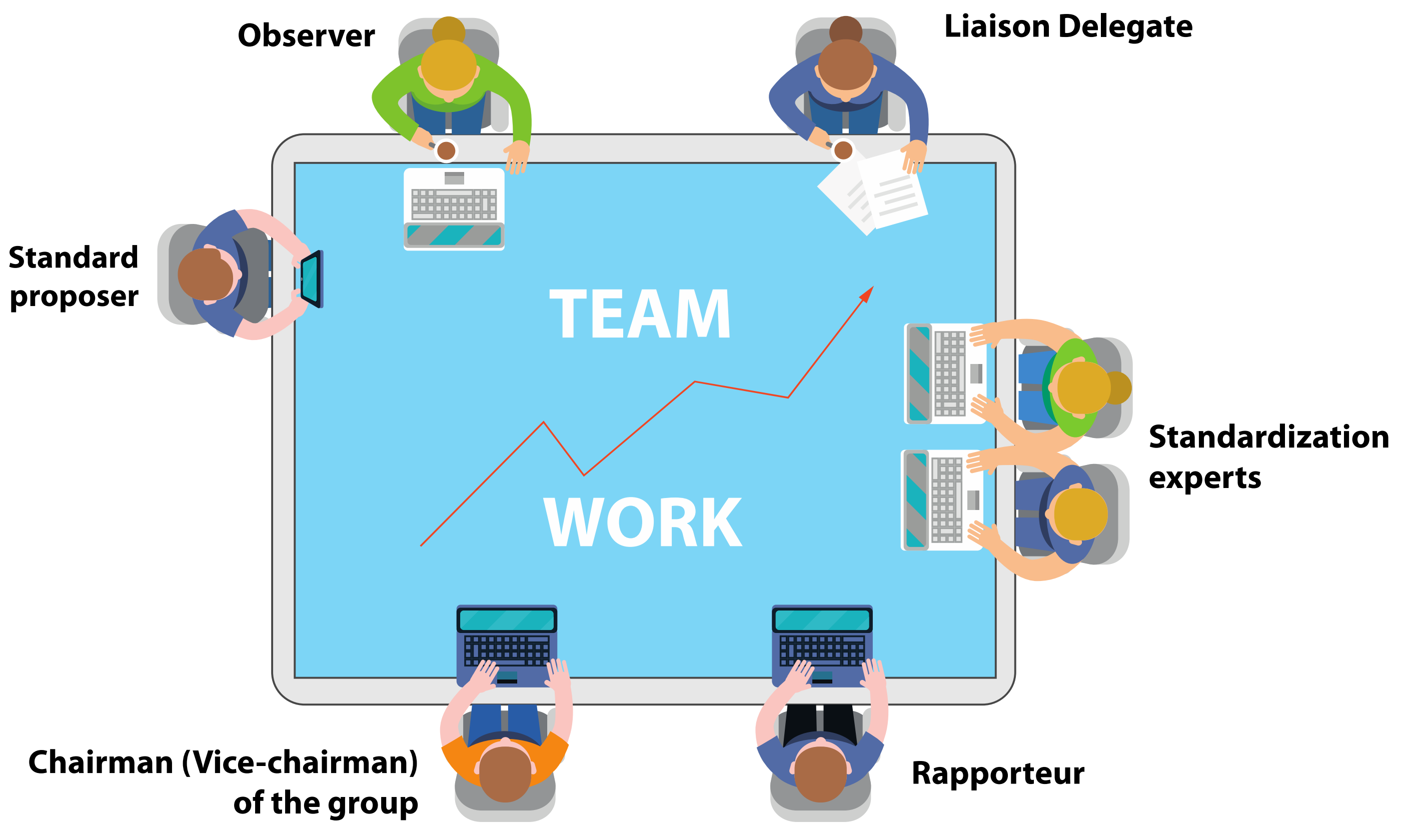


4.3 Roles and competences of the standardization expert
The rapporteur of a draft standard

- Professionals involved in standard development process and their responsibilities
  - in the committee / working group

Rapporteur

- assumes the responsibility of the standard under development
- serves as editor of the draft document
- leads drafting and comment resolution meetings
- collects contributions
- aims at obtaining consensus on the content



4.3 Roles and competences of the standardization expert
The technical officer

- Professionals involved in standard development process and their responsibilities
  - in the permanent staff of the SDO

Technical officer

- provides administrative support to the committee chairman, rapporteur and experts about the technical process, its procedure and the work programme schedule
- responds to technical queries
- organizes the approval of the standard
- enforces the compliance with the SDO standardization policies
- performs an ongoing check of the standard (editorial, project consistency …)
- works in strict impartiality and has no decision right

4.3 Roles and competences of the standardization expert
The final editor

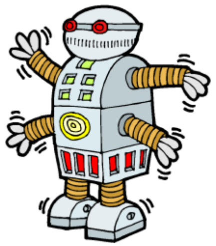
- Professionals involved in standard development process and their responsibilities
  - in the SDO secretariat

Final editor

- performs a final editorial check of the approved standard
- Corrects the text in collaboration with the authors / rapporteurs
- publishes the standard

4.3 Roles and competences of the standardization expert
Competences of the standardization expert

- Which skills the ICT professional should demonstrate and develop to be more comfortable and efficient as a standardization expert?
- A standardization expert should demonstrate a mix of
  - Hard / Technical competences
  - Soft / Personal competences



- See also (Blind and Drechsler, 2017)

4.3 Roles and competences of the standardization expert
Technical skills

- Understanding and management of technical content:

Specific hard / technical competences
Skills in mathematics, sciences and engineering (technical teams professionals)
Learning skills to follow the rapid evolution of the technology
Focus on architecture, influence the conception, development and implementation of technical innovations
Understand their 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, identifies and formulates technical problems, generalizes across problems
Can find innovative approaches to solve an issue
Design and conduct experimental proofs of concept

4.3 Roles and competences of the standardization expert
Technical skills (cont.)

- Understanding and management of ICT standardization:

Specific hard / technical competences
Experience in the field of ICT standardization
Understand the interactions and relationship between the different SDOs and their standards
Understand the international standardization strategy
Understand the process, rules and good practices applied at the SDO towards the approval of a standard
Understand the context of the committee activities
Can identify the gaps and visualize innovative trends and solutions
Can keep up with the pace of the work and not slow down the progress of the standardization work

4.3 Roles and competences of the standardization expert Technical skills (cont.)

- Understanding and management of organization strategy:

Specific hard / technical competences
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 customers / users' needs
Can commit to the organization goals

4.3 Roles and competences of the standardization expert
Personal skills

- Communication competences:

Specific soft / personal capabilities
Communicate, listen, articulate, and expose clearly 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, in other words the national official languages at national bodies, which are usually English, French or German in European and international organizations

4.3 Roles and competences of the standardization expert
Personal skills (cont.)

- Social competences:

Specific soft / personal capabilities
Cooperate easily with her/his organization teams and peer standardization experts
Persuade others with her/his own opinions and views, but at the same time, is able to listen to peer delegates 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 skills that enable to steer the group towards A satisfactory technical solution and consensus
Engender trust in her/his decisions
Coordinates the many competences in her/his business organization

4.3 Roles and competences of the standardization expert
Personal skills (cont.)

- Personal competences:

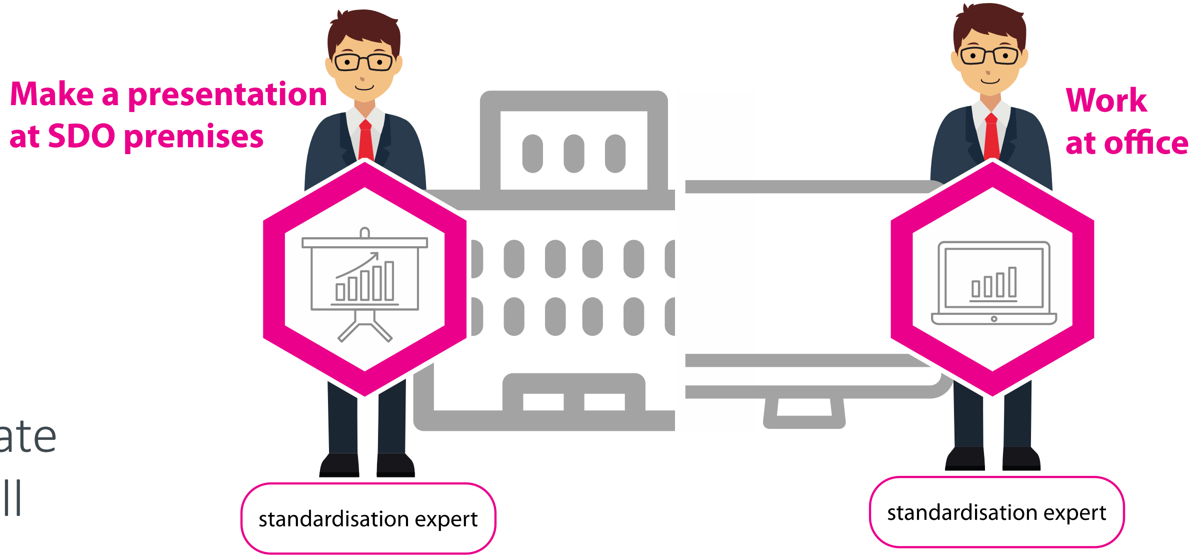
Specific soft / personal capabilities
Willing to keep learning and transfer her/his skills to peer experts
Firm when necessary and show confidence in conflict management
Flexible and able to choose, whether a compromise is acceptable
Remain open-minded when receiving criticism
Network and collaborate easily with peer delegates

- Methodology competences:

Specific soft / personal capabilities
Read a large number of documents, essentially the WG 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
Uses 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 WG participants

4.4 Activities of the standardization expert

- What are the main activities of a standardization expert?
- He is busy
  - During standardization meetings at the SDO premises: participate in standardization meetings; is active at interim times, e.g., networking breaks, …
  - Between meetings: write or review standardization documents
  - Impact and collaborate inside her/his corporate organization: relevant technical teams, as well as marketing teams and management teams



4.4 Activities of the standardization expert
As delegate at standardization meetings

- When s/he attends **standardization meetings** as **working group** member, the standardization expert
  - has prepared by reading the draft documents and contributions
  - gets involved in the discussions, while bringing in her/his own knowledge on the topics
  - participates in the decision-making process
  - as liaison officer, presents activities that are taking place at other WGs/SDOs

4.4 Activities of the standardization expert
As rapporteur at standardization meetings

- When he **attends standardization meetings** as **rapporteur** of a standard, the standardization expert
  - Presents the latest version of the draft standard
  - Presents a status report and the main ideas to be discussed
  - Collects questions, while triggering discussions
  - Proposes compromises to obtain consensus on a possible solution

4.4 Activities of the standardization expert
During networking time at standardization meetings

- During **standardization meetings breaks or networking time**, the standardization expert
  - Discusses with peers to resolve blocking issues
  - Helps fixing political deals between competing interests
  - Raises awareness about new concepts or processes to be standardized and finds supporters for triggering a new standard

4.4 Activities of the standardization expert
When back in her/his office

- When s/he is **in her/his office**,
- the standardization expert who acts as **rapporteur**
  - updates the current draft to prepare the next version
  - organizes drafting meetings where the content of the draft is discussed
  - distribute writing tasks to interested participants, collects contributions and trigger inputs from other experts
  - identifies and observes IPRs related to the topic under standardization

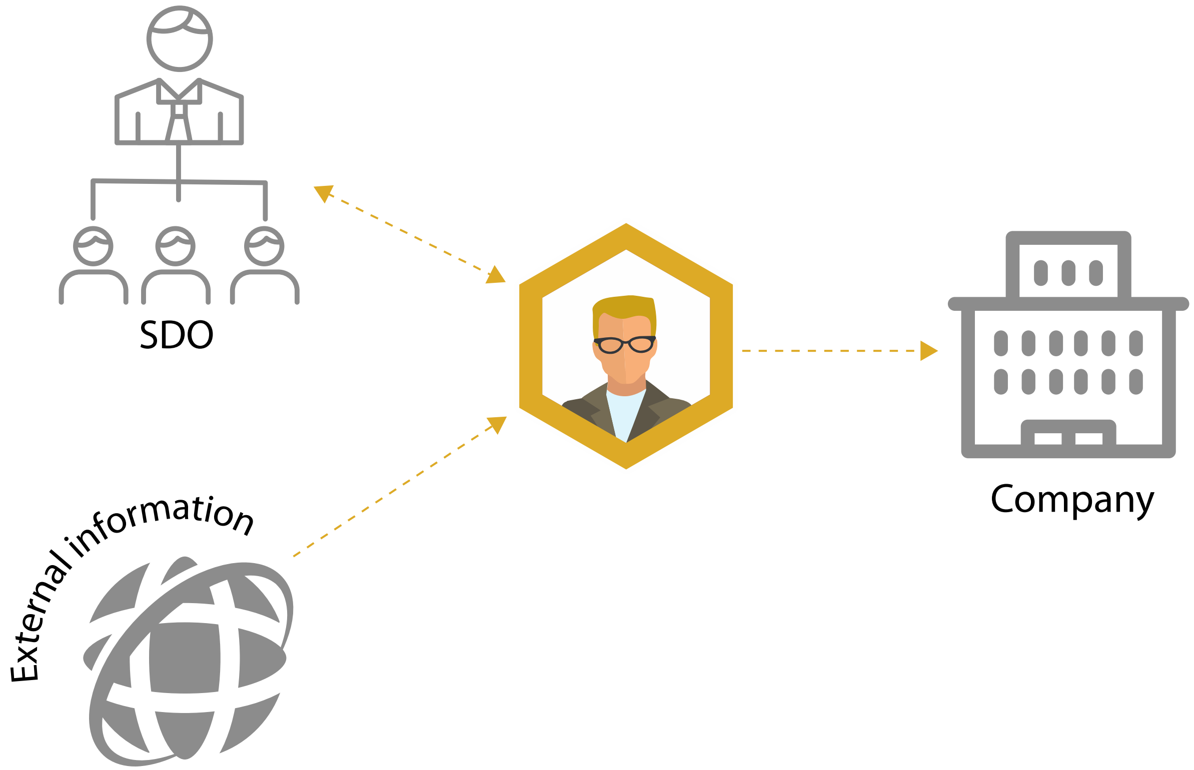
- if s/he is **not** the **rapporteur**, the standardization expert
  - prepares contributions and change requests to draft standards
  - reviews existing drafts and contributions that have been submitted to the next WG meeting
  - uses digital working tools: word processor, IM, phone, collaborative shared workspace and conference tools

4.4 Activities of the standardization expert
working with technical teams from her/his organization

- **Inside his/her company**, the standardization expert exchanges with **relevant technical teams** and
  - reports on recent standardization activities and trends, especially the latest standards approved and the liaison reports received from other SDOs
  - explains existing standards to the development teams to accelerate the product-to-market process
  - lead or participate to the definition of building prototypes that demonstrate the effectiveness of new technologies to be standardized and the correctness of the standards requirements

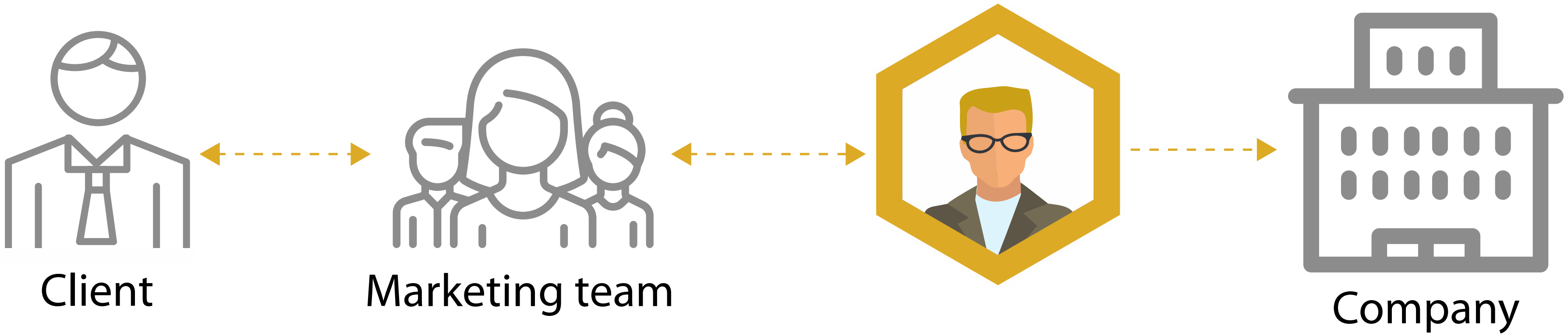
4.4 Activities of the standardization expert
working with technical teams from her/his organization (cont.)

- **Inside his/her company**, the standardization expert exchanges with **relevant technical teams** to:
  - define terminologies for a common understanding of the projects
  - contribute to the organization's knowledge management and dissemination
  - extend her/his knowledge about existing and future technologies, concepts and developments
  - try to prevent that the technical teams create proprietary solutions



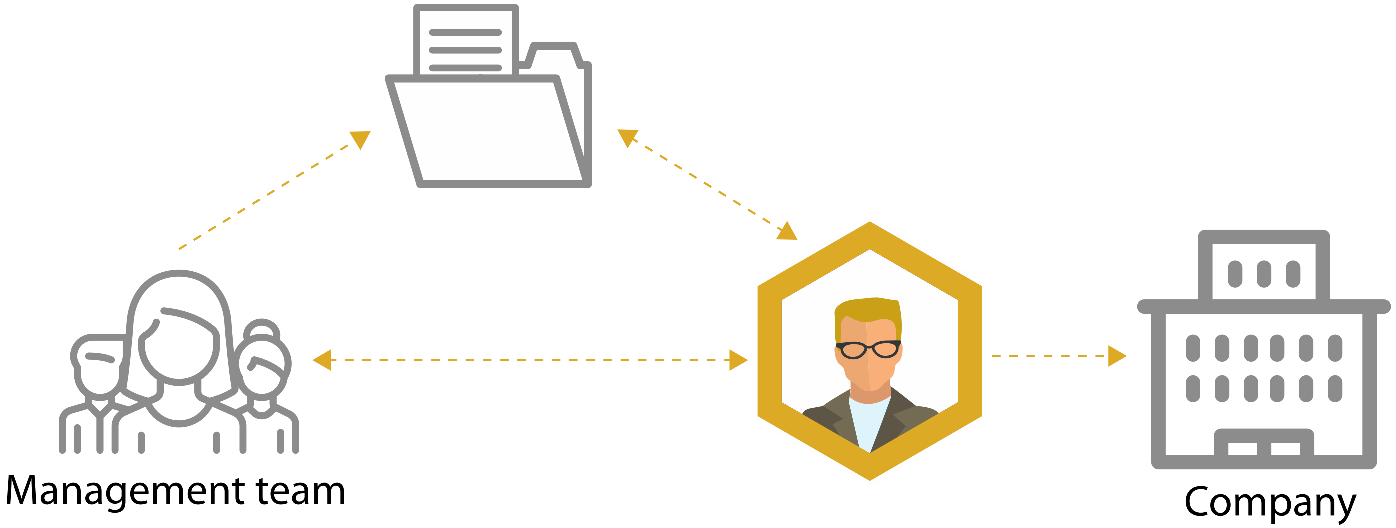
4.4 Activities of the standardization expert
working with marketing teams from her/his organization

- **Inside his/her company**, the standardization expert exchanges with **marketing teams** to:
  - define terminologies for a common understanding of the projects
  - contribute to the organization's knowledge management and dissemination
  - extend her/his knowledge about existing and future technologies, concepts and developments
  - try to prevent that the technical teams create proprietary solutions



4.4 Activities of the standardization expert
working with marketing teams from her/his organization

- **Inside his/her company**, the standardization expert exchanges with the **management team**, together with the technical and marketing teams to
  - understand the company's strategy with respect to its standard portfolio
  - analyse which SDO memberships are of interest
  - analyse how to organize and maintain the contributions to the company's standard portfolio



4.4 Activities of the standardization expert
As a national delegate

- When the standardization expert is a **national delegate**, s/he performs the following additional duties:
  - represent the point of view of her/his country in the standardization group
  - trigger at national level the adoption, promotion and dissemination of international or regional (for example European) standards and the withdrawal of national conflicting standards
  - organize meetings of national stakeholders to collect their positions
  - facilitate and coordinate the local involvement in the standards by all types of national actors: providers, academia, societal stakeholders and national authorities

List of abbreviations: Chapter 4

- CCC: Car Connectivity Consortium
- CEPT: Conférence Européenne des Postes et des Télécommunications
- ETSI: European Telecommunication Standards Institute
- EU: European Union
- GSC: Global Standards Collaboration
- HEN: Harmonized European Norms
- ICT: Information and Communication Technology
- IEEE: Institute of Electrical and Electronics Engineers
- IESG: Internet Engineering Steering Group
- IM: Instant Messaging
- ITS: Intelligent Transport System
- OJEU: Official Journal of the European Union
- PAS: Publicly Available Specifications
- RFC: Request for Comments
- SDO: Standards Developing Organization
- TC: Technical Committee
- WG: Working Group
- WI: Work Item

List of abbreviations: Chapter 4

- 3GPP: Third Generation Partnership Project
- CEN: Comité Européen de Normalization (European Committee for Standardization)
- CENELEC: European Committee for Electrotechnical Standardization
- ESO: European Standards Organization
- FTP: File Transfer Protocol
- GSC: Global Standards Collaboration
- ETSI: European Telecommunication Standards Institute
- HL7: Health Level Seven
- IAB: Internet Architecture Board
- IANA: Internet Assigned Numbers Authority
- IASA :IETF Administrative Support Activity
- ICT :Information and Communication Technology
- IEC :International Electrotechnical Commission
- IEEE :Institute of Electrical and Electronics Engineers
- IESG: Internet Engineering Steering Group
- IETF: Internet Engineering Task Force
- IM: Instant Messaging
- IPR: Intellectual Property Rights
- IRTF: Internet Research Task Force
- IRSG: Internet Research Steering Group
- ISO: International Organization for Standardization
- ISO/CS: ISO Central Secretariat
- ISOC: Internet Society
- ITU-T: International Telecommunication Union - Telecommunication Sector
- RFC: Request for Comments
- SC: Sub-Committee
- SDO: Standards Developing Organization
- TC :Technical Committee
- TR: Technical Report
- WG: Working Group

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5 Standardization and Innovation

Contents

5.1 Interdependencies standardization and innovation
Introduction to innovation

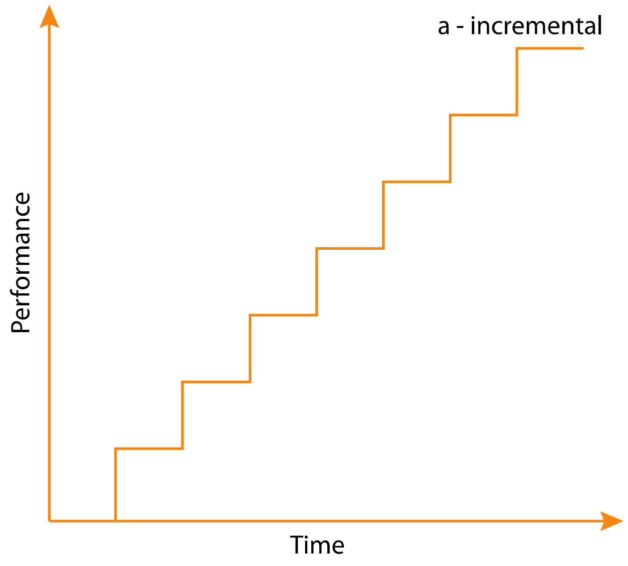
- Innovation defined by Schumpeter (1934):

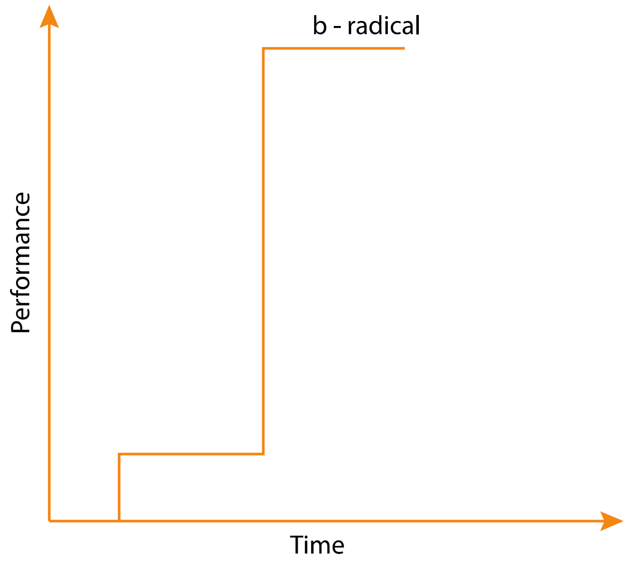
> *"The commercialization of all new combinations based upon the application of new materials and components, the introduction of new processes, the opening of new markets, and/or the introduction of new organizational forms."*

- Innovation is more than an invention: It includes the commercialization of the invention!
- Innovation may concern materials, processes, products/services, components, markets, and/or organizational forms

5.1 Interdependencies standardization and innovation
Introduction to innovation

- Degree of novelty and value-added:
  - **Incremental:** Minor improvements of existing technology (evolutionary)
  - **Radical:** Totally new technology (revolutionary)





5.1 Interdependencies standardization and innovation
Introduction to innovation

- Types of innovation (depending on novelty level):
  - New-to-the-Firm: Adoption of an existing technology that is new to the company
  - New-to-the-Market: Known technologies that are being transferred into a new market
  - New-to-the-World: Ground-breaking innovations (global level)
  - Disruptive: New technology eventually displacing established competitors (Bower and Christensen 1996)
    - Even the adoption of an existing technology is understood as innovation activity. The ability of companies to accommodate existing innovation is called absorption capacity (Cohen and Levinthal 1990).

Source: OECD (2005)

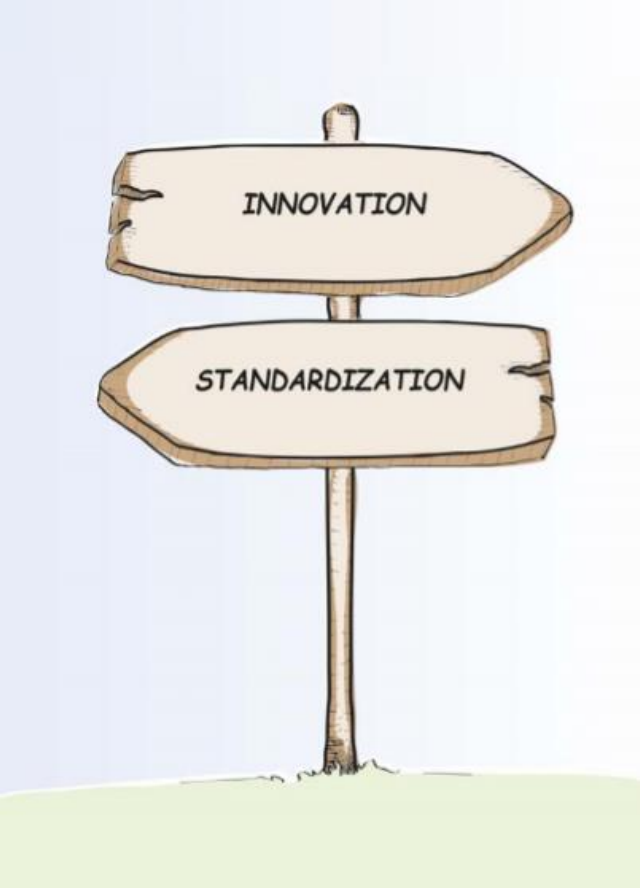
5.1 Interdependencies standardization and innovation
Traditional view of standardization and innovation

Source: Perera (2010)

- **Standardization:** Keeping things the same
- **Innovation:** Development of new things

"Standardization and innovation give the impression of being opposites."
Perera (2010)

Standards are "the flux between freedom and order".
David (1995)



5.1 Interdependencies standardization and innovation
New perspective on standardization and innovation

Source: De Vries (2006), p. 40

- Standards have been perceived as **innovation-hampering:**
  - Standards contain solutions that are intended to be used repeatedly
  - This is often perceived as “static” as the solution seems to be “frozen” during a certain period of time
  - Only when there is the necessity to develop another solution, the old one makes place for the new one
- But Standards can also **promote innovation**:
  - They allow an early market uptake and achievement of critical mass (→ agreed upon best practice)
  - Standards ensure compatibility allowing for innovation to take place based on other innovations
  - Standards allow technology transfer and facilitate research
  - …

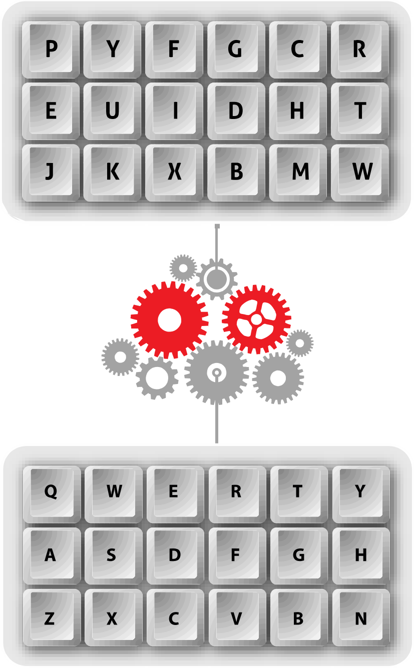
5.1 Interdependencies standardization and innovation
Example: QWERTY vs. DVORAK keyboard

Source: De Vries (2006), p. 40

- Innovation-hampering:

  Lock-in in the old technology:

  - High costs of replacing the hardware everywhere
  - Switching costs (education costs) incurred by users when learning how to work with a new standard
  - Penguin effect: New standard would only be attractive if others would use it (typists & keyboard manufacturers) - so everyone is waiting for the other to go for the new technology

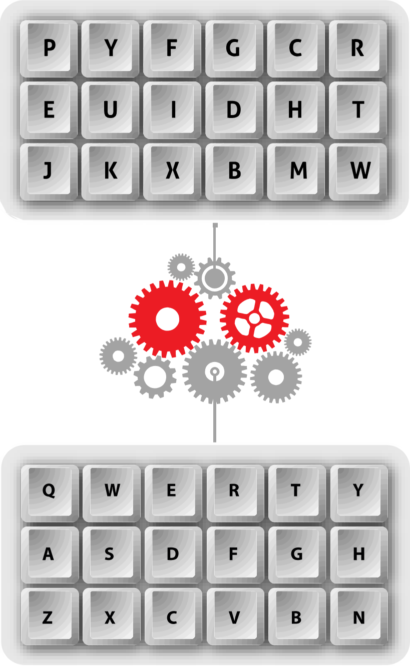


- Developed in the 1879s to slow down the speed of typist in order to make the keys less likely to jam
- Design based on the frequency of use of the letters of the alphabet since the typewrite is replaced by electronic devices QWERTY no longer makes sense
- Still the superior DVORAK design with improved ergonomics could not establish itself in the market

5.1 Interdependencies standardization and innovation
Example: QWERTY vs. DVORAK keyboard

Source: De Vries (2006), p. 40

- Innovation-fostering:
  - QWERTY is only the standard for the interface between human and machine: The machine itself has been innovated from mechanic to electronic based on the standard
  - QWERTY is used world-wide and enables suppliers (hardware, software and education) to benefit from economies of scales: This way the invention had a greater chance to become an innovation
  - An improved machine without a standard interface would not have been acceptable for the customers



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5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

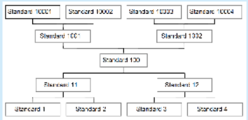
Source: Swann (2000)

- So what have we learned?
  - Certainly standardization can constrain innovation activities,
  - but standardization supports trade and subsequent innovation
- Let us move this on a higher level by using an analogy:

Optimizing the pruning and training of a tree to maximize fruitfulness

similarity

Optimizing the design of a standards system to maximize innovation-led growth



5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

- Why does a tree need pruning?
  - Remove weak, dead and damaged branches to promote healthy growth of wood
  - Thin a dense canopy on a tree to increase air and sunlight, 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: Through pruning the tree has to select a shoot and concentrates its energies into the growth of this individual shoot
  - Give the tree the form desired

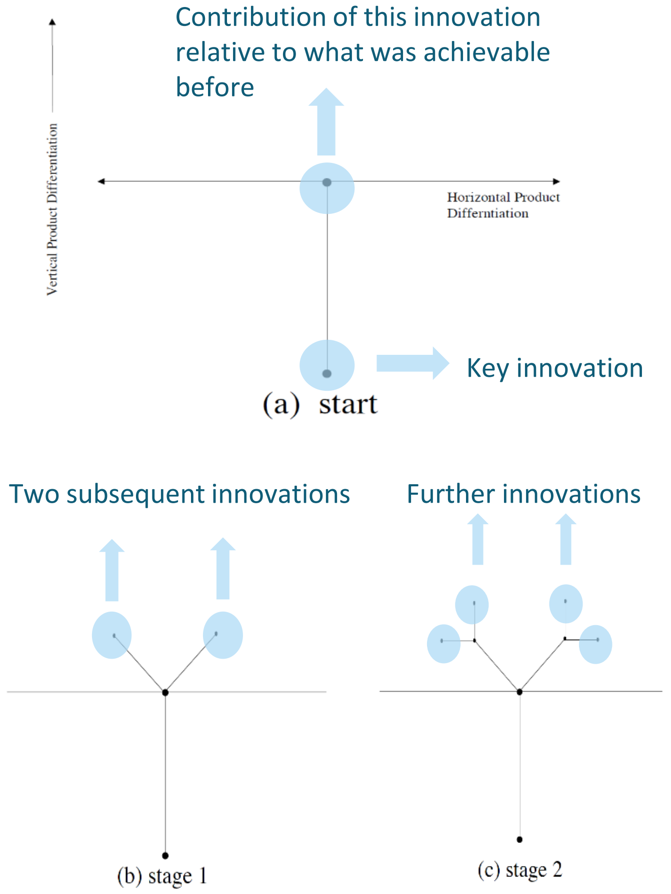
5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

- Applying this to the standards infrastructure and product/service innovation:
  - **Vertical product differentiation**: The further up the diagram, the greater the performance and/or functionality
  - **Horizontal product differentiation**: Products of different design and configuration but of roughly comparable functionality

(a) A key innovation opens up a new area of technological space

(b) Two subsequent innovations, which draw on the basic standard

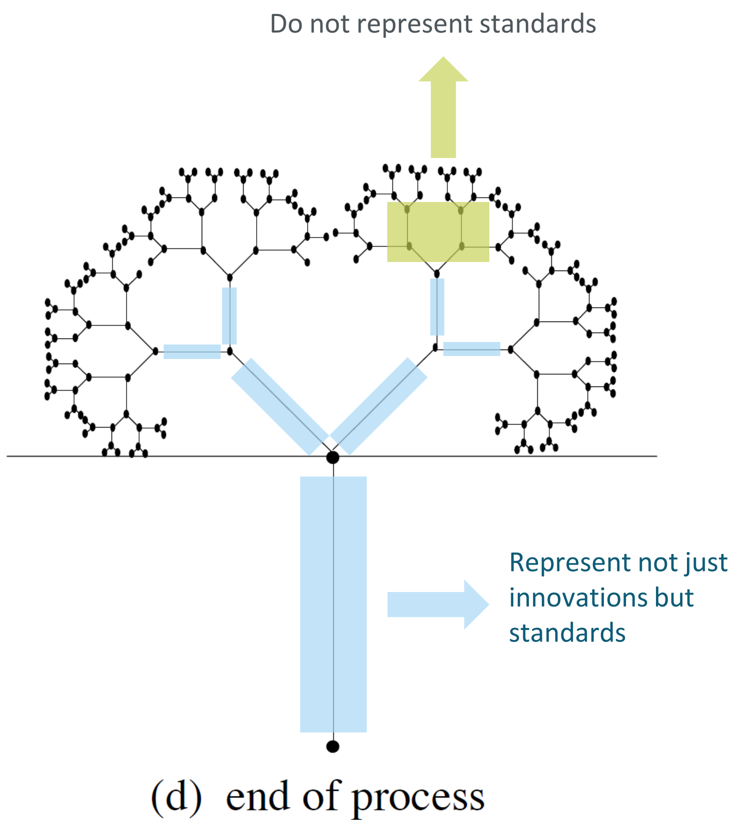
(c) Subsidiaries give rise to two further innovations



Source: Swann (2000), Abbott (1955)

5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

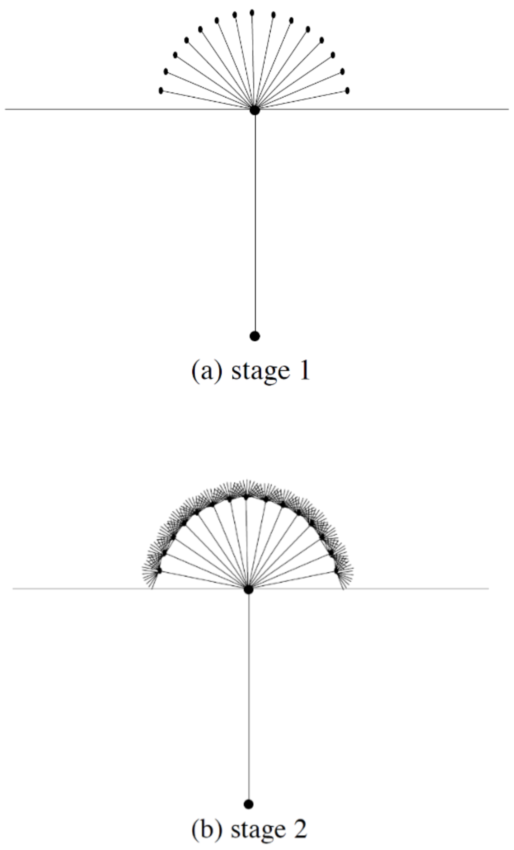
- Applying this to the standards infrastructure and product/service innovation:
  - Usual forces of product innovation/competition continue to build a “canopy” of competing products/services of different characteristics
    - Role of formal standards: Enabling and shaping this pattern of innovation
    - The closer the innovation are to a standard, the greater the confidence of consumers and producers



Source: Swann (2000)

5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

- Product/Service innovation without standardization:
  - The same process of innovation-led growth is taking place
  - Large number of slightly differentiated innovations follow different directions from the base point
  - Each stage shows a substantial amount of innovation → much duplicated effort (potential for economies of scales unused)
  - 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



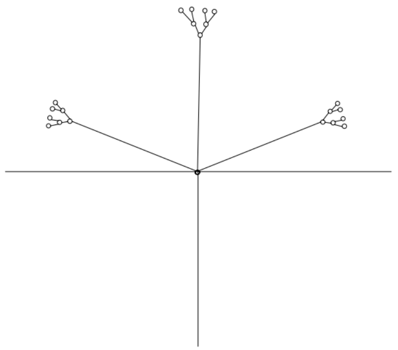
Source: Swann (2000)

5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

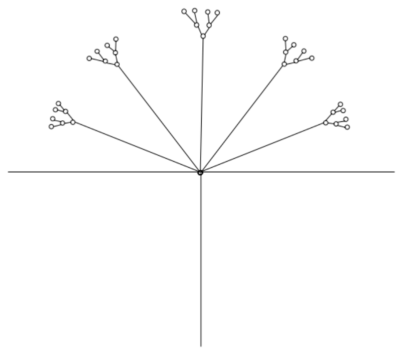
- Other mechanisms: Product innovation with patenting
  - Each major branch protected by a patent
  - Patents can open up new area of technological space, but if owner enforces property rights, no large canopy can emerge

(a) Relatively broad scope of patent protection: sparse canopy around a few major leading branches

(b) Narrow scope of patent protection: full canopy with redundancies because of proliferation of branches



(a) Broad Scope of Patent Protection

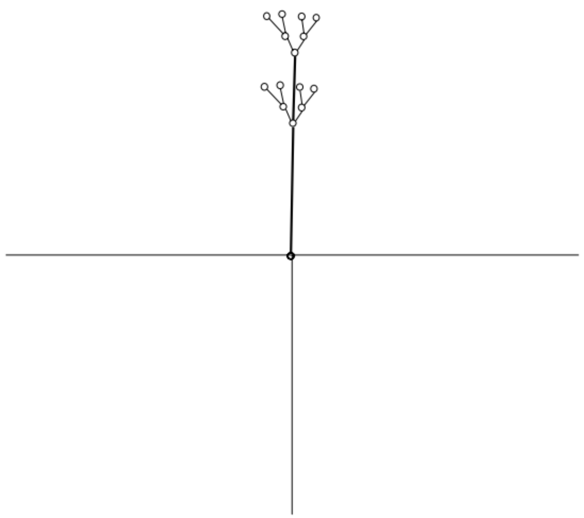


(b) Narrow Scope of Patent Protection

Source: Swann (2000)

5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

- Other mechanisms: Product innovation with a proprietary de facto standard
  - Supportive growth from other producers allowed, but only as it supports the main leading branch
  - Quality of infrastructure depends on ultimate profusion of innovations that can be built



Source: Swann (2000)

5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

- Open vs. Proprietary:
  - Best case scenario from a macro-economic perspective: Each node (e.g. key innovation) in the standards tree should be open to all competitors and not be monopolized
→ Formal standardization and all forms of open standards are an appropriate tool for this purpose (they are accessible to everybody at low costs)
  - When a standard is closed or property rights are applied over a particular node, it is not possible for a competitor to build a rival innovation using that node as a starting point

Source: Swann (2000)

5.1 Interdependencies standardization and innovation
Standards as an enabler for innovation-driven growth

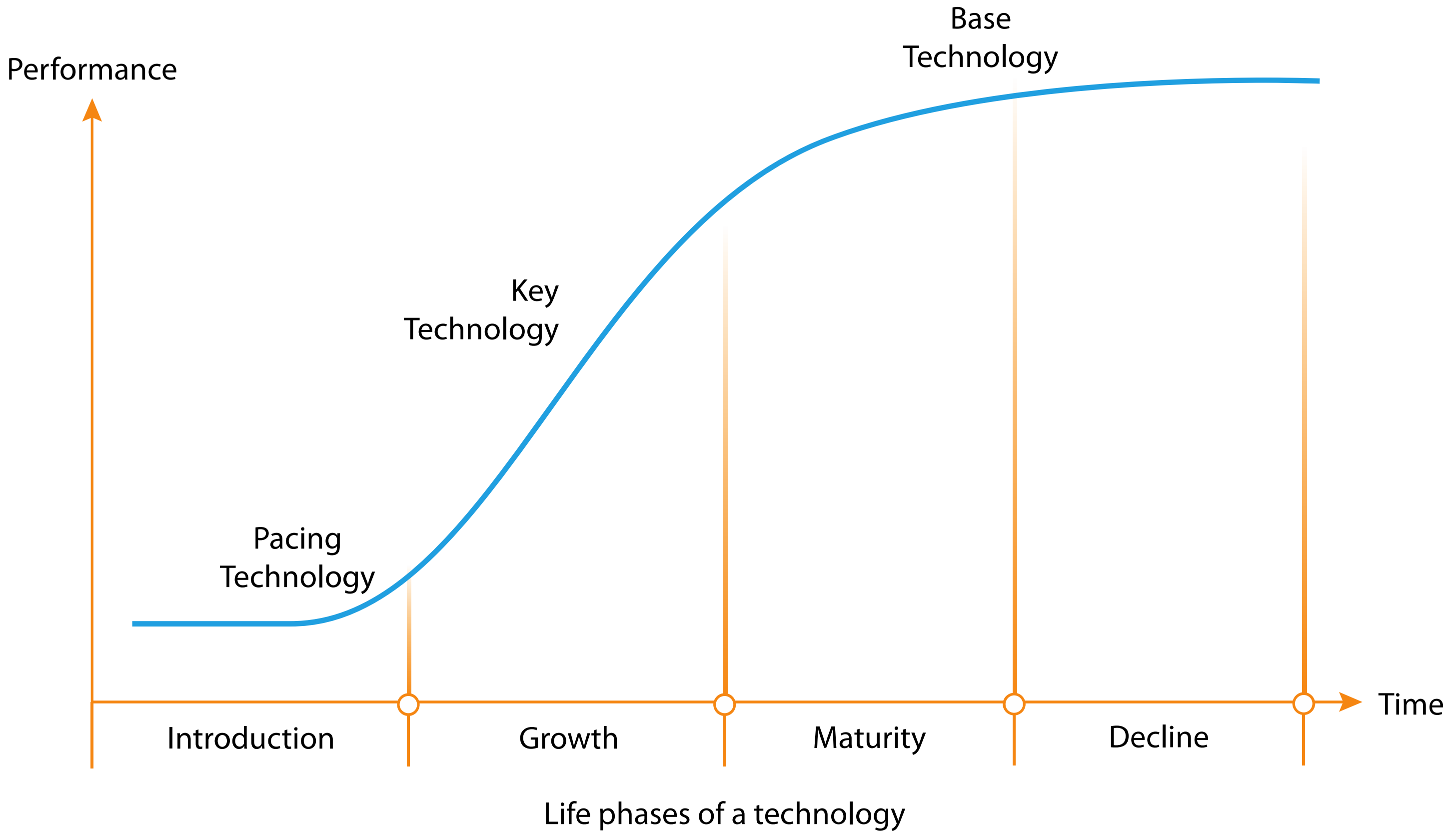
- Conclusion
  - Standardization limits variety, but it helps to develop a “strong tree”
  - Innovations help to grow the tree, but standardization stops messy proliferation by holding back subsequent messy growth

Source picture: pngall.com

Source: Swann (2000)

5.1 Interdependencies standardization and innovation
Standardization and the Technology Life Cycle

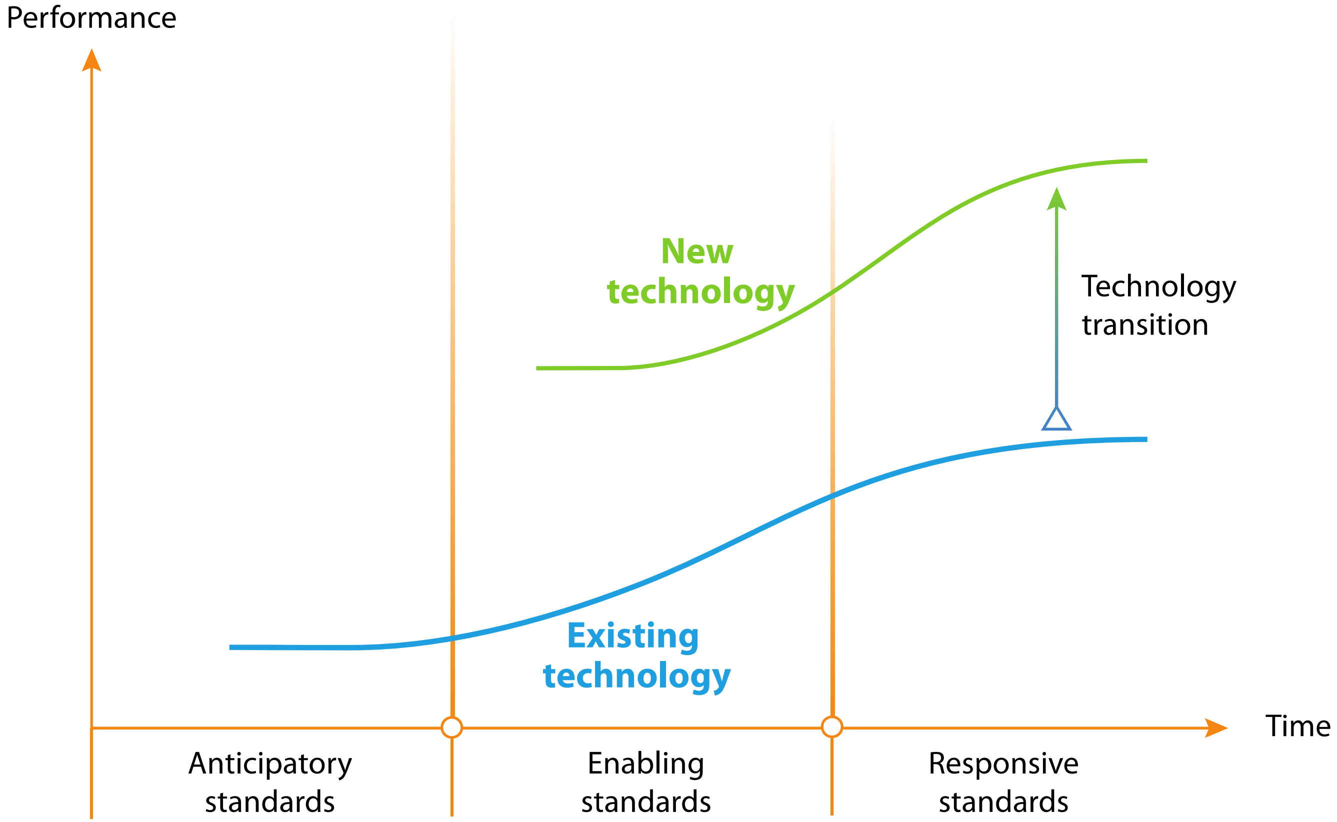
- Describes the level of commercial return and improvement in technological performance, depending on the investments in R&D
- Different phases:
  - Introduction
  - Growth
  - Maturity
  - Decline



Source: Translated from Brockhoff (1999)

5.1 Interdependencies standardization and innovation
Standardization and the Technology Life Cycle

- Standards can be related to the Technology Life Cycle
- Three types of standards are worth introducing:
  - Anticipatory
  - Enabling
  - Responsive



Source: Sherif et al. (2005)

5.1 Interdependencies standardization and innovation
Anticipatory standards

- Anticipatory standards are "forward-looking" answers to expected interoperability problems; They are indispensable for successful network systems.
- The Specification of anticipatory standards runs in parallel to the development of prototypes, pilots, 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 collaboration with other competitors are high
- Examples: X.25, ISDN, SSL, Bluetooth, UMTS etc.

Source: Sherif et al. (2005)

5.1 Interdependencies standardization and innovation
Enabling standards

- Enabling standards proceed in parallel with market growth and improvement of technology and products to enhance the agreed-upon design by extending robustness and scale.
- Competitive forces and the need to reduce production costs influence the direction, in which the standard will develop
- Enabling standards support the diffusion of technical knowledge and prevent market fragmentation
- Examples: V.90 client modem

Note: Large standards are typically a mixture of anticipatory and enabling standards

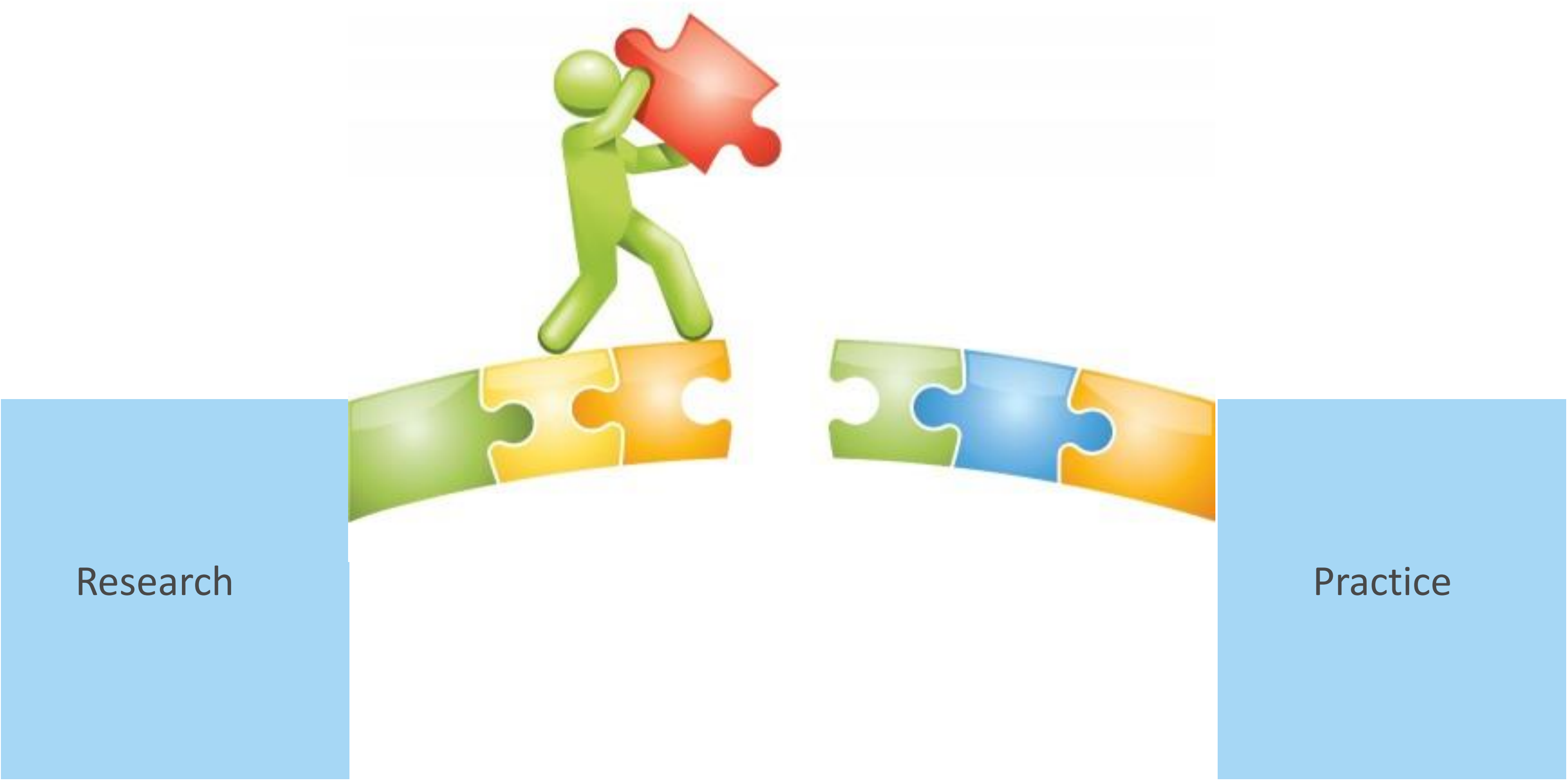
Source: Egyedi and Sherif (2008)

5.1 Interdependencies standardization and innovation
Responsive standards

- Responsive standards are created at the end of technology development
- Internal responsive standards are defined right after the dominant design has stabilized to codify best practices
- External responsive standards improve efficiencies or reduce market uncertainties for auxiliary products/services
- They may be called “business standards”, as they contribute to achieving maximum returns associated with an already established technology
- Example: 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

Source: Egyedi and Sherif (2008)

5.2 Research and standardization
Bridging the gap between research and practice



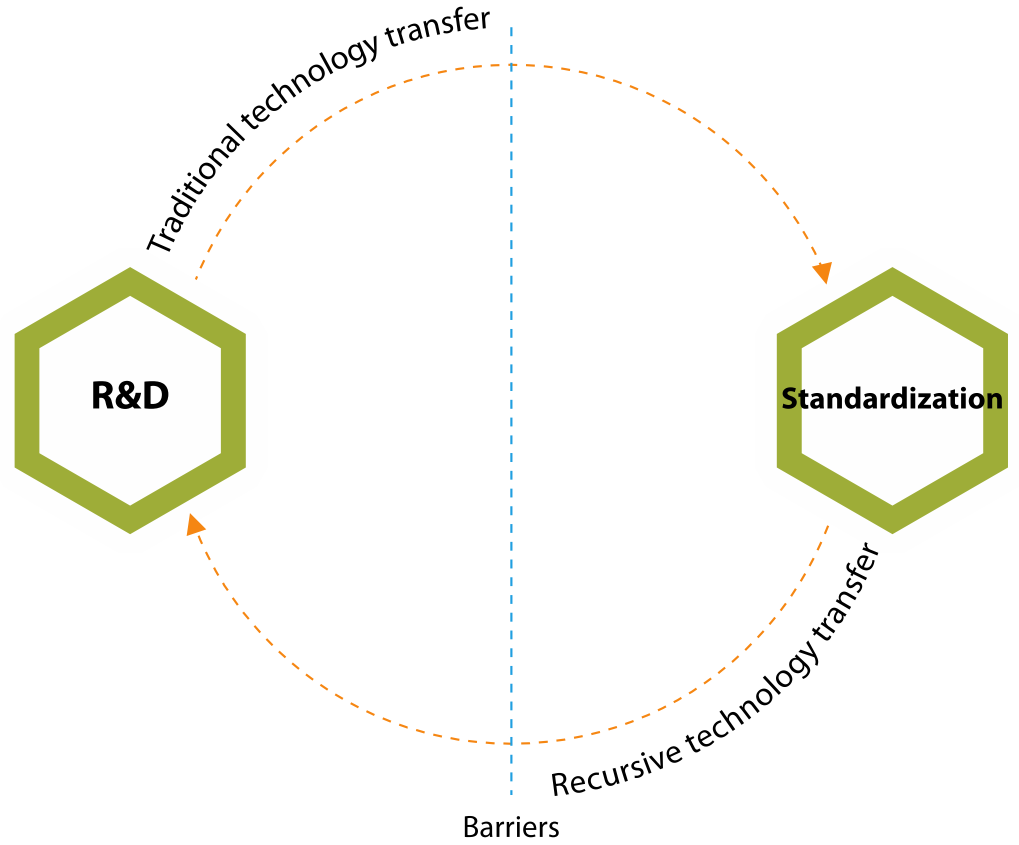
5.2 Research and standardization
Importance of integrating research results in standards

- Bridging the gap between research and practice by integrating new research/technologies into standards:
  - Companies that build upon these standards absorb the latest knowledge. This mechanism supports the transfer of research results into innovative products/services
  - Standards also support these companies in opening up new markets. Agreed upon best practices foster trust and security on the market
- Maximum economic efficiency: Public funded R&D results become public goods through standards.
- Standards, in contrast to patents, are more likely to be broadly implemented because all interested stakeholders that participated in the standardization process have reached consensus.

Source: Perera (2010)

5.2 Research and standardization
Traditional vs. recursive research exploitation

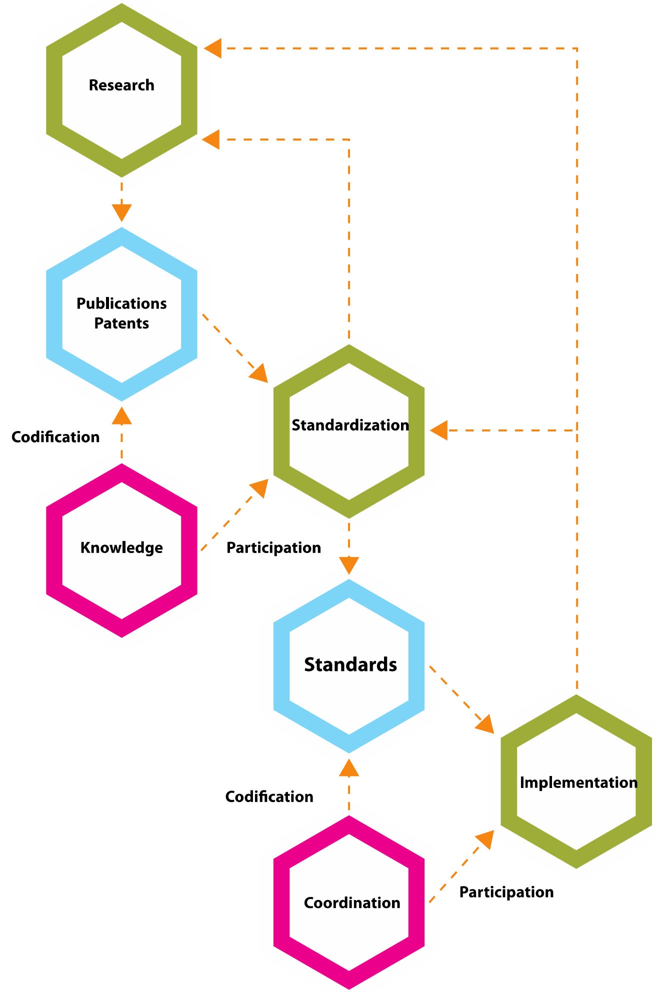
- Research produces knowledge that flows into standards (traditional technology transfer)
- Maximum economic efficiency: Public funded R&D results become public goods through standards.
  - There is a recursive knowledge flow from standardization back to research. This prevents the reinvention of the wheel and stimulates ideas for new research projects.



Source: Blind (2013)

5.2 Research and standardization
Traditional vs. recursive research exploitation

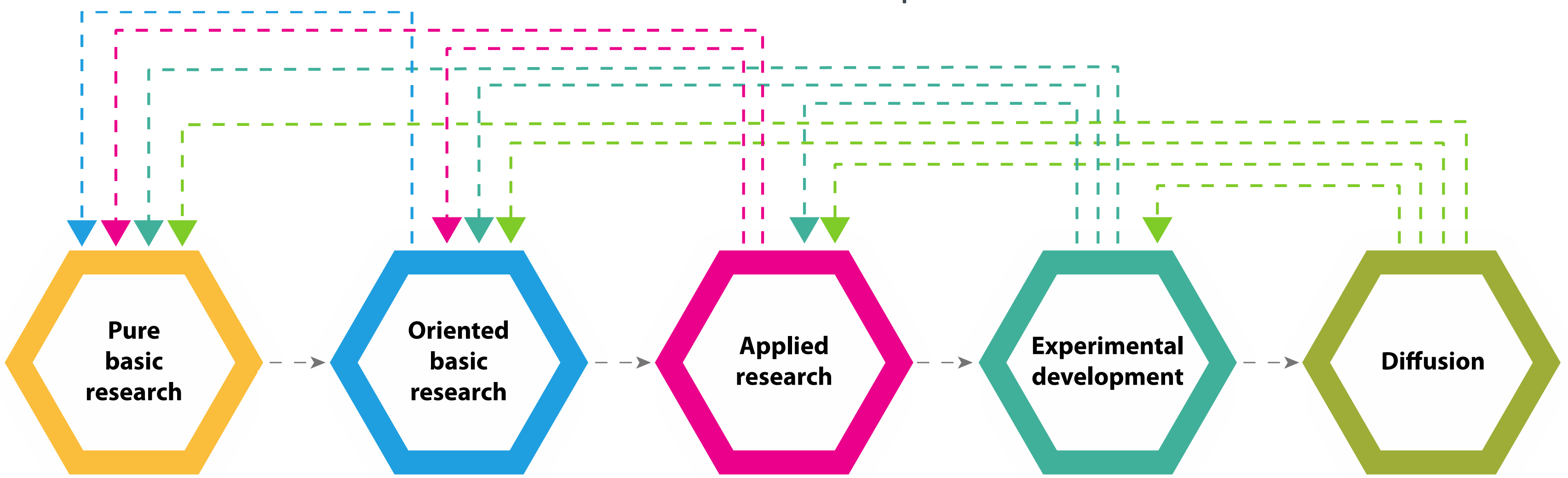
- Research produces knowledge that flows into standards (traditional technology transfer)
  - Common platform for actors with heterogeneous backgrounds (e.g. research, industry, government, Non-Profit-Organizations (NPOs), consumers)
  - Codification of knowledge and exchange of tacit knowledge
  - Integration of inputs from heterogeneous sources (e.g. knowledge from implementers of technologies and consumers)



Source: Blind and Gauch (2009)

5.2 Research and standardization
The research and innovation process

- Different phases of the research and innovation process:



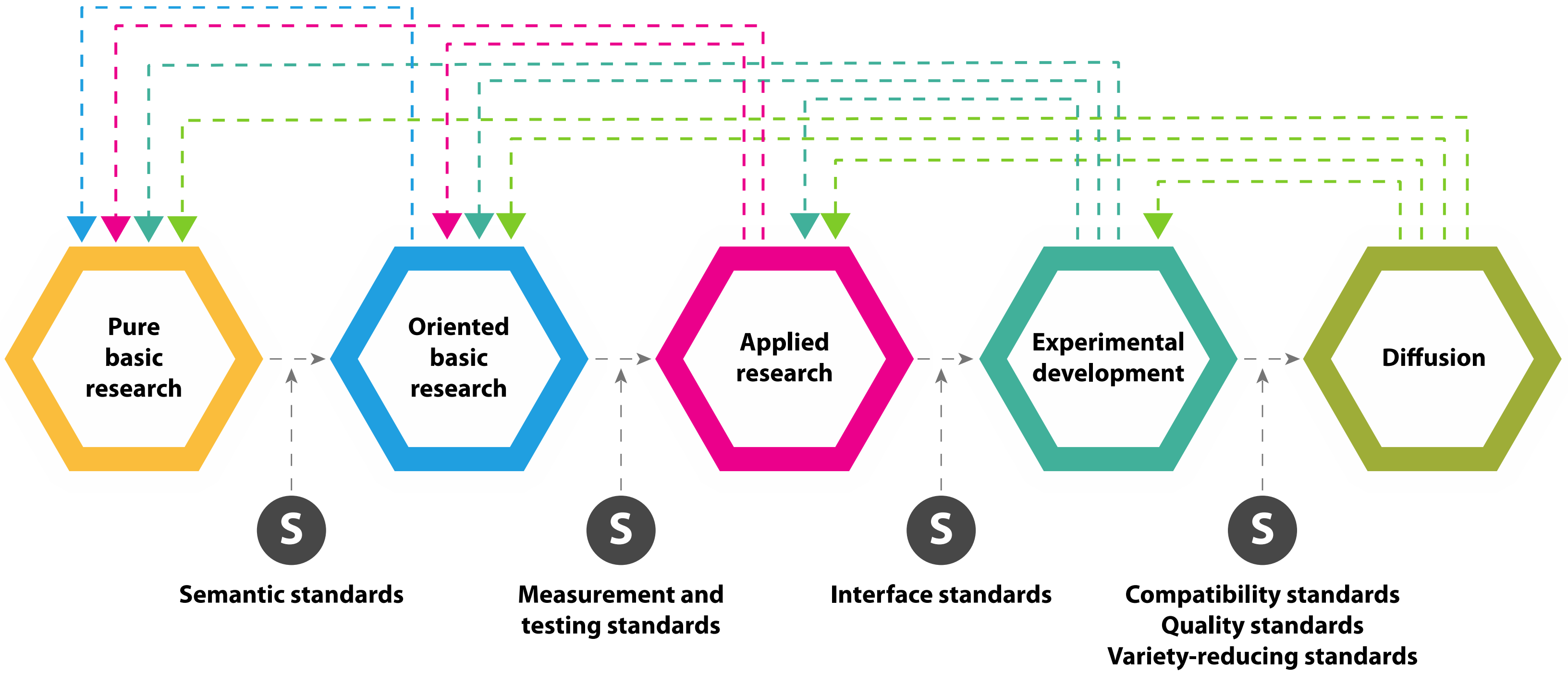
Pure basic research	Oriented basic research	Applied research	Experimental development	Diffusion
Experimental or theoretical work to acquire new knowledge of the underlying foundations	Research carried out with the expectation to produce a base of knowledge likely to form the background to the solution of current or future problems	Original investigation towards an aim or objective; Involves the practical application of science	Systematic work using knowledge gained from research and practical experience and producing additional knowledge directed to producing new products	Spread of innovations from first implementation to different consumers, countries, regions, sectors, markets and firms

Source: Blind and Gauch (2009)

5.2 Research and standardization
The interface between research and standardization: a model

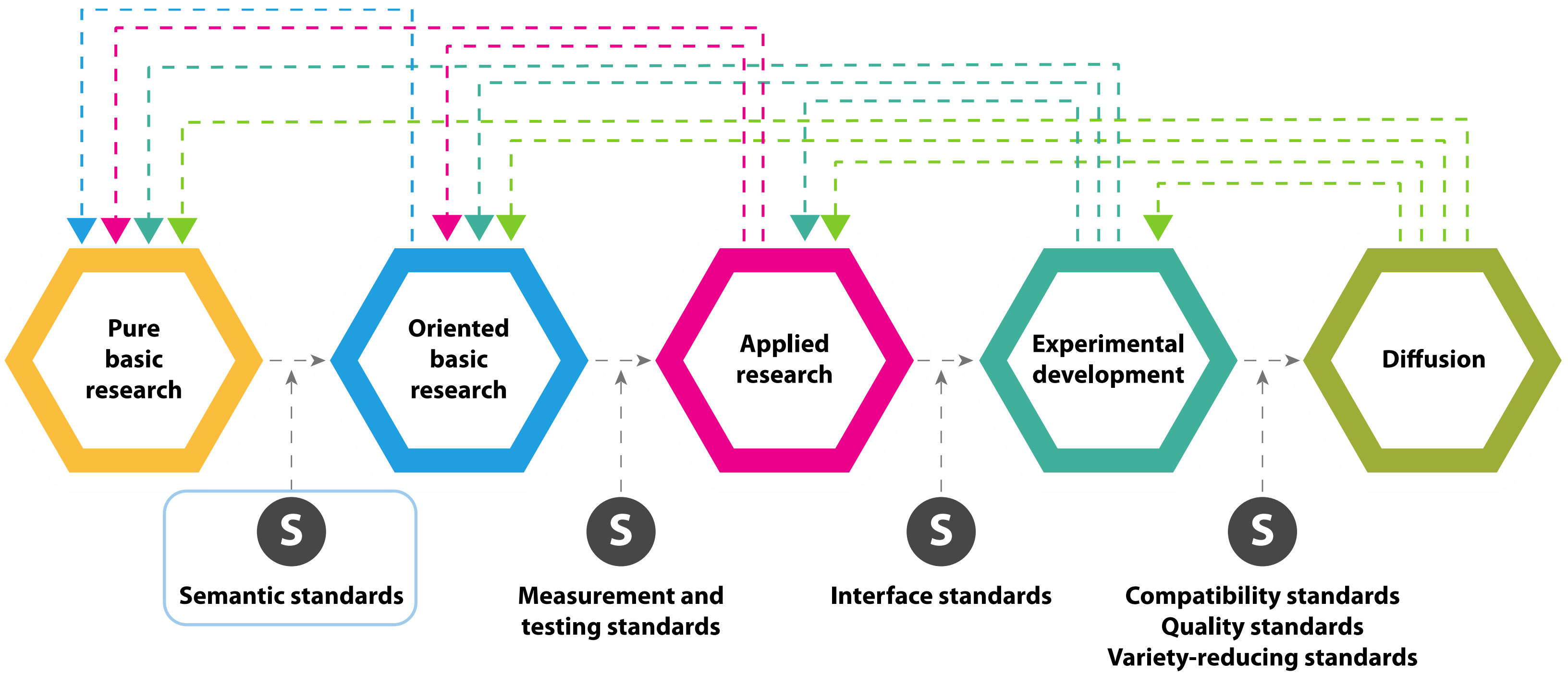
Source: Blind and Gauch (2009)

- Conceptual model of the role of different types of standards in the innovation process:



Function of Standards			
	Reduction of information cost Reduction of transaction cost	Interoperability between components Savings in adaption cost	Increased quality Reduced health, safety, privacy risks Building critical mass Economies of scale Creation of network externalities Interoperability between products

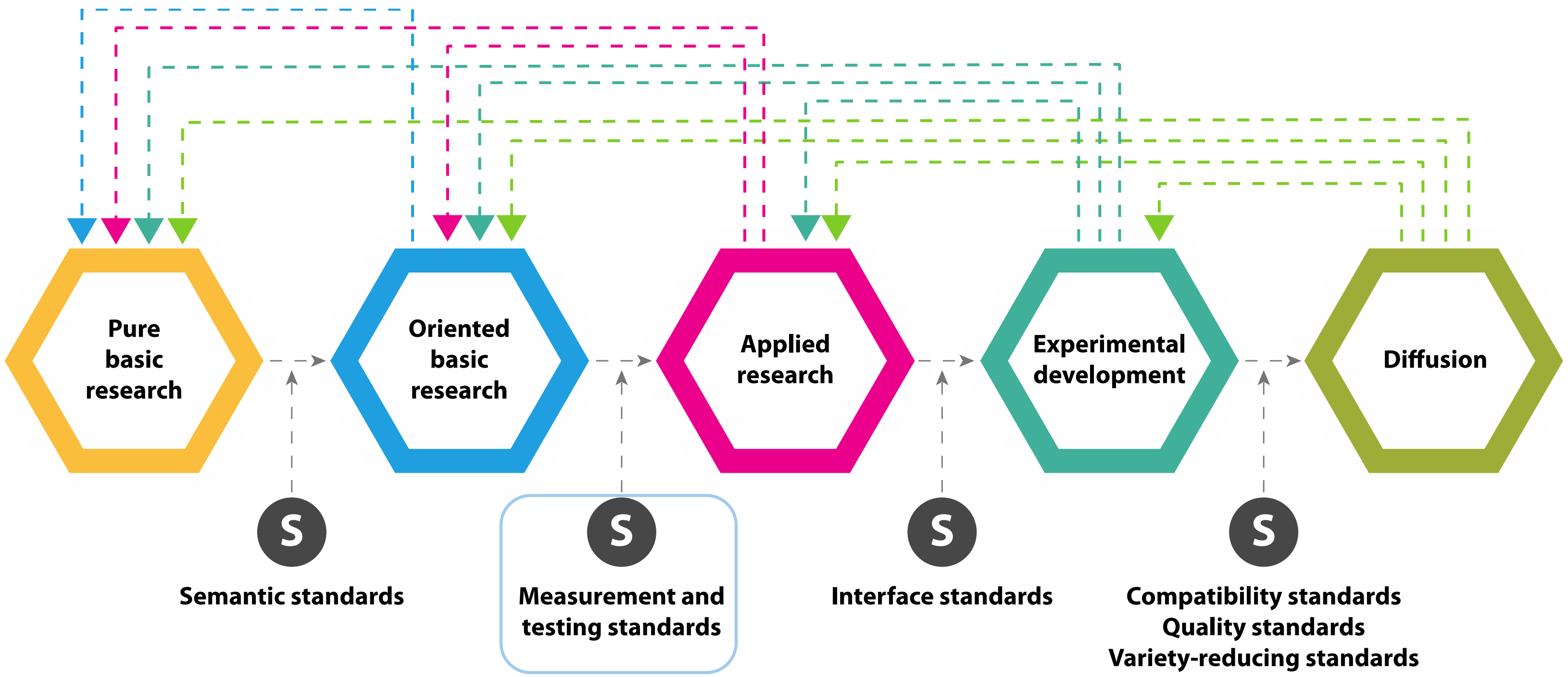
5.2 Research and standardization
The interface between research and standardization: a model



Terminology standards…
- …allow or facilitate efficient communication
- …are required in basic research as well as in the transfer of knowledge to oriented basic research and all following research activities

Source: Blind and Gauch (2009)

5.2 Research and standardization
The interface between research and standardization: a model

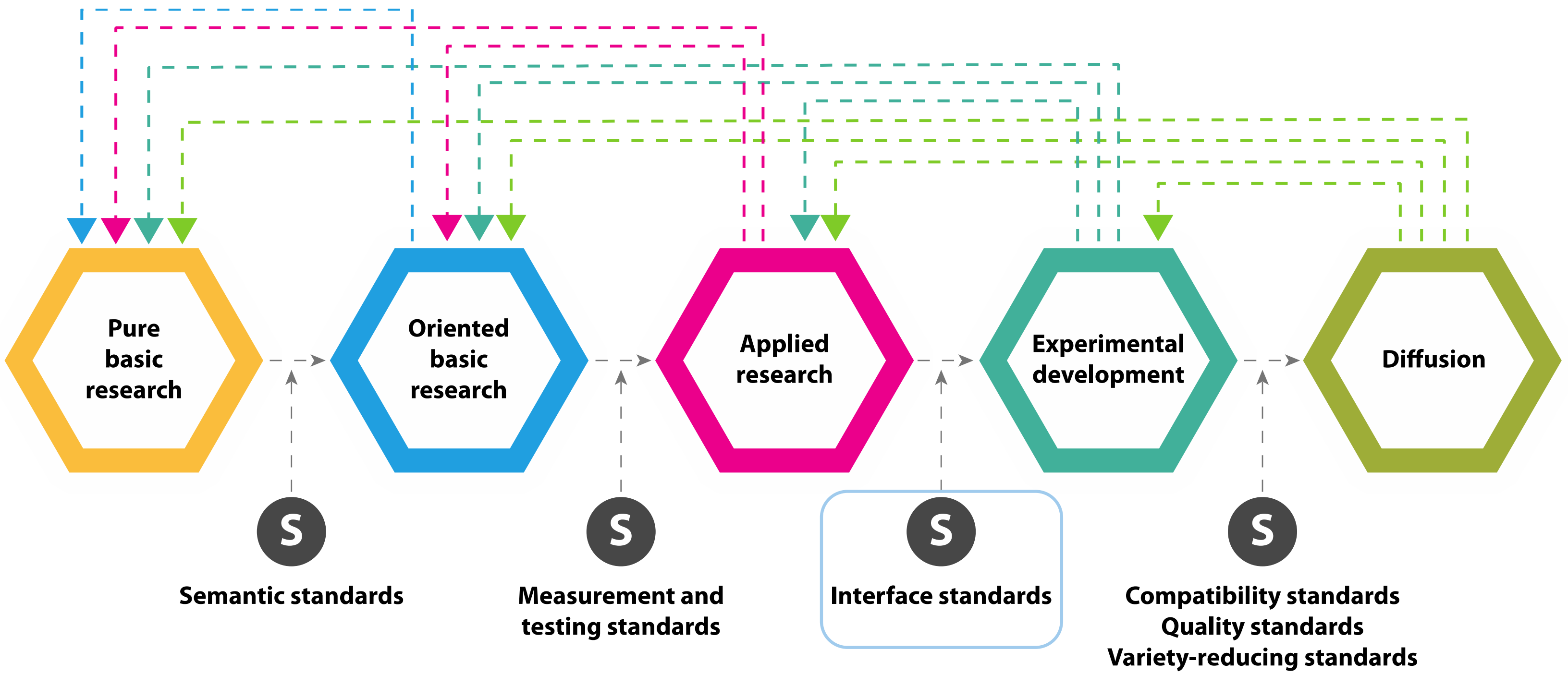


Measurement and testing standards…

- …allow first activities towards product-related developments
- …enable one to check, whether specific requirements have been met (e.g. performance criteria)
- …ensure the comparability of the results through agreed upon test methods

Source: Blind and Gauch (2009)

5.2 Research and standardization
The interface between research and standardization: a model

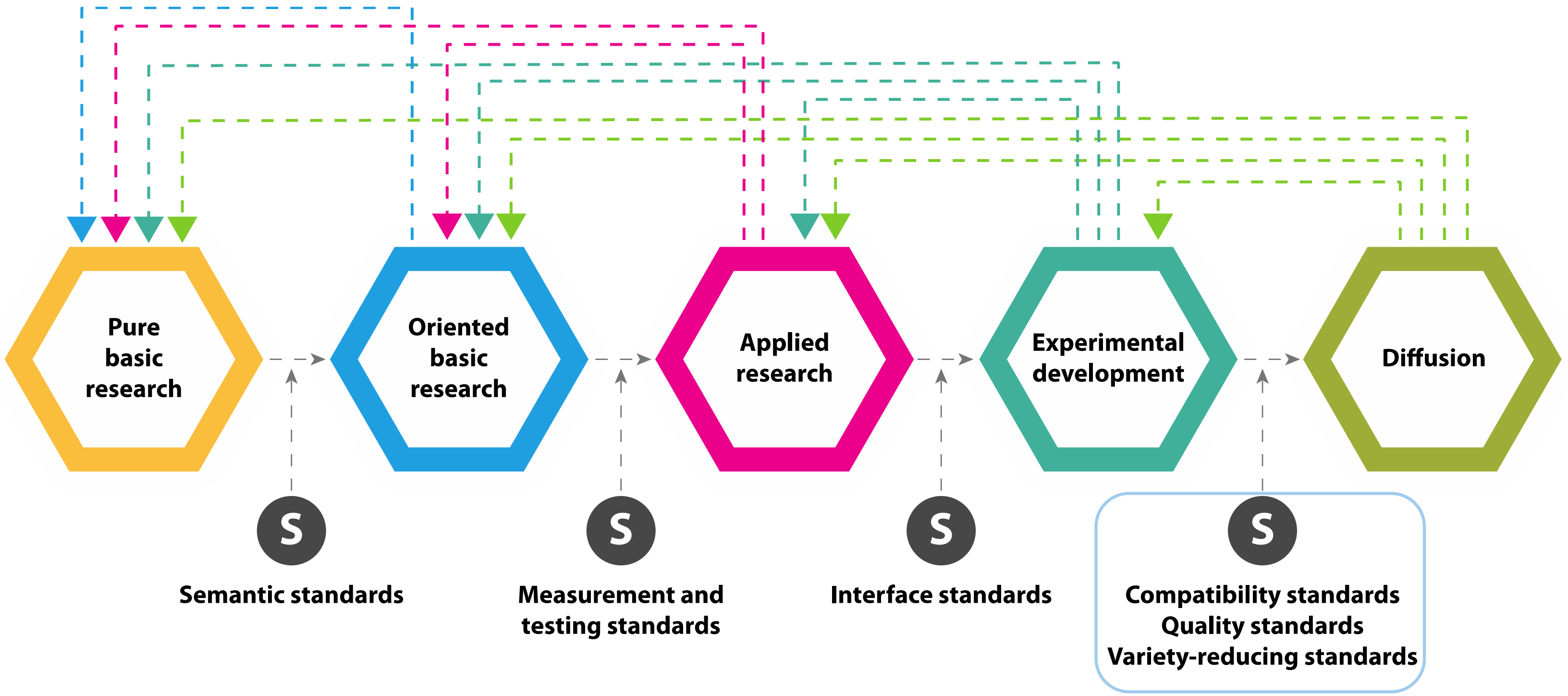


Interface standards…

- …allow interoperability of components integrated into products or process technology.

Source: Blind and Gauch (2009)

5.2 Research and standardization
The interface between research and standardization: a model



Compatibility, quality and variety-reducing standards…
- **…support the transition of products into mass markets**

Source: Blind and Gauch (2009)

5.2 Research and standardization
The interface between research and standardization: a model

- Conclusion:
  - Different standards can play different roles at several stages of the research and innovation process.
  - Standardization and research are highly interlinked.

Note: The boundaries between the different steps in the research and innovation process are not clear-cut
→ the figure displays a simplified image of the real world

5.2 Research and standardization
Example: MP3 patent included into ISO (formal) standard

- Research within the Digital Audio Broadcast (DAB) project at University of Erlangen, Germany
- First patent applications filed in 1987 based on the results of the project
- Also 1987: Fraunhofer Institute for Integrated Circuits IIS (Nuremberg, Germany) started audio encoding research within the DAB project
- Standardization committee MPEG (Motion Pictures Expert Group) founded in 1989; Included members like Sony, Phillips and EMI
  MPEG-1-Layer3 released as MP3 published in 1992
- MP3 as a standard format for MP3 player

Success of MP3 standard:

- Sale of more than 100 million MP3-players and more than €100 million license revenues for the Fraunhofer society

Source: Blind (2009)

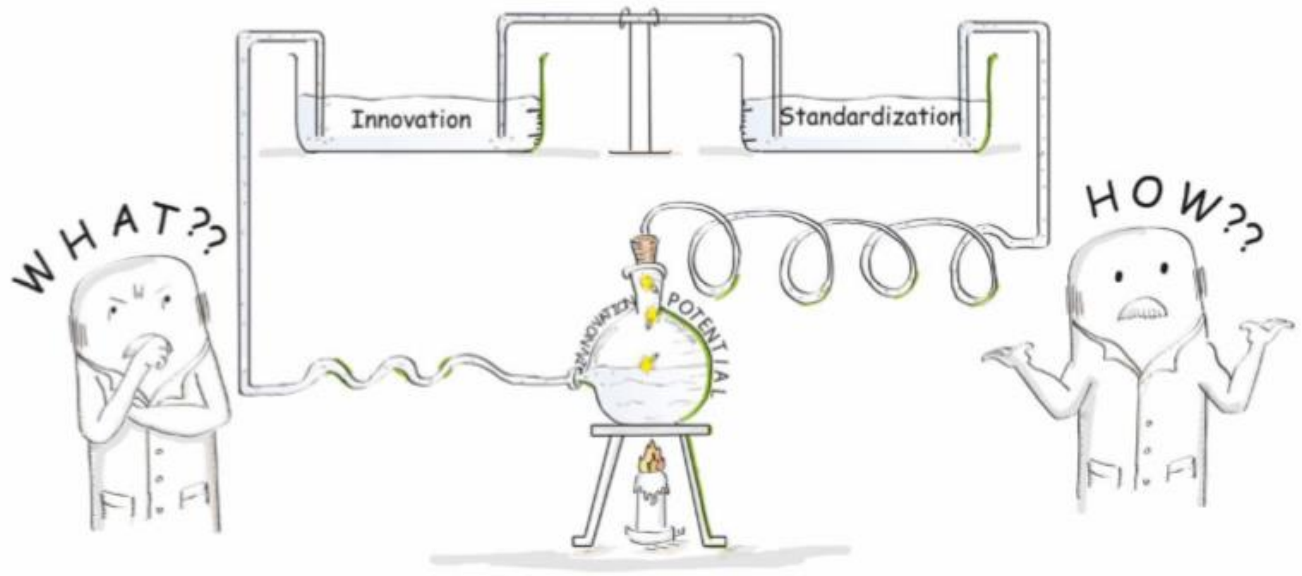
5.2 Research and standardization
Current situation in research

- Critical aspects
  - Currently there is still little awareness of the benefits of standards and standardization among researchers.
  - Broad accessibility of standards (in contrast to scientific publications and patents) allows free-riding and has resulted in too few incentives for researchers to engage in standardization.
  - Standardization communities often do not acknowledge that expertise from researchers is relevant for the standardization process.
  - Time consuming standardization processes may cause delay in the transfer process.
- Note that...
  - Patenting processes take often longer than the average standardization process of three years!

Source: Blind (2009 and 2013)

5.3 Formal standardization: A driver for innovation
An introduction

"[…] standardization is an essential part of the microeconomic infrastructure: it enables innovation and acts as a barrier to undesirable outcomes." Swann (2010), p.9



5.3 Formal standardization: A driver for innovation
The support of innovation through standardization

- Innovation potentials in standardization

	Opportunities for the support of innovation through standards and standardization	
	Invention-Support...	**Exploitation-Support...**
...through standards	• Exceeding the requirements of standards • Efficient and target-oriented innovation • Stimulating innovation through update of standards and new standards	• Business model innovation (e.g. laboratories)
...through the standardization process	• Stimulating innovation from participation in standardization process (ideas/insight from costumers, competitors and other stakeholders)	• Innovation communication • Absorption of innovation during standardization process

Source: Abdelkafi and Makhotin (2014), p.46

5.3 Formal standardization: A driver for innovation
The support of innovation through standardization

- Innovation potentials in standardization

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Source: Abdelkafi and Makhotin (2014), p.46

5.3 Formal standardization: A driver for innovation
Efficient and target-oriented innovation

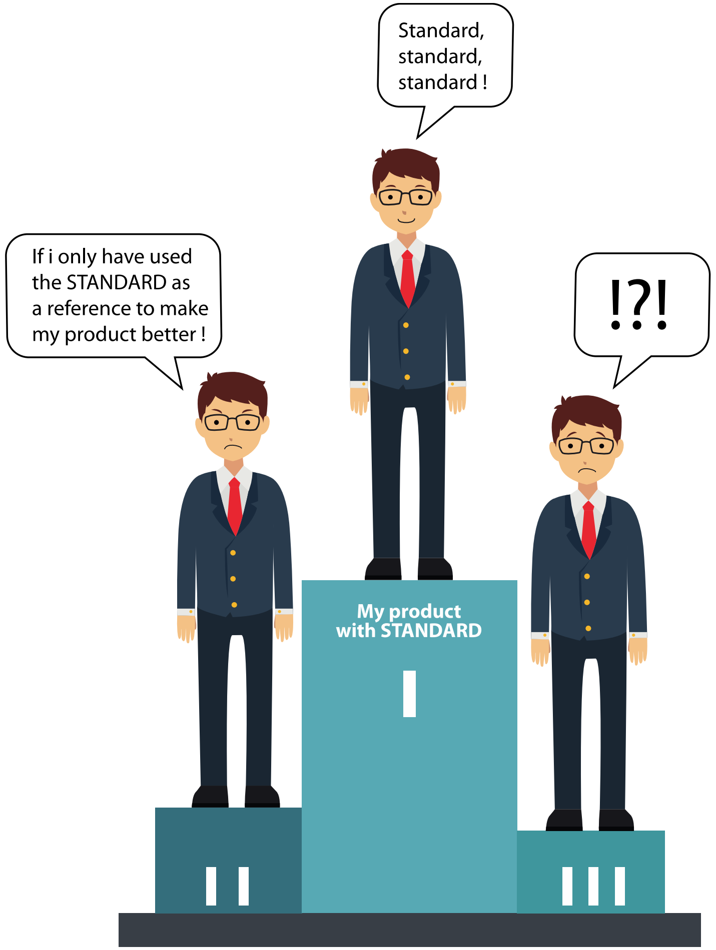
- Efficient and target-oriented innovation
  - Committee Standards provide a useful frame for the development of new products.
  - Standardization increases the effectiveness of R&D activities and enables the transfer of innovations from one sector to another.

> *"The set of standards in our enterprise is the basic prerequisite for us in order not to develop products for the trash can." (Security)*

Source: Abdelkafi and Makhotin (2014)

5.3 Formal standardization: A driver for innovation
Exceeding the requirements of standards

- Exceeding the requirements of standards
  - Knowing the basic requirements, which are captured by standards, companies are able to develop “out-of-the box” solutions.
  - Possible reasons for companies to go beyond the requirements defined by the standards are: special-purpose customer requests, marketing reasons, previous experience or hedging against uncertainties.



Source: Abdelkafi and Makhotin (2014)

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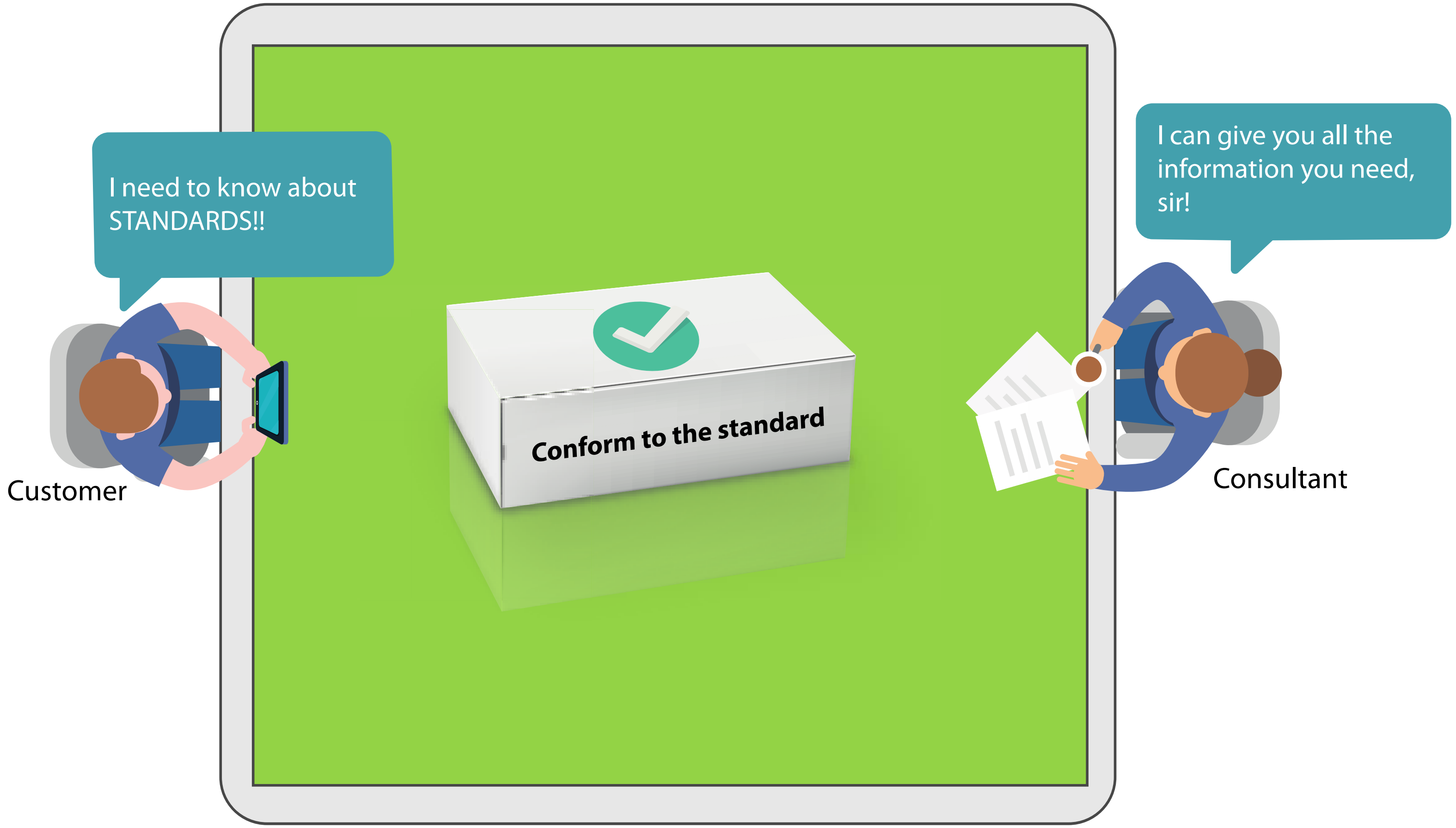
Source: Abdelkafi and Makhotin (2014), p.46

5.3 Formal standardization: A driver for innovation
Business model innovation

- Business model innovation
  - Standards can lead to new business models, such as test labs, consulting firms, and certification organizations.



Source: Abdelkafi and Makhotin (2014)

5.3 Formal standardization: A driver for innovation
The support of innovation through standardization

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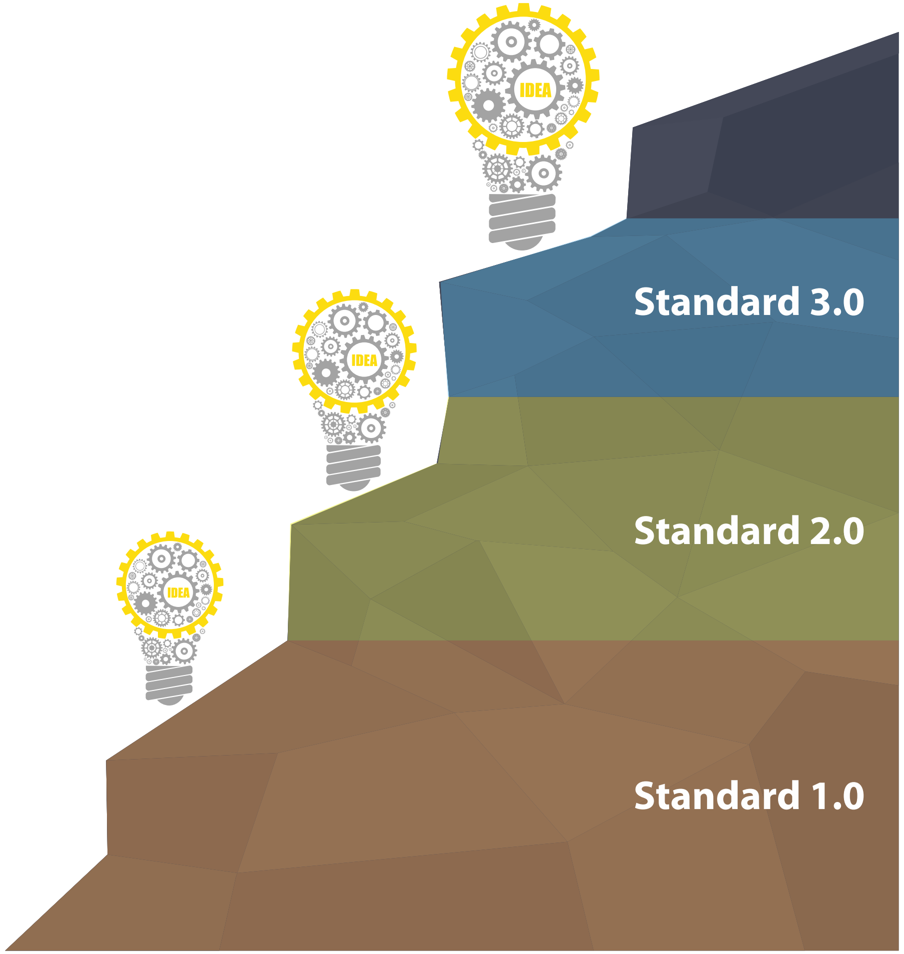
Source: Abdelkafi and Makhotin (2014), p.46

5.3 Formal standardization: A driver for innovation
Innovation impulses

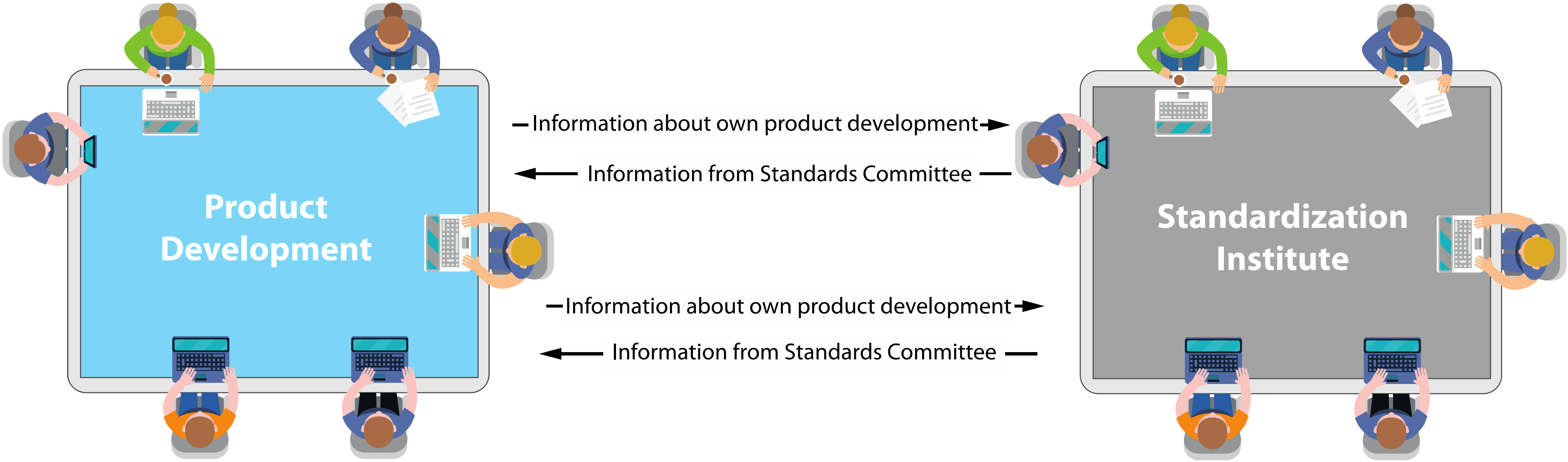
- Innovation impulses
  - Innovation impulses result from the update of an existing standard or after introducing a new one. When standards are changed over time, companies are obliged to comply, leading to incremental innovations.
  - The updates of standards can be perceived as a burden for the company because of additional development efforts.



Source: Abdelkafi and Makhotin (2014)

5.3 Formal standardization: A driver for innovation
Differentiation

- Differentiation
  - Companies can achieve a competitive advantage, depending on how well and how quickly they can fulfil the requirements of a new standard.
  - Standardization creates opportunities for the development of differentiated products:
    - Synchronizing the company's R&D process with the standard development process
    - Differentiation through the development of customer-tailored standards portfolios.



Source: Abdelkafi and Makhotin (2014)

5.3 Formal standardization: A driver for innovation
The support of innovation through standardization

- Innovation potentials in standardization

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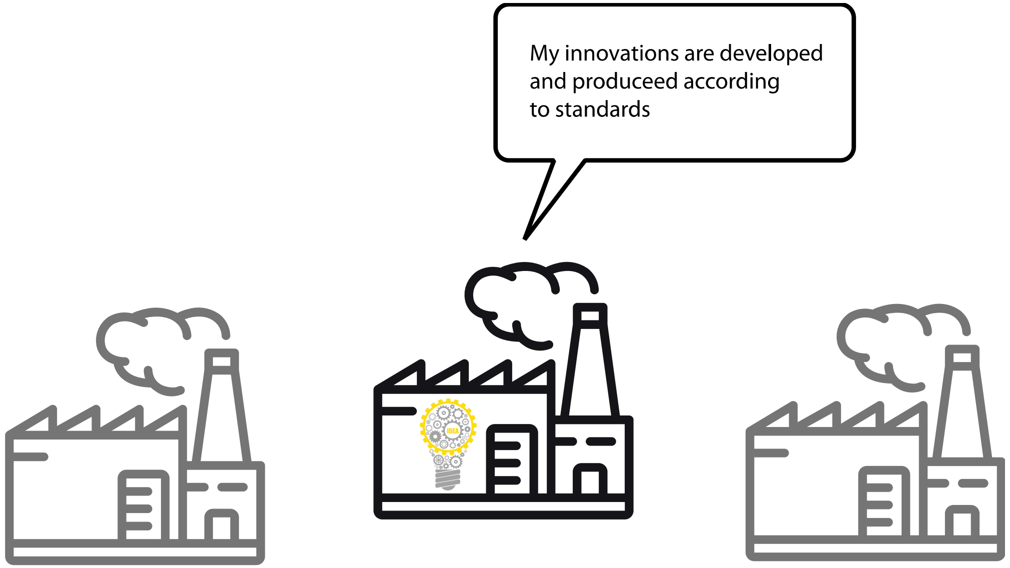
Source: Abdelkafi and Makhotin (2014), p.46

5.3 Formal standardization: A driver for innovation
Innovation communication

- Innovation communication
  - Companies that participate in standard setting processes signal know-how and high competence to the outside, which is especially important in B2B field.
  - Innovation communication with standards helps companies to build trust with their clients especially in areas with rapid technology development.

“We inform our customers about our activities in the standard setting process. So they know what we are doing. They are quite happy to receive this up-to-date information.” (Nanotechnology)

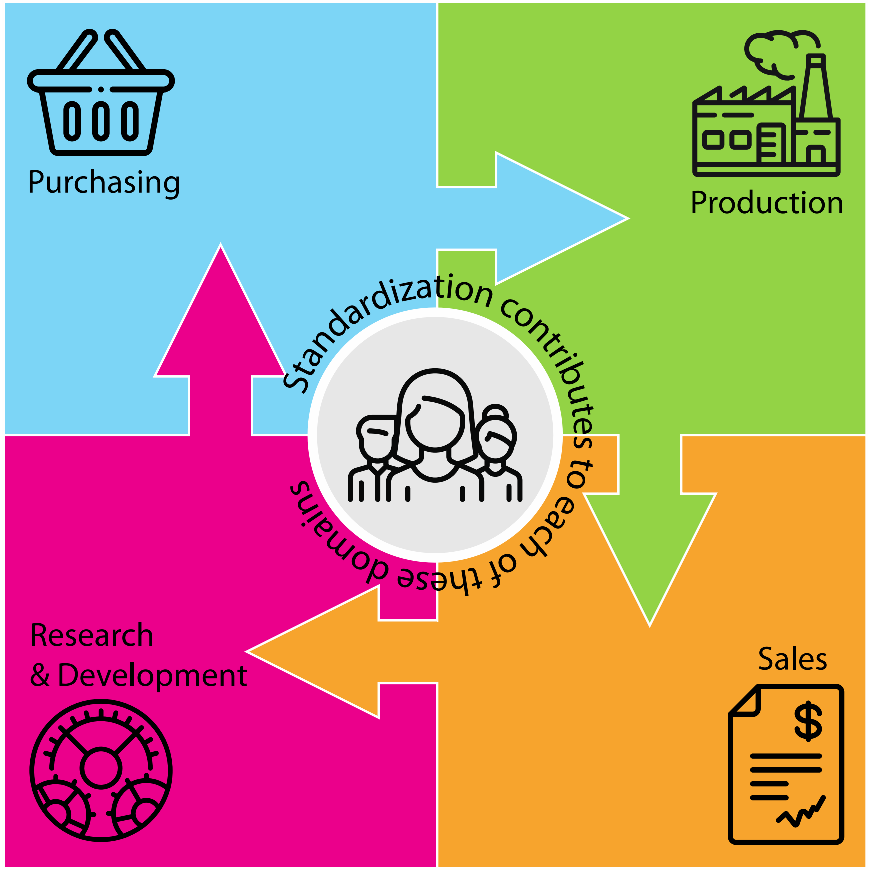


Source: Abdelkafi and Makhotin (2014)

5.3 Formal standardization: A driver for innovation
Absorption of innovation

- Absorption of innovation
    - Standardization supports the ability of companies to transfer and apply novel and useful external knowledge. The participation in standards setting process is crucial for the achievement of this innovation potential..

> *"Not only the development of standards was important, but also we were able to identify new application areas for our products. That's what was interesting in those discussions." (Security)*



Source: Abdelkafi and Makhotin (2014)

5.3 Formal standardization: A driver for innovation
The support of innovation through standardization

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Source: Abdelkafi and Makhotin (2014), p.46

List of abbreviations: Chapter 5

- R&D: Research and Development
- TLC: Technology Life Cycle
- ISDN: Integrated Services Digital Network
- SSL: Secure Sockets Layer
- UMTS: Universal Mobile Telecommunications System
- NPO: Non-Profit-Organization
- DAP: Digital Audio Broadcast
- Fraunhofer IIS: Fraunhofer Institute for Integrated Circuits
- MPEG: Motion Pictures Expert Group
- B2B: Business-to-Business

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6 A Strategic Perspective on Standardization

Contents

6.1 Introduction

- This chapter looks at participation in standardization from the point of view of an organization interested in getting involved in standardization.
- It looks at different strategies for participation, at the choice of which standards organization to join, and at more technical aspects of standardization, including implementation.
- Addressed is also the operation of standardization efforts and SDOs, including voting, and the impact of external influences.
- The organization’s internal communication aspects are discussed.
- Finally, guidance on how to select standards is discussed.

6.2 Different strategies of participation
Organizational strategies

- Organizations can be classified according to which role they play in the standardization ecosystem, using here a classification according to Corporate Strategic Standardization Management (SSM).

Leader	Contributor	Follower	Spectator
-Participation in standards-setting activity is business critical	-Active participation in standardization process -Less interested in influencing strategic direction of an SSO	-Full membership privileges wanted -Not interested in influencing strategic direction	-Main motivation: intelligence gathering -No active contribution to creation of a standard

- The role that standardization plays for the organization is a function of how important standardization and/or presence in standardization is for the overall, primarily business strategy.

Source: Jakobs (2014) Table I. Linking organizational strategies and approaches to standardization

6.2 Different strategies of participation
Organizational strategies

- An organization may have a differentiated approach and may participate in different domains with different objectives:
  - the protection of its business interest,
  - early warning for technological and market developments,
  - promotion of IPR and internal as well as proprietary standards,
  - avoiding duplication between countries or continents, etc.

- This means different roles may be taken, leader in one domain, spectator in another, etc. This may lead to issues of perception: e.g. an organization might be expected to be also a leader in other domains.

6.2 Different strategies of participation
Organizational strategies

- The business strategy is supported by a set of technology strategies.
- The standardization strategy of an organization is therefore driven by both the business strategy itself and by the derived technology strategies.
- To understand the standardization strategy of an organization, it is at least useful to know and understand also its supporting technology strategies.

6.2 Different strategies of participation
Technical focus

- Where and how to participate will be a function of the technical needs and priorities of an organization.
- Priority will certainly go to standardization topics related to the core activities of the organization.
- However, market and development of these core activities may depend on infrastructure (telecom and non-telecom) and of related activities such as privacy and security requirements.
- Therefore, the organization may decide to be present as well in domains of activity related to, but outside its core activities.

6.2 Different strategies of participation
Technical focus

- 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, incl. architecture, services, protocols incl. application protocols
IEC	Electrotechnical standards, incl. connectors, electrical safety, EMC and tests
JTC 1	ICT incl. architecture, services, protocols incl. application protocols
ETSI	Interoperable telecom specifications incl. architecture, services, protocols and tests
CEN	ICT, incl. architecture, services, protocols incl. application protocols
CENELEC	Electrotechnical standards, incl. connectors, electrical safety, EMC and tests
CEN/CENELEC	ICT architecture (OSI model) services, protocols incl. application protocols
IEEE	A wide range of technical and electrotechnical domains, incl. all LAN specifications: IEEE 802.xx, cabled LANs, Wireless LANs (WLAN), e.g. Wi-Fi
IETF	All internet related specifications including protocols, generic applications, addressing rules (IP, URL)
Ecma International	Media specifications, ICT specifications fed into ETSI, ISO/IEC, IEEE, etc.

6.2 Different strategies of participation
Localizations and relations between SDOs

- In deciding in which SDOs to participate, the interrelations between the SDOs, and the status of an SDO with respect to public authorities, may play an important role.
- The geographical location,
  - in which continent, and where meetings take place also plays a role in the decision.
  - may create complications, as it may not coincide with the organization's geographic organization.
- standards organizations typically are Non-Governmental Organizations (NGO), association without profit objectives
- Exception is the ITU, now a United Nations organization.

6.2 Different strategies of participation
Localizations and relations between SDOs

- 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	> JTC1
ISO	NGO	Geneva (CH)	Multi-national	ICT	National delegations	> ITU
IEC	NGO	Geneva (CH)	Multi-national	electrotechnical	National delegations	(> ITU)
JTC 1	NGO	Geneva (CH)	Multi-national	joint comm. ISO + IEC	National delegations	> ITU
ETSI	NGO	Sophia Ant (FR)	Multi-nat. / EU	Telecom	Organizations	> 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	(> ITU + ISO)
Ecma international	NGO	Geneva (CH)	de-facto	ICT	Organizations	> ISO

6.2 Different strategies of participation
Technology strategies

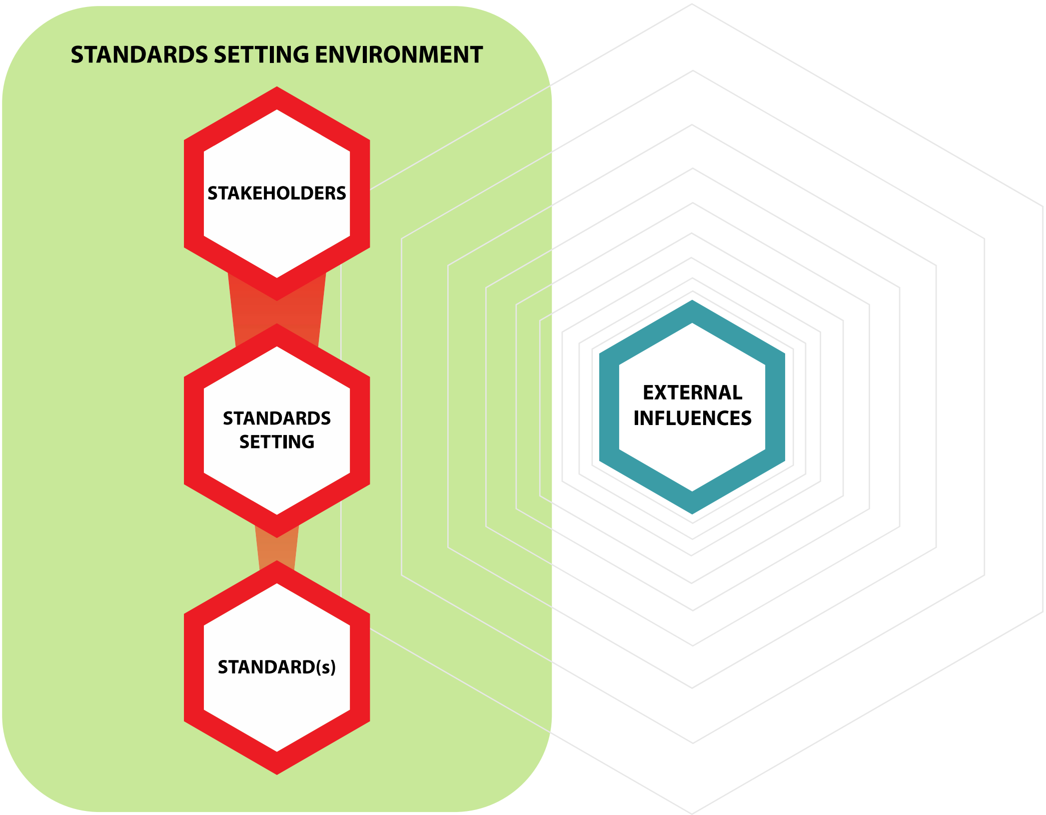
- Apart from showing presence, there are also technology related considerations for participation:
  - The “radar” function: a view on technologies and applications that may become important in the future.
  - The activity of others, as indication of R&D activity, location, priority and importance of developments.
  - It may be used for activities towards the formation of consortia, interest groups, fora, etc.
  - It may help promote ideas and solutions, including IPR.
  - It may incite dialogue with public authorities, giving a preview on public support, measures and concerns.

6.2 Different strategies of participation
Technology strategies

- Organizations may decide to be active also in standardization activities that are not corresponding to their core activities.
- It then is then likely that these organizations do not have the same level of competences in these domains, and therefore may have more limited possibilities to contribute.
- An organization leading in a domain may take an active role in new developments, or it may take a defensive role. It might not look favourably at standardization activities which might result in competition for standards in which it has invested.

6.3 Modalities and external influences
Impacts on the standardization process

- Factors and boundary conditions that have an impact on the standardization process:



Source: Jakobs (2014) Fig.1. A very simple view of what influences a standard

6.3 Modalities and external influences
Managing the relationship of standardization and market

- There is a strong interrelation between standardization, technical development and market development
- Managing the relationship with technical development
  - is challenging, needs to take into consideration as far as possible market trends, developments and market forces,
  - requires deep insight and assessment of technology developments, industrial applicability and maturity.
- Assessing the relation with market trends and developments is difficult, uncertainties include ‘unknown unknowns’, including unexpected competition developing between different technologies.

6.3 Modalities and external influences
Managing cooperation

- Standardization is a competitive domain, but requires cooperation to arrive at results:
  - active cooperation (may go together with conflicts)
  - passive cooperation
- Passive cooperation may be a pragmatic and ‘honourable’ approach, it does not, however, give an indication of commitment for adoption of the results, and does not prevent standards proliferation (‘you have your standard, I have my standard’).

6.3 Modalities and external influences
Managing synchronization

- Standardization may be considered leading, in sync or following developments, including:
  - Technological developments and technology trends
  - Market and value chain ordering
  - Market push and pull
  - Societal trends and developments
  - Legal and regulatory environment
- **Leading**, i.e. early standardization, not all issues understood
- **In sync**, i.e. ‘just in time’ needs agility of the process
- **Following** developments, i.e. ‘late’ standardization.

6.3 Modalities and external influences
Managing synchronization

- An analysis on these principles can be made by taking GSM as an example. GSM consist of a rather complex system of a range of functions. This evaluation is based on what one knows now, roughly 30 years after the development (ex post).
  - Leading, and therefore rather anticipatory: data services and roaming (limited data rates, limited roaming expected.
  - In sync, and therefore enabling: the cellular organization, including hand-over etc.
  - Following, in the sense of adopting elements of dominant design and existing standards, the 64kbit/s channels (coding techniques had advanced allowing e.g. 8 Kbit/s channel structure.

6.3 Modalities and external influences
Voting and voting rules

- Different organizations have different voting rules; possibilities include:
  - weighted voting, based on category, size, etc.; example: ETSI, CEN/CENELEC
  - Individual expert vote, based on regular attendance; examples: IEEE802, IETF
- In ETSI, the issue of a possible imbalance between the total votes of different categories of members has been raised. Large organizations represented by delegations from different countries accumulate significant amounts of weighted, revenue-linked voting rights.

6.3 Modalities and external influences
Voting and voting rules

- Also the interest of an SDO as an organization may play a role in standardization:
  - The organization, i.e. its secretariat and governance entities, likely have a role in relations with members, other SDOs and with public authorities
  - The organization’s interest may be reason to accept or reject proposals for new standardization
  - The organization’s interest might play a role in the voting.
- Public authorities address their communications mainly to an SDO as an organization; e.g. the EC, as a customer and as a sponsor, addresses its communications first of all to the ETSI and CEN/CENELEC secretariats.

6.3 Modalities and external influences
‘Backdoor policy’

- The “backdoor policy” means that a group of stakeholders decide to switch to another SDO when a first choice SDO is not favourable to undertake or accept a new standardization activity. This brings with it opportunities and issues:
  - It circumvents blockage of new or different approaches
  - It carries with it the risk of duplication of effort and standards proliferation
- Ecma International has played a role as alternative standards route, e.g. standards for ‘private telecom’ such as X.25 and ISDN found an alternative to restrictive public SDOs.
- However, a ‘backdoor policy’ together with passive cooperation may also lead to important issues, e.g. ECMA-376

6.3 Modalities and external influences
Standards portfolio management / Technology development

- Ideally standardization takes place 'just in time' or better 'in sync', i.e. when technological development and market requirements have necessarily arrived at a complementary and supportive level of expected maturity.
- This is not always achieved, resulting in growing 'stress' between the evolving technological state of the art and/or market requirements, and the developed standard.
- It may be considered normal, however, that during the lifetime of a standard such 'stress' develops between a standard and technological advances and/or changing market requirements, resulting in standards needing updates and amendments, loosing importance or being withdrawn.

6.3 Modalities and external influences
Managing phases of standardization

- As an example, in most Western European countries there is still work ongoing on completing the coverage of the territory with 2G/GSM .
- Operators may be working in parallel on the deployment of 2G, 3G, 4G and soon 5G infrastructure and services.
- Mobile phones need still to support 2G, as it has still the widest coverage.
- Similarly, standardization in 3GPP needs to consider maintenance of 2G and 3G, bug fixes in 4G and requirements for 5G.

6.3 Modalities and external influences
Managing phases of standardization

- Standardization needs to care about the following external aspects of management:
  - Standards need to comply with legal, regulatory and other requirements concerning materials, safety, safe practices, security, etc.
  - Standards need to coexist with existing or parallel developing systems. The concept of coexistence is relatively new and increasingly important, in particular of importance for access to frequency spectrum.
  - Although this may be achieved only partially, standards need to achieve interoperability between different implementations of equipment and services.

6.3 Modalities and external influences
Other activities

- SDOs may be initiated by industry and industry groupings, with other, related activities. They may also be enablers of platforms for related activities, and may take on other roles for the benefit of their members.
- An initiative in ETSI to address concerns of the European Commission regarding the timing and modalities of the introduction of Radio Equipment Directive (RED) is an example of what could be considered a natural consequence of the presence of the stakeholders, and therefore as a natural extension of ETSI's role.

6.4 Communication in standardization activities
Communication inside the organization

- The requirements for senior standardization experts include the right mix of
  - Leadership
  - Technical and/or market vision
  - Technical competence
  - Communicative skills and
  - Negotiation skills
- Meeting all these requirements requires highly skilled and communicative persons with full support from top management. This requires the organization to recruit or train senior standardization experts and give them the means to communicate with all levels of the organization.

6.4 Communication in standardization activities
Communication inside the organization

- Often only a part of these conditions is met, standardization experts may lack some of the critical support needed to fully implement their mission.
- Reasons is that structural access to top level persons in a large part of the organization, while being a 'non-resident', requires privileges given to e.g. Vice-Presidents and up.
- An alternative would be for the individual expert, or the standards entity, obtaining wide recognition; however, this leads to incomplete and informal exchange of information.
- The best solution is to have in top management a 'standardization champion'.

6.5 Choosing your standard(s)
The standardization process from an implementation viewpoint

- The ultimate goal of standardization is the implementation of the resulting standards in products and services, for the benefit of users and industry as a whole.
- Excellent examples of successful standardization are the sets of standards for mobile networks 2G, 3G, 4G (with 5G under development). These sets of standards have achieved a wide acceptance in the global markets. Technically, these standards excel in achieving interoperability, as is demonstrated by the almost flawless international roaming capabilities.

6.5 Choosing your standard(s)
What to take in consideration

- Selecting Standards and/or Specifications for my application.
- Since the need for compliance to numerous standards and specifications is increasing, and the perception of the distinction between committee standards and de-facto standards is diminishing, 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 you will need to adhere to may be rather simple. E.g., when the intention is to bring to the market products supporting access to 2G, 3G, 4G networks, the choice is obvious. There is a complete suite of standards and tests available.

6.5 Choosing your standard(s)
What to take in consideration

- Less clear, when e.g. products are aimed at the “smart anything everywhere” market, with a choice between different wireless networks (including ‘LPWANs’ such as LoRa, WAN, Sigfox, Ingenu, in addition to 2G, 3G, 4G or 5G).
- Interest in standards in a specific case may range from
  - compatibility and/or interoperability in procurement,
  - purchasing sub-systems implementing certain standards,
  - developing ‘in-house’ products that need to comply with standards and interoperate with other implementations.
- The issue “development of products that comply with standards” is particularly challenging.

6.5 Choosing your standard(s)
What to take in consideration

- Important criteria that should help organizations in the standards evaluation task:
  - Completeness: is this standard / set of standards all that is needed, or the tip of the iceberg: what other standards are needed to support or complement this standard(s)?
  - Stability: is this standard new, still developing; is it mature, widely adopted and tested; is it aging, may need brought up to date (legacy components, coexistence and interoperability with more recent systems)'; is there an installed base, what is the influence (stability, inertia)?
  - Maintenance: is maintenance of the standards ensured; are there other mechanisms to learn about issues, workarounds, and de-facto reference implementations?

6.5 Choosing your standard(s)
What to take in consideration

- Interoperability and conformance: are good conformance tests and test facilities available; required level of interoperability; what is the scope of the interoperability: some functions, a subset, all functions; is interoperability required with the standard or a dominant implementation; are good interoperability tests and test facilities available; what level of interoperability is on requires the market?
- If implementation of the standard(s) is targeted, then interoperability is of key importance. Interoperability is often achieved only partially. Conformance is a prerequisite for, but not a sufficient condition for interoperability. The complementary 'plugtest' testing is very useful addition, but not guarantee either.

6.5 Choosing your standard(s)
Supporting standard 'X', and now?

- The next step in the evaluation process would be to attribute a weight to these parameters, that may range from less important to a condition sine qua non.
- 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 his choice, may influence your position: you are now a stakeholder with an interest in a specific standard 'X'.
- For example, your interest may now be increased involvement, supporting, improving or completing the selected standard(s) and specifications, adding or improving interoperability tests and testing, etc.

6.5 Choosing your standard(s)
If one cannot find a suitable set of standards / specifications?

- 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, competitors). If the subject appears suitable for an existing SDO, then bring your request to the most suitable SDO.
- If the subject appears less suitable for an existing SDO, then consider bringing it to a suitable industry forum.
- If the subject does not appear to fit anywhere, then consider setting up your own forum, together with partners. An industry specification could later gain the status of a "public available specification". It could also become a committee standard, if the interest spreads more widely.

6.6 Summary

- In this chapter, participation in standardization is dealt with from the point of view of an interested organization.
- It examined how to choose a standards organization, SDO, to participate in, as a function of activities and location.
- It also addressed the operation of standardization efforts and organizations, including voting systems and rights, and external influences. Important external influences are market trends and developments, and technological development.
- As presented, participation in standardization requires internal and external communication within an organization.
- Finally, the chapter discussed some considerations that help evaluate and choose standards for a certain application.

List of abbreviations: Chapter 6

- SDO: Standards Development Organization
- SSM: (Corporate) Strategic Standardization Management
- ISO: International Organization for Standardization
- IEC: International Electrotechnical Commission
- JTC 1: Joint Technical Committee 1 (an ISO/IEC joint technical committee)

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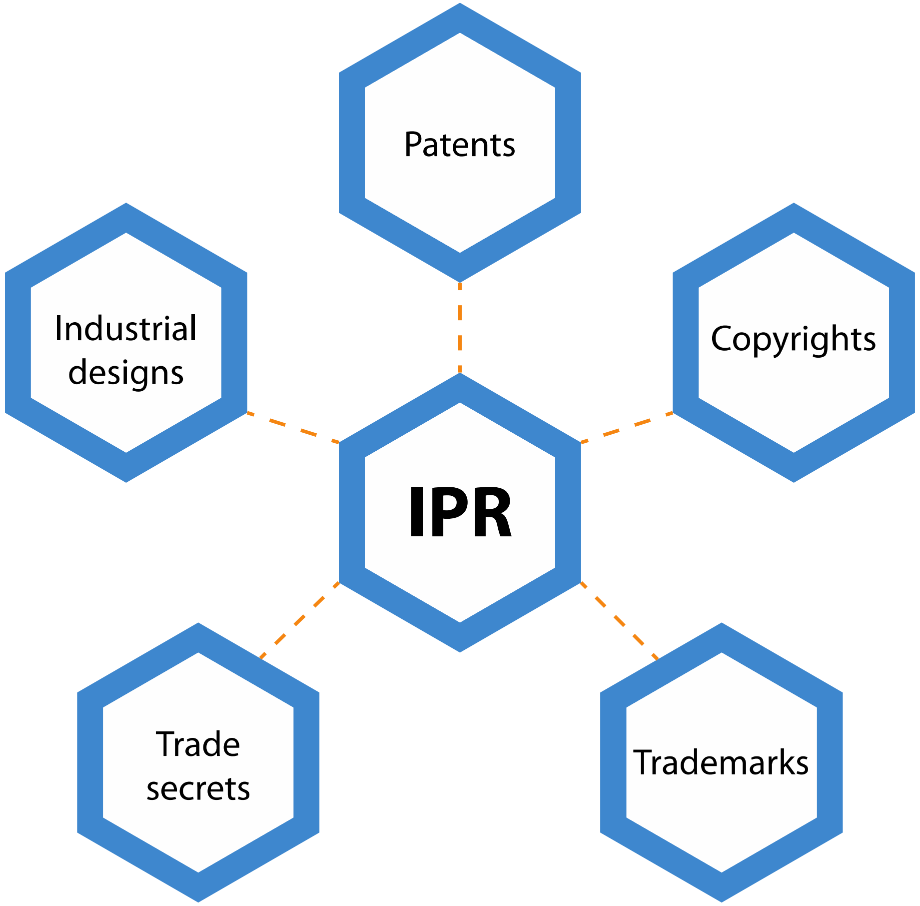
7 A Business Perspective: IPR and Standardization

Contents

7.1 IPR and SDO-supported standardization
Intellectual Property (IP): A short introduction to the term

- Intellectual property (IP) refers to creations of the mind (e.g. inventions, literary and artistic works, designs and symbols, names and images used in commerce)
- IP is protected by law to safeguard the integrity of intellectual objects:
  Patents, industrial designs, copyrights, trademarks and trade secrets
- Intellectual property rights (IPR) are critical to fostering innovation
- Without the protection of ideas, businesses could not reap the full benefits of their inventions and would focus less on research and development



7.1 IPR and SDO-supported standardization
Basics of IPR

- **Copyright:** "The exclusive and assignable legal right, given to the originator for a fixed number of years, to print, publish, perform, film, or record literary, artistic, or musical material." (e.g. software) (Oxford Living Dictionaries, n.d.a.)
- **Trademark:** "A symbol, word, or words legally registered or established by use as representing a company or product." (e.g. "just do it" by Nike) (Oxford Living Dictionaries, n.d.e.)
- **Industrial design:** "The art or process of designing manufactured products." (e.g. apple iPhone) (Oxford Living Dictionaries, n.d.b.)
- **Patent:** "A government authority or license conferring a right or title for a set period, especially the sole right to exclude others from making, using, or selling an invention." (e.g. Dropbox, GoPro) (Oxford Living Dictionaries, n.d.c.)
- **Trade secrets:** "A secret device or technique used by a company in manufacturing its products." (e.g. R&D information, software algorithms, inventions, formulas, ingredients) (Oxford Living Dictionaries, n.d.d.)

7.1 IPR and SDO-supported standardization
Most relevant instruments in this context

- Companies can choose among different types of standardization:
  - Establishment of a dominant design and/or de-facto standard
  - Active and passive participation in committee standardization:
    - Formal standardization (e.g. ISO, ETSI formal standards)
    - non-official standardization (e.g. the PAS-process, standardization in consortia)
- Companies can choose between different protection mechanisms:
  - Secrecy
  - Patenting (national, European, international)
  - Standard-Essential Patents (SEPs)

The decision process is very complex as each instrument bares its own benefits and risks in a specific context/case.

7.1 IPR and SDO-supported standardization
Selected external and internal influencing factors

Internal influencing factors	External influencing factors
Company's characteristics • Available resources • Short term and middle term goals • Company size and growth • Products/services and technology • Marketing and impact	**Company's environment** • Dynamics • Complexity • Competition intensity • Specifics of the sector such as regulations
Decision maker(s) • Previous knowledge • Experience • Perception and acceptance of the instruments	**Stakeholders** • Standards Developing Organizations (SDOs) • Customers • Competitors • Other business partners

7.1 IPR and SDO-supported standardization
Dominant design & standard wars

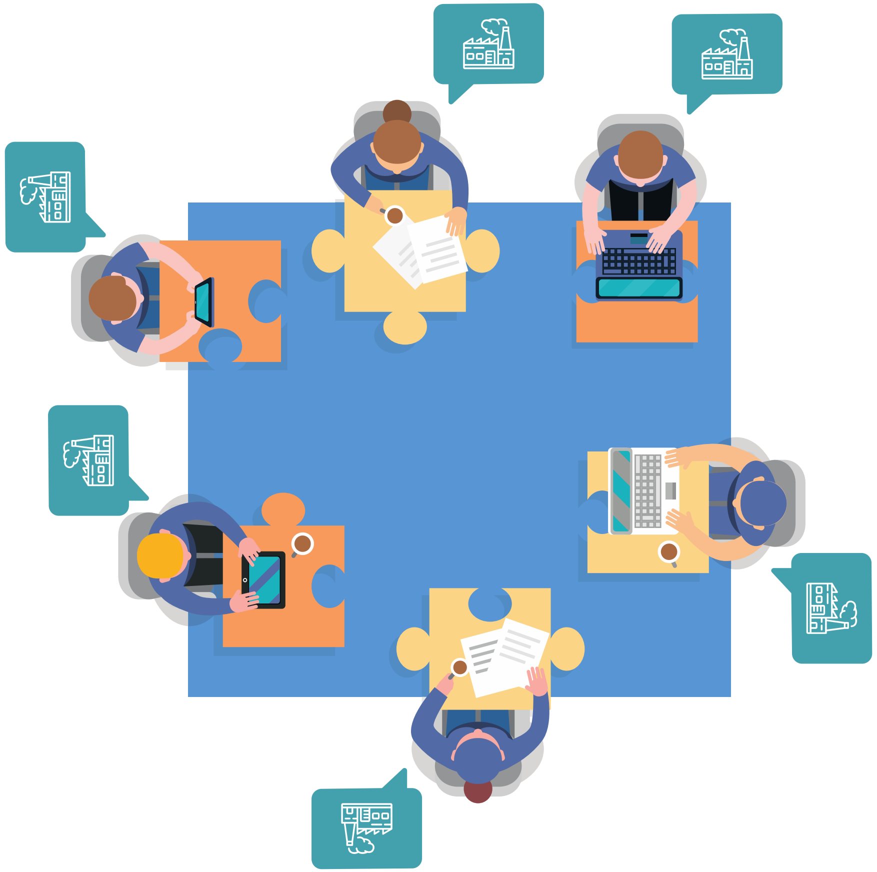
- “Standard wars” and the dominant design:
  - At early stages of a technology different solutions compete against each other, until one solution prevails (technological superiority does not necessary play a role here) → this is called a “**standard war/battle**”
  - VHS vs. BETAMAX and BLU-RAY vs. HD DVD are examples for standard wars
  - **A dominant design** is a technology that achieves market dominance;
    It is then a de-facto standard (Narayanan and Chen 2012)
    - – Achieving **a dominant design means great effort** as a company needs to win the battle on the market field and make sure of the diffusion of its own technology
    - + The company has **full control over the standard contents**
- Committee standardization:
  - + In contrast to a dominant design, committee standardization can serve as a **“low-cost” option to conquer a market**
  - But committee standardization is much more than that…

7.1 IPR and SDO-supported standardization
Dominant design & standard wars

- A committee standard is…

> *"…a document established by a consensus that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context"*
> *(Egyedi and Blind 2008, S.8)*

- In contrast to a dominant design a company participating in committees (e.g. formal SDOs, respected consortia) is **working together with other market participants to establish a standard based on agreement** among all/the majority of participating actors
- The standardization process is facilitated by the SDO that provides (more or less) "neutral grounds" for the negotiation process



<u>Note:</u> Companies **do not have full control** on the standardization outcome, but still benefit greatly from active or passive participation in a technical committee.

7.1 IPR and SDO-supported standardization
Formal and non-official standardization

- Formal standardization
  – Process duration: 3 or more years
    (Slow speed of delivery)
  ± Consensus mandatory
    (participants can block standards)
  ± Involvement of all interested parties
  + Higher perceived quality

- Non-official standardization (e.g. PAS)
  + Process duration: ca. 6 month
    (Higher speed of delivery)
  ± Consensus not mandatory
    (could influence the acceptance and quality of a standard negatively)
  ± Involvement of all interested parties not necessary
  – Lower perceived quality

Note: In some technological areas formal standardization is more common (e.g. telecommunication) and in others non-official standardization, especially through consortia (e.g. internet technologies)

7.1 IPR and SDO-supported standardization
The benefits of committee standardization

- Competitive advantage:

  Companies participating in standards development gain a competitive advantage over those who do not:

  + Use technical committees to **scan the environment** for new market chances and identifying competitors
  + Gain **inside knowledge** and **early access** to information
  + Create **additional services** such as consulting and auditing
  + Chance to **influence future technologies** proactively
  + **Increase the diffusion** of (own) integrated technologies/knowledge
  + Develop **new markets** and **increase market shares** for products, services, and technologies; strategic positioning within those markets

Note: On almost any given day, a working group or technical committee is meeting and making decisions that could affect "our" bottom line (Caldas 2017)

7.1 IPR and SDO-supported standardization
The benefits of committee standardization

- Networking:
  - Active participation **fosters social networking**, alliance building and finding new business partners: Personal trust and connections on a 1:1 basis
  - Can be seen as a special form of **R&D collaboration** (Blind 2006)

- Customer's confidence:
  - The endorsement of a technology by a SDO is perceived as **proof of quality** and can enhance a company's **reputation**
  - Committee standards are freely available by other market participants: This **reduces the dependence on specific suppliers** (avoid vendor lock-in) and **lowers transaction costs** on the customers' side (better comparability between products).

- Marketing:
  - The active participation in standardization can serve as **free advertising**

7.1 IPR and SDO-supported standardization
The benefits of committee standardization

- Efficiency/cost savings:
  - Facilitating the **coordination between several economic players**
  - Feedback from all participating stakeholders enables a **target-oriented development** (can enhance the overall service/product quality)
  - Background knowledge from the standardization process **fosters R&D** and the general implementation of technologies.
  - In the case of complex technologies: Standards can ensure **compatibility and interoperability** between technologies and complementary devices
  - Standardization supports **economies of scale**
  - **Reduces bargaining costs**: standards can serve as a basis for contracts (even job offers)
  - Provides **legal security**

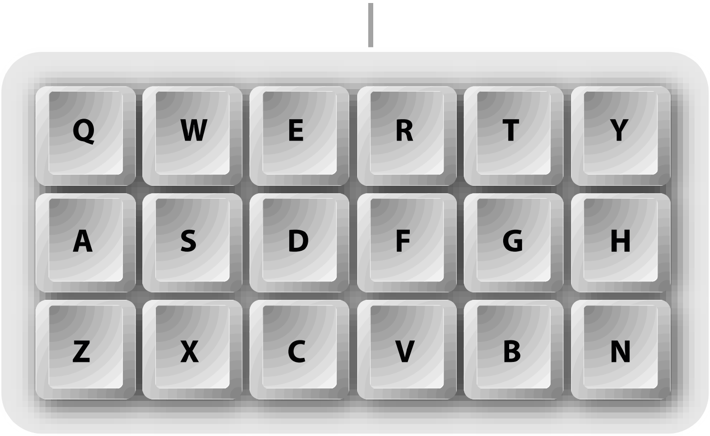
BUT: Standardization also bares risks for companies…

7.1 IPR and SDO-supported standardization
The risks of committee standardization

- Risks that can result from committee standardization :
  - Enclosure of IP and loss of exclusive rights because of the integration of technologies/knowledge in a standard
  - Possible unintentional knowledge spillovers during the standardization process
  - No 100 % influence on the outcome of the standardization process (acceptance of compromises)
  - Risk of backing the wrong horse: There is no insurance for the implementation/diffusion success of a standard in the market (e.g. Open Systems Interconnection (OSI) standard)
  - Free riding: Companies that do not participate actively in standardization can still benefit from committee standards

7.1 IPR and SDO-supported standardization
Example: Intergraph

- **Risks that can result from committee standardization :**
  - Focused on American market (intended to expand to Europe); Intergraph Europe headquartered in The Netherlands
  - Product family: wide range of software and hardware solutions, computers for graphical applications; in this case: dedicated keyboards for its graphical computers with function keys with a status indicator for which LEDs were used



- **Connection to standardization:**
  - US → UL (Underwriters Laboratories) requirements apply;
  - Europe → CENELEC standards apply
  - To be informed, Intergraph Europe participated in the Dutch standardization committee
  - Red colour used for the LEDs in the keyboards did not meet international standard IEC 60073 and European equivalent EN-IEC 60073 ⍰ Red should be used exclusively to indicate danger
  - Estimated total costs for the adaptation process: € 19,000
  - As a member of Dutch committee, they were informed that the IEC standard was going to be modified by adding the text: “Where colours are used for functional controls or indicators, any colour, including red, is permitted provided that it is clear that safety is not involved.”

→ Company recovered cost of participation

Source: De Vries (2006)

7.1 IPR and SDO-supported standardization
Example: Tyco Electronics/AMP: SC-Connector

- Company overview:
  - Field of electrical and electronic connectors and interconnection systems
  - Product family: Fibre-optic products, switches, IC sockets, application tooling
  - Increased market share by participating in standardization
- Participation in standardization process:
  - ANSI/EIA/TIA 568 standard (published 1991) → dominant standard for commercial building telecommunications wiring in US market
  - Initiation of development of a similar standard in Europe by CENELEC and an international standard
  - Tyco Electronics/AMP joined the standardization process, so new standards refer to their developed SC-connector → does not mean an exclusive right to produce the technology (rules and regulations of CENELEC and IEC forbid that) BUT:
    - Competitive advantage in terms of knowledge, time to market, and economies of scale

In the period 1995-2004: additional profits estimated to be in-between US$ 50 000 000 and US$ 100 000 000, whereas cost of the company's participation estimated between US$ 100 000 and US$ 200 000 → cost benefit rate of 1:500

Source: De Vries (2006)

7.1 IPR and SDO-supported standardization
The risks and benefits of patenting

- Patents:

> "Is an exclusive right granted for an invention (product or process) that provides a new way of doing something, or offers a new technical solution to a problem" (WIPO - World Intellectual Property Organization n.d.a.)

Benefits	Risks
+ Capitalizing IP through royalty fees + Temporary monopoly/ exclusive rights (20 years) + Serves as a form of signalling for potential costumers and investors + Patenting protects IP in the standardization process	– Includes the disclosure of the patent contents (even if the patent has not been granted yet) – In many cases the imitation of patents can be hidden very well and is hard to detect – The easier a patent can be bypassed, the more limited is its efficiency – Especially young companies and SMEs often do not possess the resources to peruse patent infringements – Duration of the process: 1,5 – 3 often more years (disadvantageous in markets with a high pace of innovation) – The cost of registering and maintaining the patent

7.1 IPR and SDO-supported standardization
Standard essential patents (SEPs)

- Standard Essential Patents (SEPs) claim an invention that must be applied by all companies in order to comply with a technical standard
- Most of the formal SDOs only allow the inclusion of patented technology in a standard, if patent holders disclose the presence of patented technology
- Patent holders have to license their relevant IPR to standard implementers on FRAND terms
  - This does not necessarily mean that licensing incomes will be lower as **standardization supports the diffusion of the patent and makes a higher number of licensees more likely**
  - The MP3 example of the Fraunhofer shows that FRAND-license can be a very lucrative market: ca. 100 million EUR royalty income (Blind 2009)
  - E.g. Qualcomm with UMTS/LTE: Around 3% of the smart phone price (Forbes 2014)
- SDOs and standard implementers/developers fear monopoly and lock-in situations in the context of SEPs → competition law plays a crucial rule in this context

7.1 IPR and SDO-supported standardization
Risk and benefits of secrecy

- **Trade secret**: Any type of confidential knowledge or business information that gives the owner of a secret an opportunity to **obtain an advantage over competitors** who do not know or use the secret
  - The unauthorized use of such contents by third parties is regarded as an unfair practice and a violation of the trade secret
  - The protection of trade secrets depends on the legal system: Either it forms part of the general concept of protection against unfair competition or it is based on specific provisions or case law

+ Trade secret protects information, knowledge and technologies that are critical to the firm → competitive advantage
+ Especially technologies that can be easily imitated can benefit from secrecy

7.1 IPR and SDO-supported standardization
IPR in SDOs

- Integrating technology, knowledge or other contents in a standard often involves company's IPR.
- Therefore SDOs have developed policy rules to deal with IPR issues during the standard-setting process (e.g. ITU has issued IPR guidelines concerning patents, software copyrights and trademarks).
- Companies participating in standard-setting (at least in the formal organizations) are obliged to disclose any existing patents etc. that are related to the standard to avoid patent hold-ups etc.
- Patents should be licensed under FRAND (Fair, Reasonable And Non-Discriminatory) conditions as standards are a form of common property; This gives especially implementers greater security.
- FRAND should also function as an incentive for companies as they can retain of their IPR.

7.1 IPR and SDO-supported standardization
Intellectual Property (IP): An example

- Sun Microsystems (SUNM) & Java:

  - SUNM recognized that rapid and significant investments in new technology are accompanied by the industry's desire to protect their investments
  - Best way: Move Java into a stable, experienced, formal SDO that is recognized worldwide by government, industry and other SDOs

7.1 IPR and SDO-supported standardization
Intellectual Property (IP): An example

- Sun Microsystems (SUNM) & Java:

  - They chose to apply as a PAS (Publicly Available Specification) submitter to ISO/IEC JTC1 and won in 1999

A Publicly Available Specification is published to respond to an urgent market need. The objective of a PAS is to speed up standardization in areas of rapidly evolving technology. A simple majority of the participating members of a Technical Committee or Subcommittee approve the document. PAS have a maximum life of six years, after which they can be transformed into an International Standard or withdrawn.
Source: ISO/IEC (n.d.) and IEC (n.d.)

7.1 IPR and SDO-supported standardization
Intellectual Property (IP): An example

- Sun Microsystems (SUNM) & Java:

  - SUNM aimed at retaining its patents (although no fees are asked), its copyrights (joint-copyright ownership was suggested, no fees asked), trademarks (e.g. control over compatibility logo) and also staying in charge of the maintenance of the standard (Schoechle, 2009).
    - SUNM wanted to get the endorsement of a standards organization but it was not willing to give up control over the technology (in this case especially over the trademark and maintenance)
  - SUNM's model of competition strongly conflicted with cooperative standard-setting trough ISO
  - As a result SUNM declared its plans to have ISO adopt Java dead and turned to other SDOs

7.1 IPR and SDO-supported standardization
Interplay of IPR and standardization: The role of patents

- Interplay
  - IPR regimes protect the exclusive rights of inventors
  - Especially patents play a key role in standardization
  - Standardization encourages widespread practice of inventions codified by standards
  - Companies can incorporate patented inventions into standards or use both tools in parallel
  - Standard Essential Patents (SEPs): Claim an invention that must be used by any company to comply with a standard

Standards define **common characteristics and requirements** of a technology. They open up new markets for innovative products that comply to these requirements.

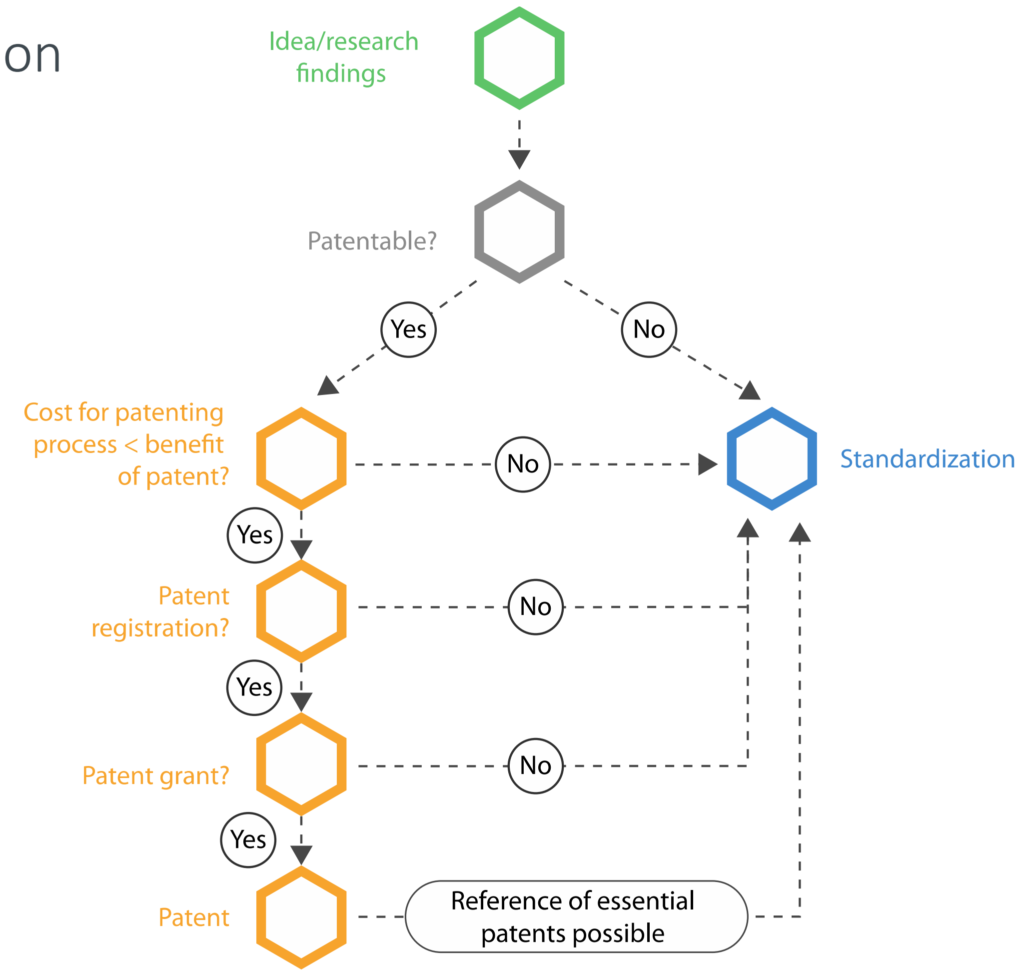
Interplay

Patents define **unique selling proposition** and secure the protection of intellectual property and competitive advantages.

Source: (DIN Deutsches Institut für Normung e. V n.d.b.)

7.2 A decision making tool: IPR vs. standardization
The basic process

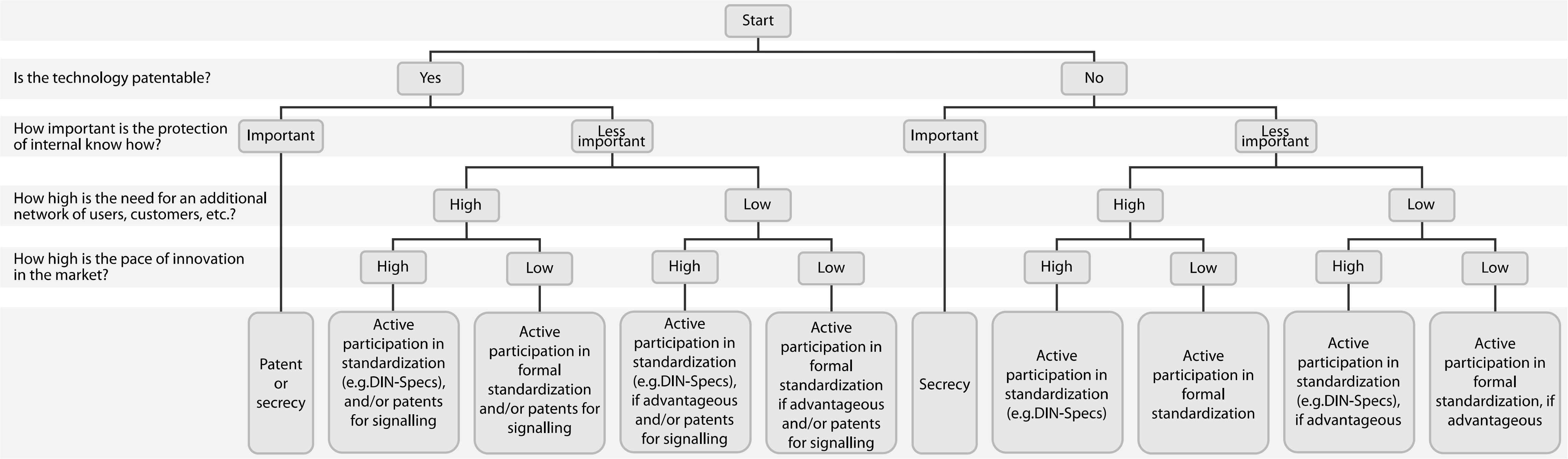
- The relationship between formal standardization and patenting decisions:



Source: translated from Blind (2013)

7.2 A decision making tool: IPR vs. standardization
The decision tree: An overview

- The decision making process is highly complex
- Companies can choose between the instruments secrecy, patents, active participation in formal and non-official standardization, SEPs or a combination



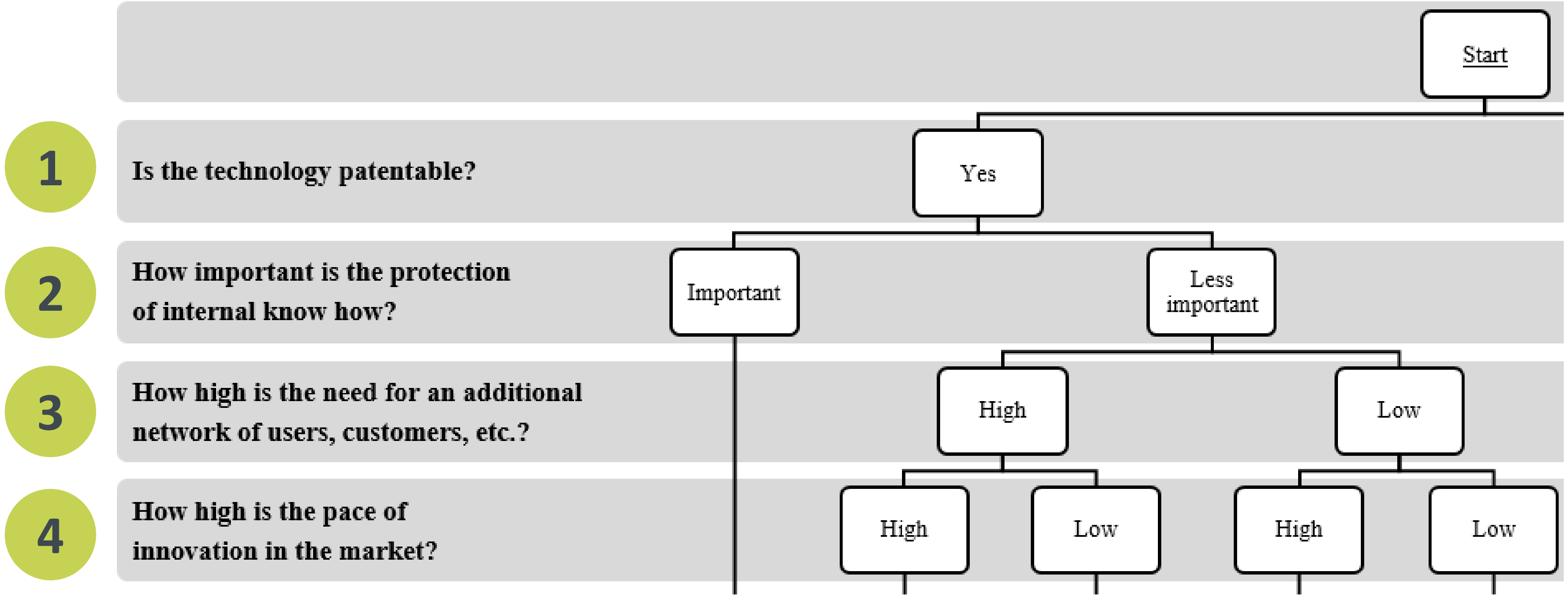
Source: Abdelkafi et al. (2016), p.20, Figure 1

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

- Who should use this tool?
  - Entrepreneurs, developers, etc.
- Why should this tool be used?
  - Strategic decision support
- When should the decision tree be used?
  - After successful development of a new technology

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

- The four levels of the decision tree define the most important questions that an entrepreneur has to evaluate in order to choose the right instrument for his/her case:

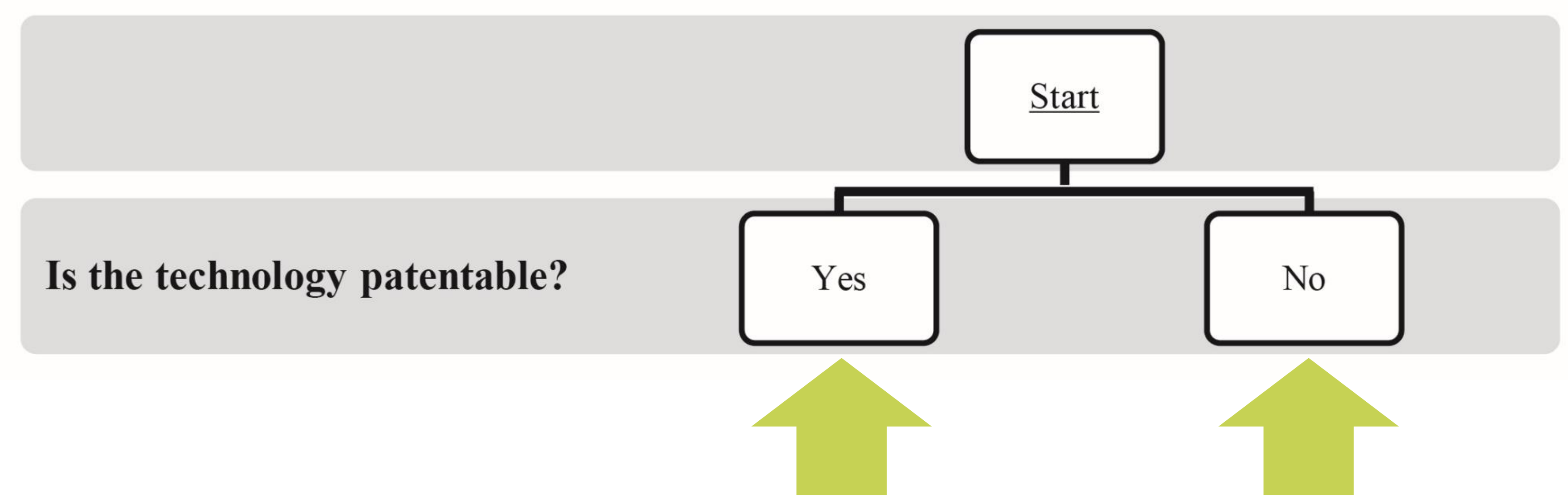


Source: Abdelkafi et al. (2016), p.20, Figure 1 (zoom in)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

1. Is the technology patentable?

- Yes or no?



Source: Abdelkafi et al. (2016), p.20, Figure 1 (zoom in)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

1. Is the technology patentable?

- Inventions from all fields of technology are patentable – in the case of ICT: Hardware and computer-implemented inventions
- The responsible patent office will assess the patentability of an invention on the basis of three requirements:
  - It has to be a '**novelty**' (this means no prior use of anything similar in the market),
  - involve an **inventive step**,
  - and exhibit **industrial applicability**.
- Answering the question of patentability is not a straightforward process. It includes extensive research and often the help of a professional patent attorney is needed.

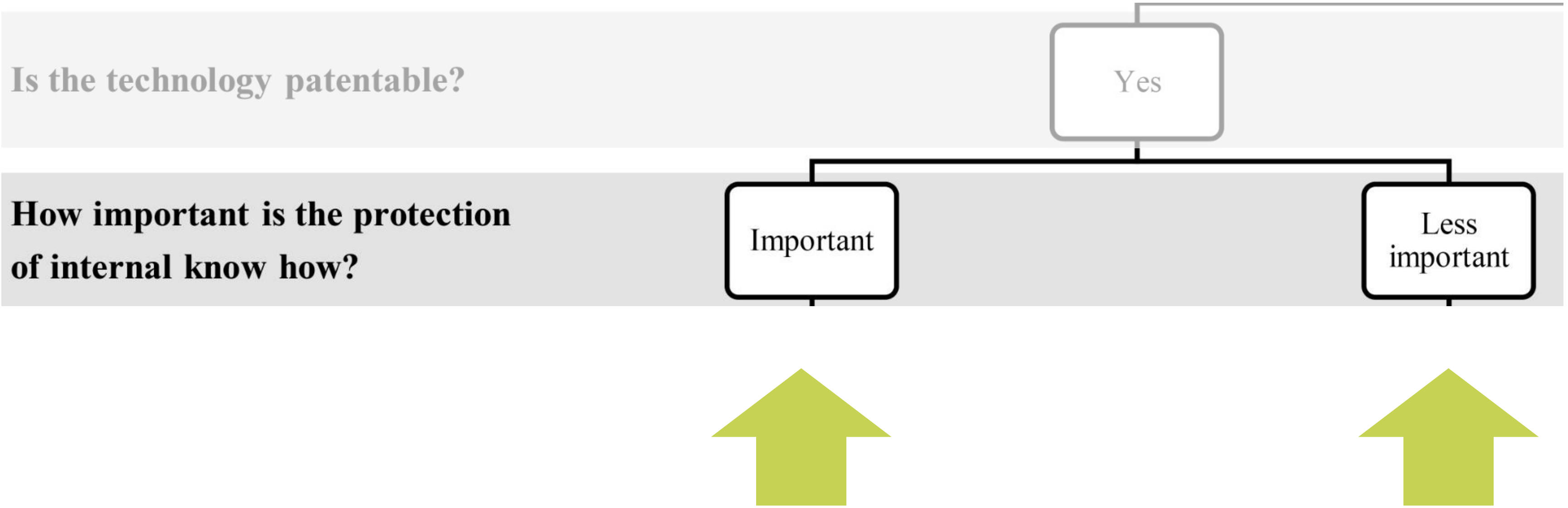
Note: Only because patenting is possible it is not necessary the best option.

Source: EPO (2013)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

2. How important is the protection of internal knowledge?

- Important or less important?



Source: Abdelkafi et al. (2016), p.20, Figure 1 (zoom in)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

2. How important is the protection of internal knowledge?

- This decision depends on the specific **goals of a company**: A company that is not planning on exploiting a technology will make a different decision than a company whose core business depends on a specific technology
- The **efficiency of a specific tool depends on the context** in which it is used (e.g. in China the enforcement of IPR is weak, both in investigation and judicial process)
- Further influencing factors are the **type and characteristics of a technology** (e.g. a company producing measuring instruments patented the underlying process and standardized the relevant performance indicators and measurement procedures)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

2. How important is the protection of internal knowledge?

- Company goals:
  - How important is the broad diffusion of a technology or specific knowledge in its periphery?
    - Is it important that others use the technology or included knowledge?
    - What parts of the technology are central to the companies core business and should therefor remain exclusive or even a secret?
- Context:
  - How are the conditions in the geographical target market?
  - Can licensing incomes be generated?
  - Is it possible to detect and pursue patent infringements?
  - Is there a lot of competition? What are competitors interests?

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

2. How important is the protection of internal knowledge?

- Technology:
  - Is it easy to imitate the technology?
  - Can the technology be separated into different parts of which some are suitable for patenting and some for standardization?

Note: Some technologies can have inherent characteristics that are, per se, more conducive to standardization than patents, and vice versa (e.g. more potential for patenting in the domain of hardware)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

2. How important is the protection of internal knowledge?

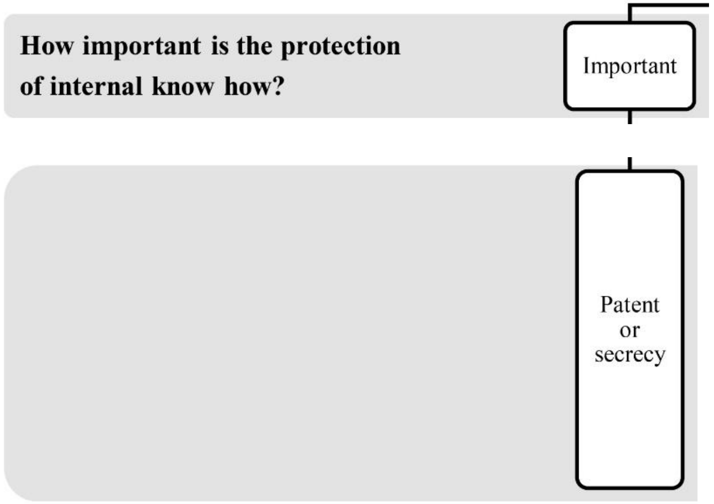
- Standardization:
  - Fosters **visibility and diffusion** of a technology or knowledge in its periphery
  - Serves as a form of publication and **prevents others from patenting** in this area
- Patenting:
  - Used to **protect** the company's **intellectual property**
  - Used to generate **licensing incomes**
  - The company needs to be **able to detect and pursue patent infringements**
  - If a technology is **easily imitable and patents can be easily bypassed** the instrument might be inefficient
  - **High competition** is more conducive to **patenting** than standardization
- Secrecy:
  - Used if the **solely disclosure of a technology** would pose an enormous **risk to the companies success**

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

2. How important is the protection of internal knowledge?

Note: If 'important' is chosen there are only two options:

- Patenting: Guarantees exclusive rights (e.g. important for the generation of licence incomes)
- Secrecy: Targeted prevention of the disclosure of business-critical technologies, information and other types of knowledge

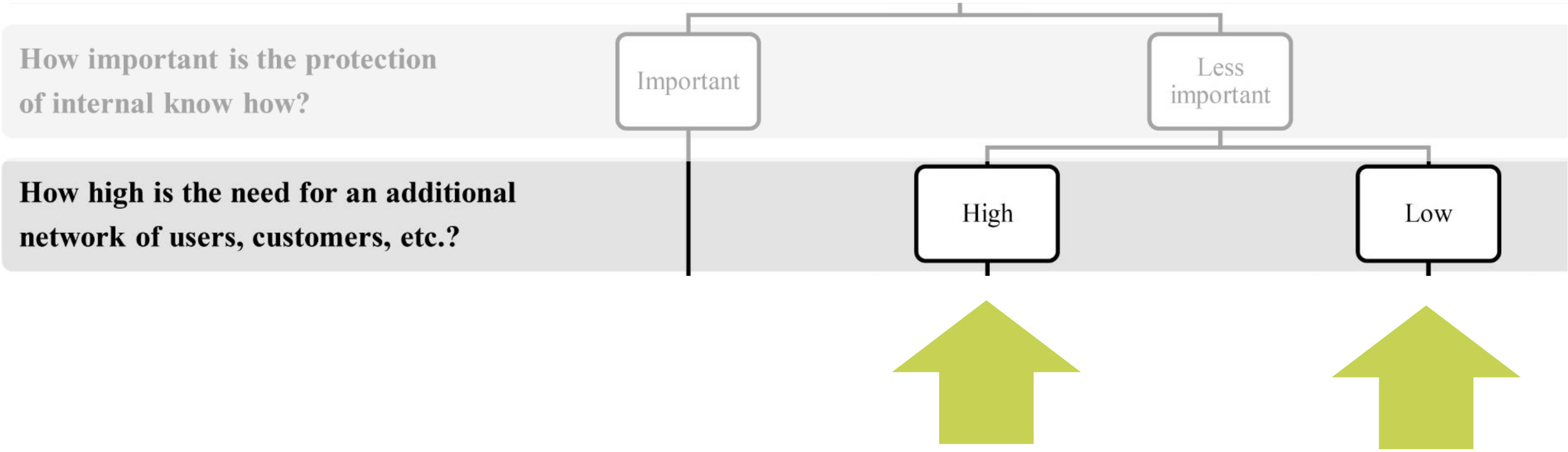


Source: Abdelkafi et al. (2016), p.20, Figure 1 (zoom in)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

3. How high is the need for an additional network of users, costumers etc.?

- High or low?



Source: Abdelkafi et al. (2016), p.20, Figure 1 (zoom in)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

3. How high is the need for an additional network of users, costumers etc.?

- Companies have **different needs** if it comes to their **business network**: Attracting investors and costumers, achieving positive network effects, cooperative R&D etc.
- ICT technologies and systems are often too complex to develop them in isolation: Companies **need to cooperate with other stakeholders** (e.g. competitors, suppliers) to realize their business ideas.
- Especially for young, small and medium enterprises the **development** of a working **business network is challenging**

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

3. How high is the need for an additional network of users, costumers etc.?

- Most important questions:
  - Is signalling important for the technologies or companies success (in the sense of reputation and visibility)?
  - Is it difficult to take up contact with “big players” in the technologies area?
  - Is compatibility to other systems or technologies important?
  - Does the technology benefit highly from positive network effects?
  - Is additional knowledge needed?
  - Are there SDOs active in the area of the companies technology?
  - Are potential business partners and/or competitors active in a specific SDO?

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

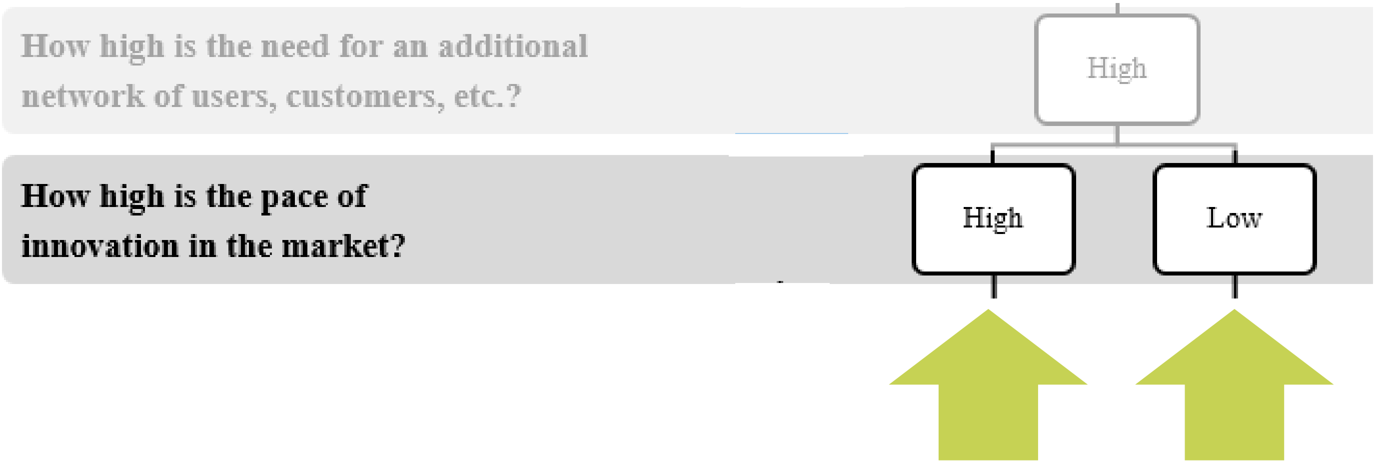
3. How high is the need for an additional network of users, costumers etc.?

- Standardization:
  - **Supports networking**: In technical committees competitors, suppliers, users and other important stakeholder work together to develop standards → contact on a 1:1 basis
  - **Insights** from the standardization process and the **knowledge exchange** between all participants foster R&D and the **target oriented development** of technologies (e.g. trough feedback from other stakeholders)
  - Supports **compatibility**, **diffusion** of a technology (thereby also positive network effects) and can be seen as a special form of **R&D collaborations** (Blind 2006)
  - The endorsement of a technology by a SDO is perceived as **proof of quality** and can enhance a company's **reputation**
- Patenting:
  - Patenting is a form of **signalling** and serves as a **proxy for innovation**
  - Especially **investors** see patents as a **leading indicator of profits**

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

4. How high is the pace of innovation in the market?

- High or low?



Source: Abdelkafi et al. (2016), p.20, Figure 1 (zoom in)

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

4. How high is the pace of innovation in the market?

- The **innovation pace** of a technological area influences the decision process: The development of patents and formal standards can take up to three years
- The duration of a **technologies lifecycle** is an important factor in the decision process: E.g. if the lifecycle is short a non-official standardization process could be more favourable because of its shorter duration (ca. 6 month)
- New market are often defined by a high **degree of uncertainty** concerning future technology paths and developments

7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

4. How high is the pace of innovation in the market?

- Most important questions:
  - How high is the market uncertainty concerning future developments?
  - How long is the lifecycle of own products or products in the market?
  - How many competitors exist in the market?

Note: Short product lifecycles and a high number of competitors are a reference to a high pace of innovation in the market.

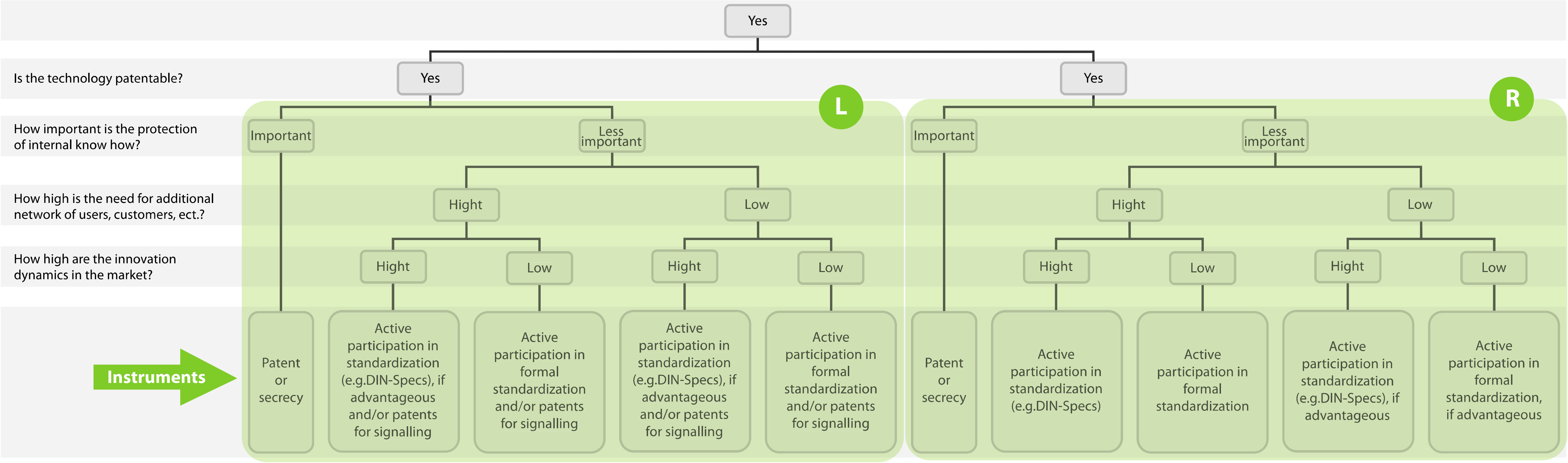
7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

4. How high is the pace of innovation in the market?

- Standardization:
  - The active or passive participation in standardization can support **positive knowledge overflows** and a better information base to **estimate future technology developments** in uncertain market environments
  - If the innovation pace is high or the own product lifecycle short the **time consuming process of formal standardization could prove itself as inefficient** (main risk: by the time of the publication the standard is already out of date)
  - **non-official standardization** could be an appropriate measure to **publish a standard promptly** (also: no 100% consensus has to be achieved)
- Patenting:
  - The process of patenting can take up to 3 years (or even more): As patenting is very costs sensitive this process could prove to **be inadequate in markets with a high pace of innovation**

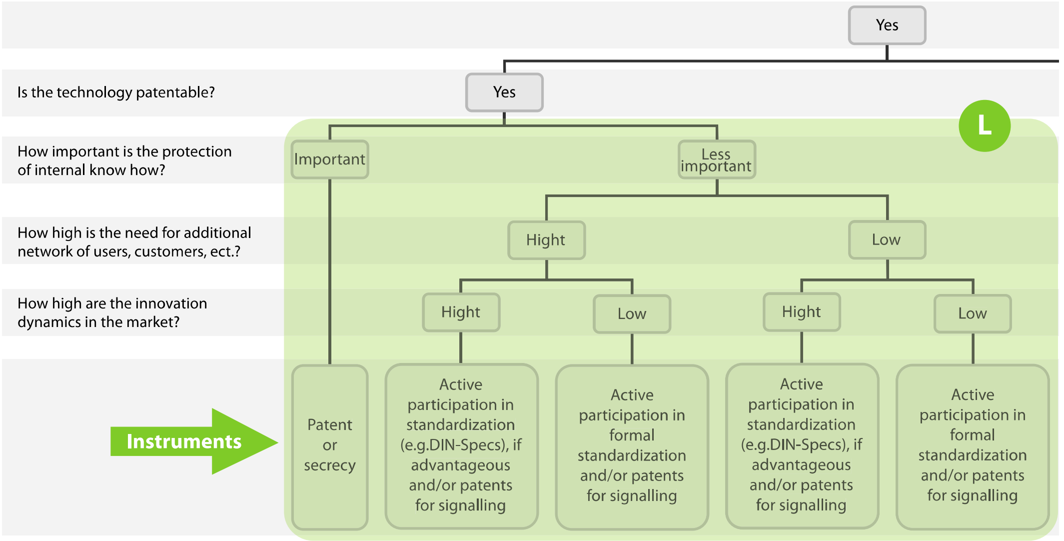
7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

- Depending on the path that a decision maker takes trough the decision tree, he/she can choose between different instruments
- The left part (L) describes solutions where patenting is possible and the right part (R) focuses solely on standardization



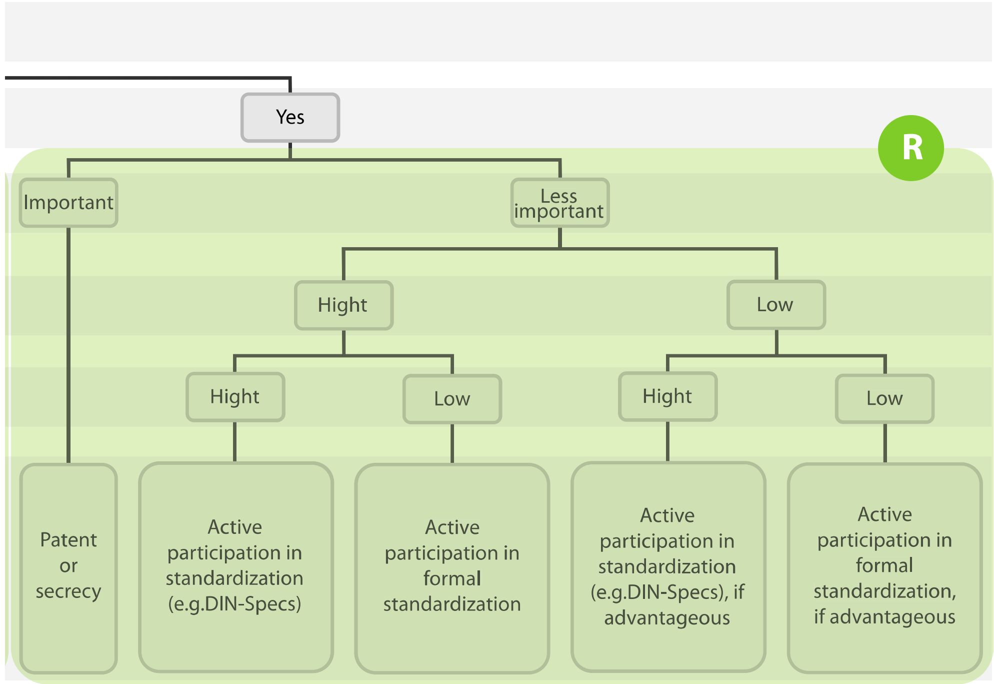
7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

- Instruments (left side of the tree):
  - **Patent**: Development of a patent
  - **Secrecy**: Keep internal knowledge and technologies a company secret
  - **Active participation in (non-official) standardization and/or patenting for signalling**: Choose a combined or a single strategy
  - **Active participation in formal standardization and/or patenting for signalling**: Choose a combined or a single strategy
  - **Possible combinations of standardization and patenting:**
    - Technologies could be integrated into standards in form of SEPs (in many cases this also increases possible licensing incomes)
    - Companies could patent their technologies and participate independently in standardization (patents around a standard are more likely to generate increased licensing incomes)
    - If a company cannot fight patent infringements it can be advisable to keep a low radar (if the IPR rules of a SDO allow so) and not disclose relevant IPR



7.2 A decision making tool: IPR vs. standardization
Decision tree: to standardize or to patent?

- Instruments (right side of the tree):
  - **Secrecy**: Keep internal knowledge and technologies a company secret
  - **Active participation in (non-official) standardization**: Participate actively in (non-official) standardization
  - **Active participation in formal standardization**: Participate actively in formal standardization



Note (applies to both sides of the tree): The term ‘if advantageous’ implies that the active participation in standardization should be carefully evaluated as its positive effect is lower than in the other end notes of the tree. E.g. if the ‘need of an additional network’ is ‘low’ a company must have other good reasons to participate. This could be the case if the integration of a technology in a standard is targeted to support its diffusion.

7.3 Case Studies: to standardize or to patent?
Secure Data GmbH (1/5)

- Secure Data offers IT security software, infrastructure and consulting for secure communication
  - Company data:
    - Start-up offering IT-services,
    - Hard-/software for secure communication
    - Founded 2008 in Germany
    - < 25 employees
  - Market situation:
    - Dynamic market, high innovation potential
    - Serve the German market
  - Participation in standardization process:
    - DIN SPEC
    - Network architecture of company’s services served as basis for DIN SPEC

7.3 Case Studies: to standardize or to patent?
Secure Data GmbH (2/5)

- Decision process
  - **Standardization (DIN SPEC)** is the selected instrument

A **DIN Specification**, or **DIN SPEC**, is also a document that specifies requirements for products, services and/or processes. However, in contrast to standards, DIN SPECs do not require full consensus and the involvement of all stakeholders. They are drawn up in temporary bodies called workshops. DIN SPECs are a trusted strategic instrument for quickly and easily establishing and disseminating innovative solutions on the market.

Source: DIN Deutsches Institut für Normung e. V (n.d.a)

- Why this choice?
  - To offer and promote new services (consultancy and certification) at the periphery of their technology

"The advantage of the standard is, that others might want to get certified and we can earn money from that. With the patent we most probably would not have a chance to do so, because people would simply use it without us ever noticing it."

7.3 Case Studies: to standardize or to patent?
Secure Data GmbH (3/5)

- Decision process
  - **Technology**
    - Technology is patentable
    - Technology can be standardized
    - Low chances to check for patent infringements
    - Technology is superior to available solutions
    - SDO was highly interested in the technology
  - **Resources**
    - Lack of resources
    - DIN-SPEC is funded with own money (no governmental subsidies)

"Patents have as much value as you can enforce by law."

"There is nothing comparable [to our product]. This had been checked extensively."

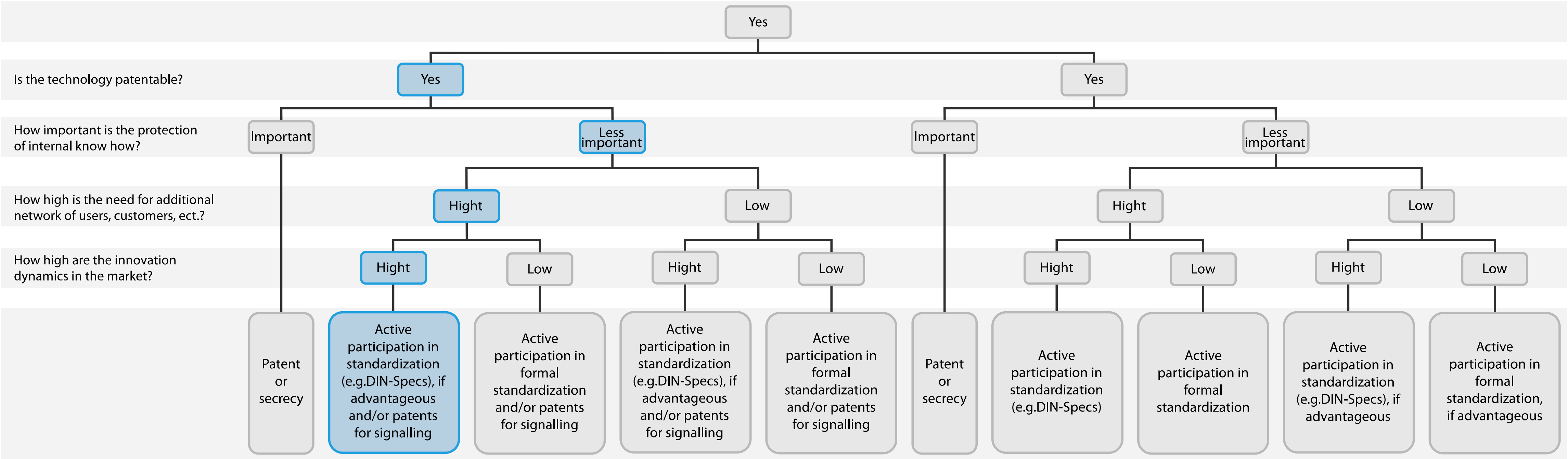
7.3 Case Studies: to standardize or to patent?
Secure Data GmbH (4/5)

- Decision process
  - **Knowledge protection vs. Knowledge diffusion**
    - Secure Data GmbH would not be able to check for patent infringements. Patenting is expensive (> 150.000 Euro estimated costs)
    - Fight against patent infringements would be costly
    - Standardization is more adequate because of the stronger reputation and diffusion
    - Standard will be sent to a big number of SDO partners

> *“Thanks to the DIN, the solution becomes more popular. […] It used to be a niche product. Only because of the publication process we got some extra requests for it.“*

7.3 Case Studies: to standardize or to patent?
Secure Data GmbH (5/5)

- Decision process
  - Secure Data GmbH opted for standardization (DIN SPEC)



7.3 Case Studies: to standardize or to patent?
Locator GmbH (1/5)

- Locator GmbH offers an embedded location platform (hard- and software) which enables robust, energy efficient ranging and localization

  - **Company data:**
    - operate in IT-business for 25 years
    - < 25 employees
    - Product portfolio: IC's wireless modules, tags, anchors and location engine software
  - **Market situation:**
    - Dynamic, high innovation potential
    - Formal and non-formal standardization documents are binding and of high importance
  - **Participation in standardization process:**
    - Patented embedded location platform
    - Standardized in IEC/ISO 24730-5 RTLS air-interface (global tracking)

7.3 Case Studies: to standardize or to patent?
Locator GmbH (2/5)

- Decision process
  - **Mixed approach: Formal standardization and patenting**
  - **Why this choice?**
    - To ensure exclusive rights and to generate license revenues, especially regarding the standardization activities (SEPs)
    - To achieve a wide dissemination of the company's patented technology and to conquer new markets

"We had developed the IP and we wanted to make them the standard."

"[…] to not just write the patent, but also to develop the strategy around it. I tell myself: what is the overall strategy for Innovations? It consists of both patents but also standards."

7.3 Case Studies: to standardize or to patent?
Locator GmbH (3/5)

- Decision process
  - **Technology**
    - Technology is patentable
    - Technology can be standardized
    - The patent portfolio covers the inventions and is considered an important asset (e.g. to attract investors)
  - **Resources**
    - Lack of resources
    - Investor needed to be convinced concerning the standardization activities

> *"Patents are generally needed when I search for investors. Until now I could not manage to raise enthusiasm among investors for having pushed forward a standardization."*

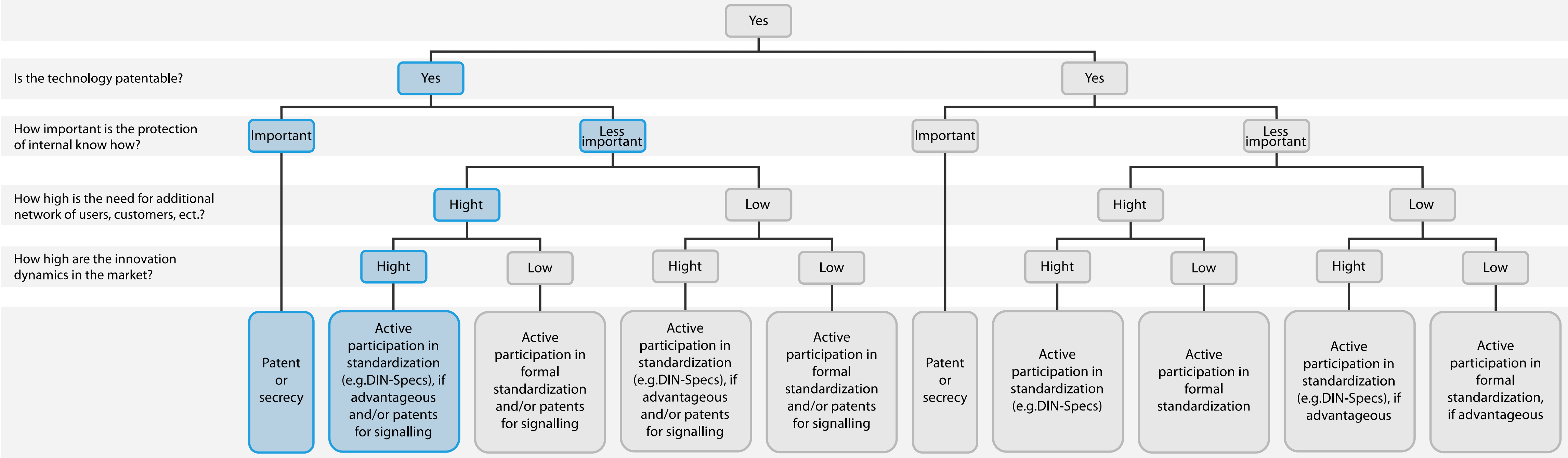
7.3 Case Studies: to standardize or to patent?
Locator GmbH (4/5)

- Decision process
  - **Knowledge protection vs. Knowledge diffusion**
    - Protection of IP was very important
    - Locator GmbH cannot fight patent infringements.
    - Use of standardization as a tool to diffuse their patented technology on an international level
    - Licensing of essential patents under fair and non-discriminatory terms (FRAND)

"I do not choose the countries because of the standardization activities, but I take the standardization to approach the countries."

7.3 Case Studies: to standardize or to patent?
Locator GmbH (5/5)

- Decision process
  - Locator GmbH pursues a hybrid strategy



List of abbreviations: Chapter 7

- IPR: Intellectual Property Rights
- IP: Intellectual Property
- SDO: Standards Developing Organizations
- ITU: International Telecommunication Union
- FRAND: Fair, Reasonable And Non-Discriminatory
- SUNM: Sun Microsystems
- PAS: Publicly Available Specification
- SEP: Standard-Essential Patent
- VHS: Video Home System
- HD DVD: High Definition Digital Versatile Disk

List of abbreviations: Chapter 7

- LED: Light Emitting Diode
- UL: Underwriters Laboratories
- CENELEC: European Committee for Electrotechnical Standardization
- AMP: Accelerated Mobile Pages
- IC: Integrated Circuit
- IEC: International Electrotechnical Commission
- LTE: Long Term Evolution
- RTLS: Real-Time Locating System

References: Chapter 7

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8 An Economic Perspective on Standardization

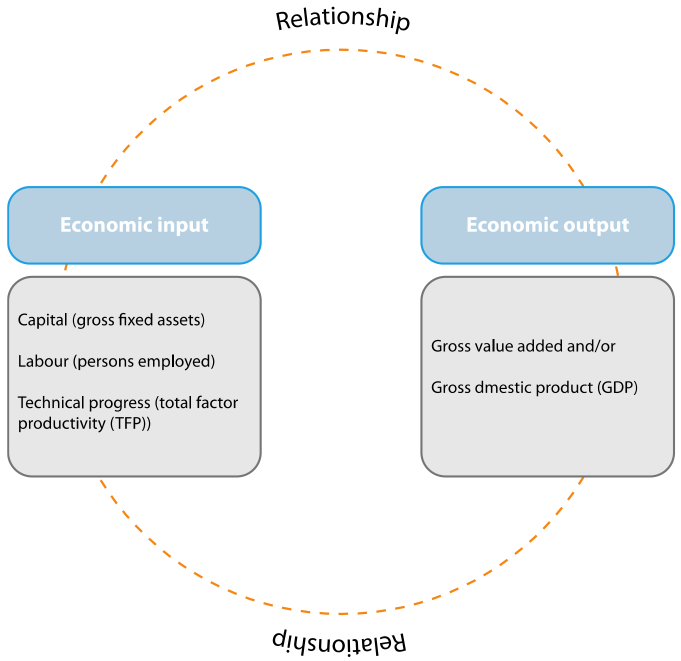
Contents

8.1 Economic contribution of standards
Contribution of standards to the GDP

- Several studies calculated the contribution of standards to economic growth:
  - Great Britain (DTI, 2005)
  - Germany (Blind et al., 2011)
  - France (Miotti, 2009)
  - Canada (Haimowitz and Warren, 2007)
  - …
- They are based on regression analysis: A statistical process for estimating the relationships among variables

8.1 Economic contribution of standards
Important variables (Blind et al., 2011)

- The Cobb-Douglas production function encompasses the entire business sector:



- Furthermore a national economy is also affected by external political factors (e.g. oil crises, “new economy” bubble burst) which have to be taken into account

Source: Blind et al. (2011)

8.1 Economic contribution of standards
The TFP (Total Factor Productivity)

- A country's technical progress increases with the number of companies that incorporate the technological knowledge; This means economic growth depends on:
  - Generation of knowledge/inventions
  - Wide dissemination among as many companies as possible
- Therefore the TFP comprises three factors:
  - Technological knowledge generated in a country
    (number of patents)
  - Technological knowledge imported from abroad
    (number of technological licence payments abroad)
  - The diffusion of this technological knowledge
    (number of standards)

8.1 Economic contribution of standards
The role of standards

- Committee standards are developed in consensus with the participation of all market participants (best case scenario)
- Opposed to codified knowledge in patents standard documents are accessible to all
- The benefits of standardization for economic growth lie in the dissemination of technological knowledge:
  - Increase the innovative strength and technological progress of a national economy
  - Counteract the diminishing marginal returns in capital and labour and therefore lead to sustainable growth (we are living in a knowledge economy)

8.1 Economic contribution of standards
The example of Germany (Blind et al., 2011)

- Increasing contribution of standards to the GDP throughout the 1970s
- 1986 – 1990 adjustments of the standard collection
- After German reunification the values stabilize at 0,7 to 0,8%

CONTRIBUTION TO GROWTH OF VARIOUS PRODUCTION FACTORS, IN %

	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.

Source: Blind et al. (2011)

8.1 Economic contribution of standards
Contribution of standards to the GDP

- So what does 0,7 – 0,8% of the GDP mean in monetary value?

16.77 billion Euros a year*

*from 2002-2006 in Germany

- After German reunification the values stabilize at 0,7 to 0,8%

Country	Publisher	Time frame	Growth rate of GDP	Contribution of standards
France	AFNOR (2009)	1950 – 2007	5.4 %	0.8 %
United Kingdom	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.				

Source: Blind et al. (2011)

8.1 Economic contribution of standards
Costs of standardization/standards from company's perspective

- Financing of standardization:
  - Usually participants (e.g. companies, academics) have to finance standardization activities themselves:
    - Membership fees (e.g. ETSI 6000€/year for SMEs)
    - Travel costs
    - Working hours of representatives
  - Offset of short-term costs versus long-term pay-off
- Standards can also work as barriers to trade (e.g. if set at an unreasonable level)

8.2 Economic effects of standardization
There is more to standards and standardization

- Our world is strongly reliant on standards: So how do standards impact our economy exactly?
- We already learnt that knowledge/innovation diffusion is one of the economic effects of standardization but there are more…

8.2 Economic effects of standardization
Effects of standardization

	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-competition, 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 • Raising rival's costs
Variety Reduction Standards	• Economies of scale • Building focus and critical mass	• Reduced choice • Leading to monopoly, market access barriers
Information/ measurement Standard	• Facilitates trade • Reduced transaction costs • Providing codified knowledge	• Regulatory Capture

Table: Effects of standards (Source: Swann (2000), Pham (2006), Blind (2013), modified)

8.2 Economic effects of standardization
Effects of standardization

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Table: Effects of standards (Source: Swann (2000), Pham (2006), Blind (2013), modified)

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- Compatibility

  An Essential role of standards is to ensure compatibility. The term includes two sub characteristic (ISO 25010):

  - **Coexistence**: An IT service/product sharing a common environment and resources with other independent services/products without adverse side effects
  - **Interoperability**: Ability of those components to work constructively with one another

8.2 Economic effects of standardization
Compatibility/ Interface Standards

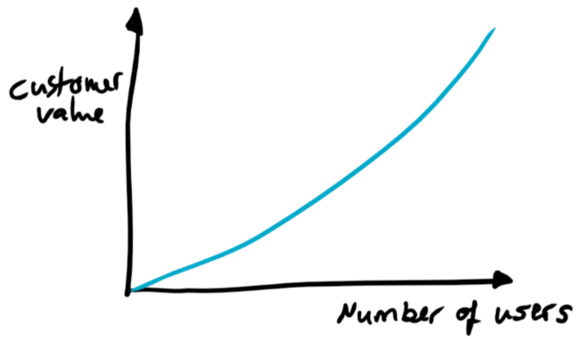
- Developments in the ICT sector demonstrated the economic importance of compatibility/ interface standards plays crucial role
- Two economic phenomena can influence costumers and producers in such markets:
  - Switching costs
  - Network effects
- If both exist, there is a risk that another economic phenomena occurs:
  - Lock-in effect

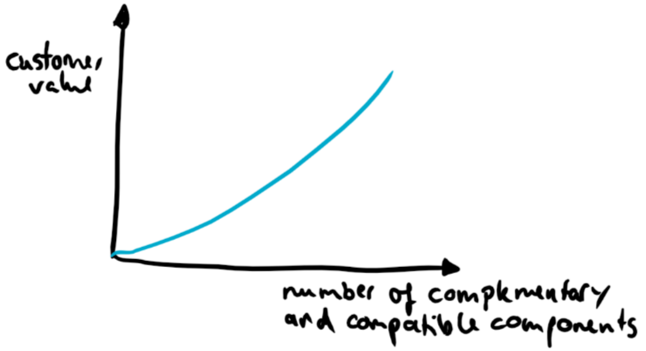
8.2 Economic effects of standardization
Compatibility/ Interface Standards

- Network effects – two forms:
  - Direct: The value of a good/services changes because the number of people using it changes

    Examples: Telephone, Fax, Facebook, Twitter, …
  - Indirect: The value of a good/service does not depend directly on the number of users but rather on the availability of complementary and compatible components

    Examples: Video game consoles, computer hardware and software, …





Source: Greenstein and Stango (2008)

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- Switching costs:
  Once producers or customers have invested into a particular interface or standard switching to another will become increasingly expansive

- Examples:
  - **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

Source: Parr et al.(2005)

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- Lock-in: Markets can get locked into inferior products/services/technologies because producers and costumers will only switch to a better design when:
  - All others do so too
  - They can afford the switching costs
- If one of the two conditions is not satisfied lock-in occurs

Source: Parr et al.(2005)

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- There are two dominant ways a standard can arise in the market:

Formal standard	De facto standard
• Developed in SDOs • Open and consensus oriented with opposition option, which may sometimes lead to lengthy decision procedures • Clear and transparent participation and voting rules • IPR policy has to follow FRAND licensing 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 • Flexible IPR rules according to the preferences of the initiators and technological/market contexts, which may favour exploitation of IPR

Notice: The winners of standard races do not necessarily possess the technology with the best performance, but are most effective in building a wide network and attracting suppliers of complementary products

Source: Blind (2008) modified

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- When a **standard is proprietary** lock-ins are more likely as one party has full control over it

- For the market lock-ins mean:
  - Barriers to market entry (e.g. high costs for proprietary standards or patents, high critical mass needed to pull current users to another environment)
  - Antitrust actions against a monopoly

Source: De Vries et al. (2008)

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- **Examples:**
  Microsoft (Windows API, file formats etc.)

> *In terms of the Windows API the Microsoft general manager for C++ development Aaron Contorer stated in an internal Microsoft memo 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)*

- **Windows exclusive franchise**: Windows grants other suppliers the right to use the Windows API (application programming interface) to produce systems according to its specifications
- Strategic role of API to maintain network effects and block competition
- Use of proprietary file formats in Microsoft's application software exhibits lock-in

Source: Deek and Am McHugh (2007)

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- **Examples:**

  Apple Inc. (iPod)

  - Digital music files with DRM (digital rights management) purchased from Apple's iTunes store in proprietary AAC format only compatible with Apple's iTunes media player software → User could not play purchased music in other software environments
  - After the launch of the iPod in 2001 and a licence deal with major music labels, Apple controlled almost 75% of US market for paid downloads
  - DRM conditions and incompatibility with other music players caused conflicts with consumer rights
  - After several suits for "unlawful bundling", since 2009 DRM is removed from digital music files

Source: Raustiala and Springman (2012)

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- **Open standards** have several positive effects on the market:
  - Attract producers of complementary products and customer who want to avoid dependence on one firm
  - Promote competition among multiple producers using the same standards while proprietary ones enhance the market power of a single producer (leading to a monopoly)

    > *“[…] it is better to have a share of a large market than a monopoly of a tiny one.” Swann (2000), p.5*

  - The risk of lock-in may be reduced because the standard is freely available (lowers barriers to entry and switching costs for consumers)
- Individual enterprises seeking for first mover advantages are more interested in closed and proprietary standards and later entrants will favour open ones

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- Compatibility standards help to reduce transaction costs: If buyers know that a particular piece of software is compatible with a particular operating system, the burden to verify that the software will run as expected is reduced

- These reduction of transaction costs also facilitate division of labour; Example of the computer industry:
  - A computer contains components from all over the world
  - Internationally accepted compatibility standards have led to a complete globalization of the industry
  - Producers specialize in a small part of the value chain to achieve economies of scale and sell their products around the world

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- Barriers to entry (effects can cut either way):
  - **Positive effects**: Generally accepted compatibility standards reduce the barriers to entry for small scale entrants producing “add on” products; Example:
    - Growth of cottage industry producing “Apps” for the iPhone:
    - Many of these companies are micro companies who could barley enter the software market at all in the absence of well-established platforms wit accepted compatibility standards
  - **Negative effects**: Closed standards can act as an barrier to entry which can lead to problems of monopoly around a proprietary standard

8.2 Economic effects of standardization
Compatibility/ Interface Standards

- What does this mean for companies?
  - Compatibility or interface standards support the increase of network effects and by this reaching a critical mass in the market
    - If network effects are important to the buyer it is likely that the supplier will produce a product/service that conforms to the prevailing compatibility standard on the market
    - To be successful companies can set on the prevailing standard in a market
  - If the market is young and fragmented standard races might take place
  - Producers that set on open standards might face higher competition (others could set on the same standard)

8.2 Economic effects of standardization
Effects of standardization

	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-competition, leading to monopoly • Lock-in in old technologies in case of strong network externalities
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Table: Effects of standards (Source: Swann (2000), Pham (2006), Blind (2013), modified)

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- **Minimum quality standards** refer to minimum acceptable requirements for the reliability, durability and safety of products/services and also working conditions.
  - They can be welfare improving for an economy (also in the areas of health and environment)
  - Help reduce the risk felt on the buyers side and increases trust between traders
    - E.g. the commodity market: Traders must be in a position to buy and sell large volumes without even viewing their trades presumes a clearly designed standard grade and also certification that the traded commodities meet that grade.
  - If set at an unnecessary high level they can also function as a barrier to entry

Source: Swinnen (2015) and Locksley (1990)

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- Costumers face a huge variety of different products and find it hard to assess which is suited for their purpose

- If buyers can not distinguish between different product variants it is hard for the quality seller to sustain a price premium (if costs exceed those of low quality sellers)

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- This is called Gresham's law - "bad drives out the good": Bad sellers (who only sell low quality products) drive out good quality sellers by undercutting them
- Worst case: The market will break down and lead to market failure

Source: Swann (2000)

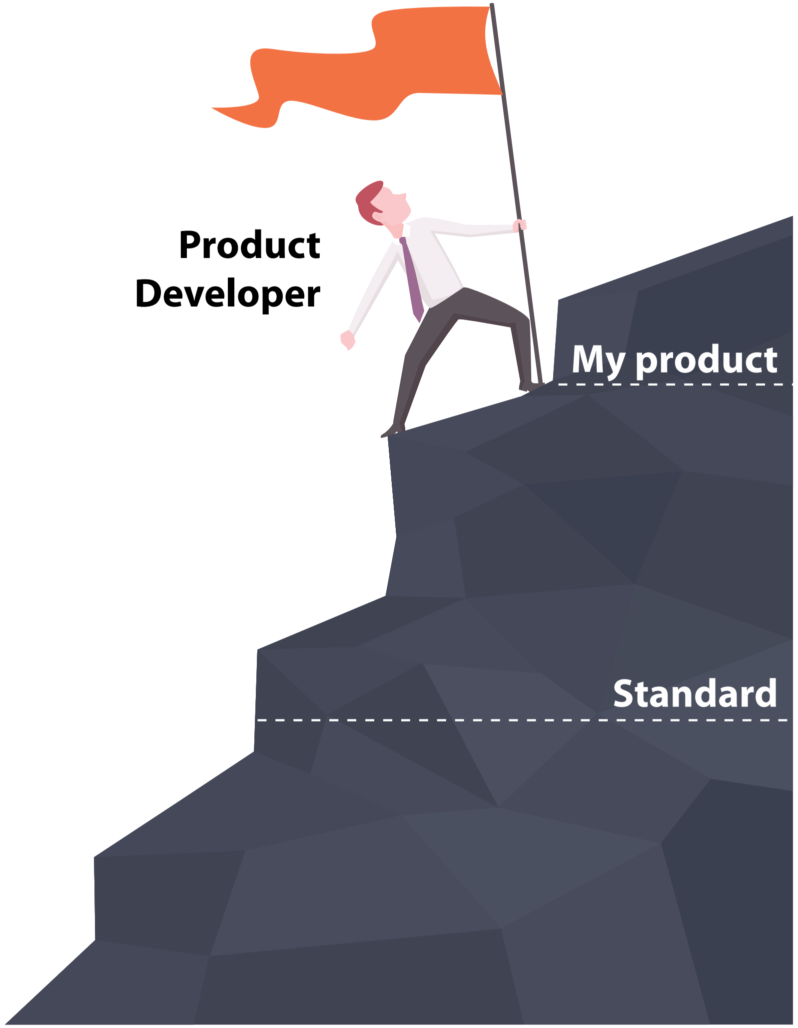
8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- This problem is based on information asymmetries between the buyers and sellers
- Information asymmetries mean that one party has more or better information than the other (here the buyer) which makes it hard for the former to make an informed decision
- Leland (1979) showed **minimum quality standards can help to overcome information asymmetries** as they function as a measure and define the minimum requirements a product should have: Buyers make faster and easier decisions

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- Some companies even trade on their reputation and can sustain a price premium for their products that are of quality well above the minimum threshold of a standard (the standard functions as proof for the distinguishing feature)

- Ex post restitution (e.g. a guarantee) can also work as a substitute for a certified minimum quality standard



8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- Minimum quality standards reduce transaction and search costs caused by economic exchange
- If a product is defined in a way that reduces buyer uncertainty:
  1. The buyer's risk is reduced
  2. Less need for the buyer to spend money and time on evaluating different products before a purchase
- Product certification can function as a shortcut for buyers as it proofs the compliance to a standard

Source: Pham (2006); Swann (2000); Swann (2010)

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- **What do minimum quality standards mean for new market entrants?**

  The effects of minimum quality standards on barriers to entry are uncertain:

  - General Presumption: When a products characteristics are documented in an open standard the playing field between incumbent and entrant gets levelled
  - In its absence incumbents have an information advantage over entrants: A standard can even this out!

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- **What do minimum quality standards mean for new market entrants?**

  The effects of minimum quality standards on barriers to entry are uncertain:

  - BUT: Quality standards set at an unnecessarily high level in order to deter entrants are a barrier to entry
    → Even if those standards impose a cost burden on incumbents this strategy can be very effective when the cost burden on entrants is greater still (→ "**raising rival's costs**" Salop and Scheffman (1983))

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- The concept of "**regulatory capture**" can be considered as a variant of the "raising rivals costs" concept:
  - **Basic idea:** Some producers may lobby to persuade the regulator to define regulations in their interest rather than in the interest of the buyer/costumer (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)

8.2 Economic effects of standardization
Minimum Quality/ Safety Standards

- Minimum quality standards should be **open** and **defined co-operatively** to ensure that all parties benefit and to overcome Gresham's Law
- Minimum quality standards can also **protect third parties**, e.g. in the area of health or environment to reduce negative impacts during production and consumption of the products

8.2 Economic effects of standardization
Effects of standardization

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Table: Effects of standards (Source: Swann (2000), Pham (2006), Blind (2013), modified)

8.2 Economic effects of standardization
Variety Reduction Standards

- **Variety reduction standards**: The reduction of the characteristic values of a product.

- Two main functions:

  1. They support economies of scale, by minimizing the proliferation of minimally differentiated models
     → E.g. standard clothing sizes: This also means compromises for non-standard customers and individual wishes (choice vs. price)
  2. They transaction costs on the customer's side, because they do not have to choose between a vast number of products

8.2 Economic effects of standardization
Variety Reduction Standards

- Variety Reduction can also **prevent market fragmentation** and support a **joint vision**:
  - Standards can shape future technological trajectories and are an instrument in the development of new markets (Dosi (1982); Swann and Gill (1993))
  - 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))
  - Some technologies get locked into a pre-paradigmatic stage because suppliers and users are too dispersed: Missing focus or critical mass impedes the development of a market (Swann and Watts (2002))

8.2 Economic effects of standardization
Variety Reduction Standards

- For suppliers less fragmentation also means reduced risk (even if they face more competition)
- Variety reduction standards can also reduce barriers to entry and transaction costs (effects could cut either way) …
  - …variety proliferation is sometimes used by incumbents to limit competition from small scale entrants who cannot provide the same degree of variety
  - …some incumbents try to restrict entry by companies with and idiosyncratic product specification

Source: Swann (2000); Pham (2006)

8.2 Economic effects of standardization
Variety Reduction Standards

- Do variety reduction standards need to be defined publicly?
  - **Not necessarily**: Economies of scale (best-known function of this type of standard) can also be obtained with an idiosyncratic model range
  - **But**: A store selling cloth in idiosyncratic sizes will not perform too well

8.2 Economic effects of standardization
Effects of standardization

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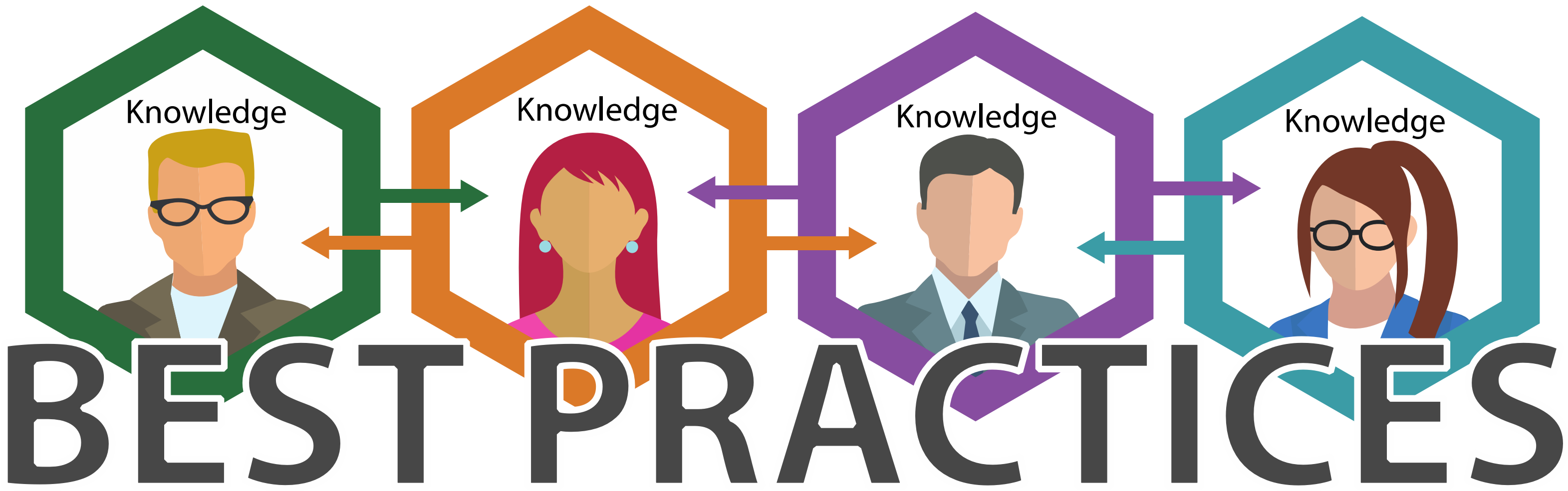
Table: Effects of standards (Source: Swann (2000), Pham (2006), Blind (2013), modified)

8.2 Economic effects of standardization
Information/ measurement Standard

- **Information and measurement standards**: Standards that contain codified knowledge and product descriptions
  - All standards contain information somehow: This type of standard can be seen as a hybrid of the former discussed functions of standards
  - As such this type of standard also triggers similar economic effects

8.2 Economic effects of standardization
Information/ measurement Standard

- Can be seen as important instruments of technology transfer as they...
  - ...contain the work and experience of generations
  - ...act as instruments in the dissemination of best practices



8.2 Economic effects of standardization
Information/ measurement Standard

- They have a positive effect on the market by **disseminating the knowledge** they contain. This way they support…
  - …building up competencies
  - …spreading essential production knowledge
    (⇨ open standards) and therefor supporting the levelling of the playing field between incumbents and entrants
  - …avoiding information asymmetries
  - …reducing barriers to market entry

8.2 Economic effects of standardization
Information/ measurement Standard

- During 1990s: rapid diffusion of image and video processing applications and advancement of multimedia technologies
  - → Increased importance of compression methods
- International SDOs developed several standards describing different compression methods, e.g. JPEG ("Joint Photographic Experts Group")
  - → Offered new solutions for saving storage place and reducing transmission rate requirements to industry
- Many software products based on these compression methods, e.g. sharing of digital images, remote sensing, archiving, image search

Source: ANSI (n.d.)

8.2 Economic effects of standardization
Information/ measurement Standard

- They **reduce transaction costs** between companies and sub-contractors by providing a **common language** and therefor…
  - …ease the writing of job descriptions, contracts etc.
  - …achieve a feasible division of labour

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Table: Effects of standards (Source: Swann (2000), Pham (2006), Blind (2013), modified)

8.2 Economic effects of standardization
Ultimate economic effects

- Economies of scale have positive effects on labour productivity and, in ‘healthy’ competitive conditions, also on prices
- Division of labour has been identified as a source of productivity growth and (mostly incremental) innovation; It is also associated with outsourcing and a growth in trade (mostly intra-industry)
- Growing competencies, greater precision and increased trust between traders are expected to increase productivity and innovation
- Declining transaction costs, greater precision and increased trust between traders are regarded as being linked to outsourcing, a growth in trade and with reduced incidence of market failure
- Declining barriers to entry and increasing network effects will have beneficial effects on new market entrants, competition and innovation

8.2 Economic effects of standardization
Demand side

- From a demand's perspective, standardization can support...
  - ...create critical mass
  - ...allow to start the exploitation of economies of scale in the formative stages of a market (standards can focus demand for innovation that might otherwise be fragmented over many technical solutions)
  - ...facilitate the formation of an installed base

→ This is especially true for ICT: Standards ease the emergence of technological platforms based on independent but interoperable components due to common technical standards

8.2 Economic effects of standardization
Open standardization

- Open standardization processes allow…
  - …that standards reflect users needs and this way promote the diffusion of new products by early adopters
  - …to set minimum requirements for environmental, health and safety aspects in order to reduce information asymmetries and to promote trust in innovative products

8.2 Economic effects of standardization
Major demand-side effects for innovation

- Different types of standards and their major demand-side effects for innovation:

	Different Types of Standards and their Major Demand-side Effects for Innovation			
	Generation of Network Effects	Generation of Economies of Scale	Reduction of Information Asymmetries	Reducing Uncertainty and Risk
Compatibility/ Interoperability	X			
Minimum Quality/ Safety				X
Variety Reduction		X		
Information			X	

Source table: Blind (2013), p.15

8.3 Public procurement and standardization
The use of Public procurement and standardization

- The public sector can use standards in the context of public procurement (e.g. in tender specifications) to benefit from these demand-focused functions of standardization
- The public sector can use standards in the context of public procurement (e.g. in tender specifications) to benefit from these demand-focused functions of standardization

8.3 Public procurement and standardization
A explanation of the term public procurement

- Public Procurement
  - 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 furniture for a public prosecutor’s office
    - Contracting cleaning services for a public university

Source: Blind (2013)

8.3 Public procurement and standardization
Positive effects of innovation for public procurement

- Positive effects:
  - Improve the quality of public services and infrastructures
    → high costumer, e.g. citizen, satisfaction
  - Improvement in public services can lead to intensified competition between regions
  - Innovations may lower costs over the whole life cycle of a technology (lower maintenance, energy or repair costs)

8.3 Public procurement and standardization
Example: Disseminating accessibility standards

- Access to ICT supports people with disabilities to equal access to education and services
- ETSI standard EN 301 549 (intended for use in public procurement) ensures that software products, web applications and digital devices satisfy basic accessibility requirements
- Governments can improve accessibility of ICTs by referencing the standard in public tenders (e.g. ticket vending machines, websites)
- Companies applying for these tenders need to comply with the accessibility criteria laid down in the standard

Source: ETSI (2014); Rice (2015).

8.3 Public procurement and standardization
Negative effects of innovation for public procurement

- Negative effects:
  - Due to new features or improved functionalities the purchase price might be higher
  - Innovative technologies bear higher risks for the user, but also e.g. for the environment → can increase maintenance costs due to less experience
  - Specific innovation can only be produced by a small number of companies (or even a single one)

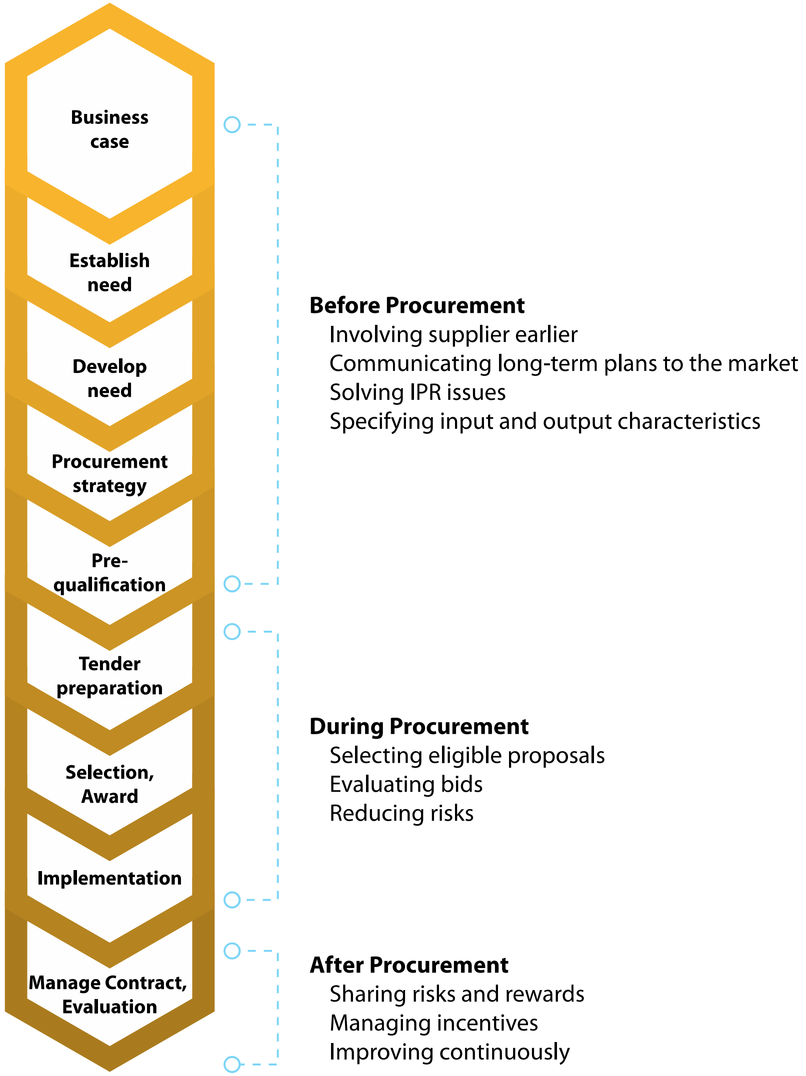
8.3 Public procurement and standardization
Standards in public procurement

- Standards referenced in public tender mean:
  1. Innovative products can reduce production costs: Lowering the price to be paid by public procurers
  2. Securing the interoperability of the purchased innovation with already existing infrastructure
  3. Pushing the competition and therefor the innovation pressure among competitors for public tenders
  4. Reduction of the risk of lock-in to a specific supplier
  5. Direct innovation effects for companies through the implementation of newly released standards
  6. Reduced risk related to costs, health, environment and safety
  7. Facilitation of positive spill-overs on innovation promoting procurement processes in the private sector

Source: Blind (2013)

8.3 Public procurement and standardization
The procurement process

- Standards come into pay at various stages of the procurement process:



Source: Blind (2013)

8.3 Public procurement and standardization
The procurement process

- Public procurement process and standards
  - Before procurement
    - Analysis of appropriate standards
    - Strategic referencing of standards
  - During procurement
    - Selection of proposals can be based on compliance to required basic standards
    - Possible conflicts can be solved with help of standards
  - After procurement
    - Reduced transaction costs by identifying deviations using standards as references
    - Easier monitoring of technology by taking newly released standards into account

Source: Blind (2013)

List of abbreviations: Chapter 8

- GDP: Gross Domestic Product
- DTI: Department of Trade and Industry (United Kingdom)
- TFP: Total factor productivity
- AFNOR: Association Française de Normalization
- JPEG: Joint Photographic Experts Group
- API: Application Programming Interface
- DRM: Digital Rights Management
- AAC: Advanced Audio Coding

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