



International Standardization in Software and Systems Engineering and the Global IT Market

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Thesis

- **Information and Communications Technologies (ICT) are a critical infrastructure of the global economy**
- **ICT are ubiquitous in post-industrial societies**
- **ICT Systems are Software Intensive**
- **ICT industry and services are a significant component of the world economy**
- **ICT industry and services, including software systems development and operations, are now globalized**
- **All of the above trends are increasing...**

Consequently

- **An Internationally recognized body of Software and System Engineering standards is required for:**
 - **Protect the public by ensuring product and services quality**
 - **Facilitate global ICT commerce**

CONTENT

- **What is a standard?**
- **Types of standards**
- **International standardization**
- **Value-add of international standardization**
- **International IT standardization**
- **Software and system engineering**
- **The global IT market**
- **SC7 Standards and the Global IT Market**
- **Conclusions**

Introduction – International Standardization

What is a Standard?

Guideline documentation that reflects agreements on products, practices, or operations by nationally or internationally recognized industrial, professional, trade associations or governmental bodies

or

is accepted as a de facto standard by industry or society.

Types of Standards

- **Organization Standards**
 - Such as internal company standards
- **Market Standards (De Facto)**
 - Such as Microsoft Windows
- **Professional Standards**
 - Developed by Professional organizations (such as IEEE)
- **Industry Standards**
 - Developed by industrial consortia (such as the OMG)
- **National Standards**
 - Developed by national standards organization
- **International Standards**
 - Developed by formal international standard organization

International Standardization

(Technical standards)

- **International Telecommunication Union (ITU)**
 - **Founded:** 17 May 1865
 - **Scope:** international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services.
- **International Organization for Standardization (ISO)**
 - **Founded:** 1947
 - **Scope:** The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity.
- **International Electromechanical Commission (IEC)**
 - **Founded:** June 1906
 - **Scope:** the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies.

Normal (ISO) Standardization Process

The normal process for international standardization is:

- **Stage 0 (preliminary stage):** A study period is underway.
- **Stage 1 (proposal stage):** An New Project is under consideration.
- **Stage 2 (preparatory stage):** A Working Draft is under consideration.
- **Stage 3 (committee stage):** A Committee Draft /Final Committee Draft is under consideration.
- **Stage 4 (approval stage):** An Final Draft International Standard is under consideration.
- **Stage 5 (publication stage):** An International Standard is being prepared for publication.

Available Processes

- International standards can come into being through different processes:
 - as a proposal that is then developed in working groups (3-5 years);
 - as a proposal with a base document which can be internally *fast-tracked*, e.g. processed through a compressed schedule (about 2 years);
 - as a proposal with a complete document that can be fast-tracked by JTC 1 (one four months ballot) (< 1 year);
 - as a proposal with a complete document that can be proposed by external (but recognised) organisations and fast-tracked as a 4 month ballot - known as the PAS process (1-2 years).

Time to market

The perception that the development of formal international standards always takes an exceeding amount of time is basically wrong.

When it is the case, this is for usually one (or a combination) of the following:

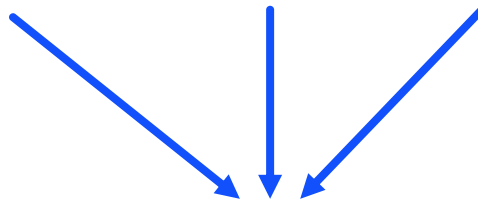
- **The topic is new and it takes time to come with a unified international view**
- **International consensus on the topic is weak due to positions that are difficult to bring together**
- **Management of the development process is sub-optimal**

Internationalization of Standards

National
Standards

Professional
Standards

Industry
Standards



**International
Standards**

Consensus

- **Key concept in the development of International standards**
- **ISO defines consensus as [4]:**

General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments.

Consensus

In a nutshell, this means:

- **That all the parties involved were able to voice their views.**
- **That the best effort was made to take into account all of the above views and resolve all issues (meaning all comments tabled during a ballot).**
- **That nearly all or (ideally) all the parties involved can at least live with the final result.**

Value add of International Stds

In addition to the Brand:

- **They represent an international consensus attained through a very rigorous and uniform process**
- **International standards usually represent set of conventions and/or technical requirements or practices that are relatively stable**
- **The development process makes it relatively difficult and costly for special interests to take over a given standardization project, especially if the topic is controversial.**



Information and Communication Technologies (ICT) Standardization

In 1988, ISO and IEC put together a Joint Technical Committee, Joint Technical Committee 1 (JTC 1) with the following mandate:

Standardization in the field of Information Technology.

Information Technology includes the specification, design and development of systems and tools dealing with the capture, representation, processing, security, transfer, interchange, presentation, management, organization, storage and retrieval of information

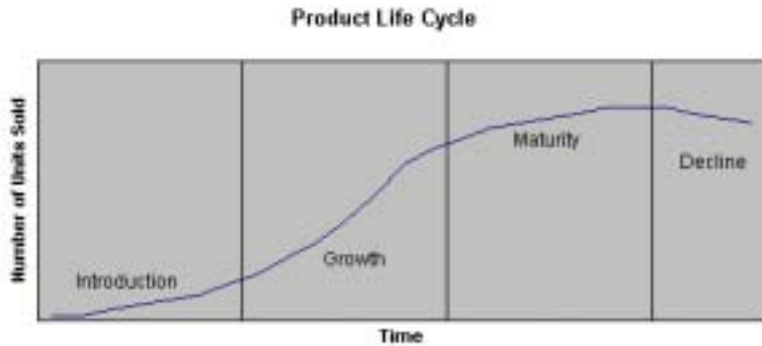


JTC 1

Technical Areas	JTC1 Subcommittees and Working Groups
Application Technologies	SC 36 - Learning Technology
Cultural and Linguistic Adaptability and User Interfaces	SC 02 - Coded Character Sets SC 22/WG 20 – Internationalization SC 35 - User Interfaces
Data Capture and Identification Systems	SC 17 - Cards and Personal Identification SC 31 - Automatic Identification and Data Capture Techniques
Data Management Services	SC 32 - Data Management and Interchange
Document Description Languages	SC 34 - Document Description and Processing Languages
Information Interchange Media	SC 11 - Flexible Magnetic Media for Digital Data Interchange SC 23 - Optical Disk Cartridges for Information Interchange
Multimedia and Representation	SC 24 - Computer Graphics and Image Processing SC 29 - Coding of Audio, Picture, and Multimedia and Hypermedia Information
Networking and Interconnects	SC 06 - Telecommunications and Information Exchange Between Systems SC 25 - Interconnection of Information Technology Equipment
Office Equipment	SC 28 - Office Equipment
Programming Languages and Software Interfaces	SC 22 - Programming Languages, their Environments and Systems Software Interfaces
Security	SC 27 - IT Security Techniques SC 37 - Biometrics
Software and Systems Engineering	SC 07 - Software and System Engineering

Information and Communication Technology (ICT) Evolution and Software and Systems Engineering

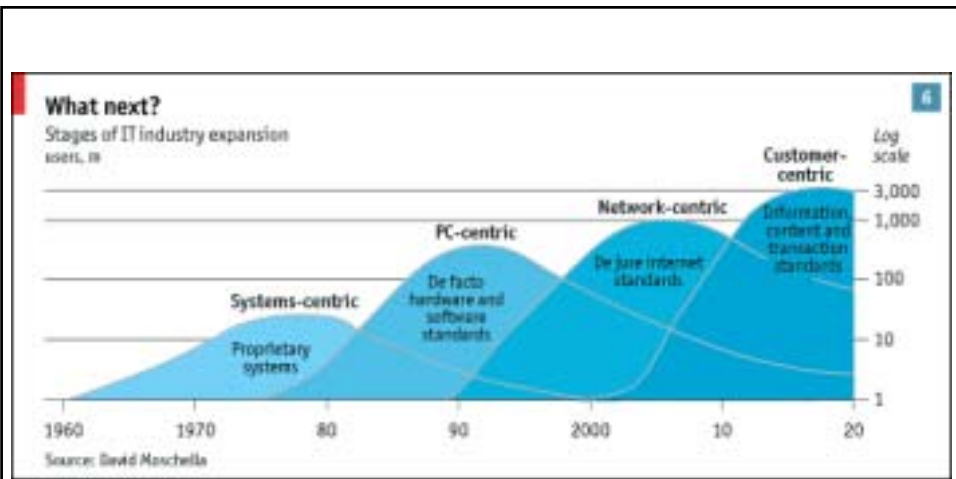
Classic S Curve



<http://www.sfu.ca/~mvolker/biz/pushpull.htm>

Technology Hype Cycle





From: *The fortune of the commons. In Coming of Age - A Survey of the IT Industry.*
The Economist, May 8th 2003

How much information ?

Table 1.2: Worldwide production of original information, if stored digitally, in terabytes circa 2002. Upper estimates assume information is digitally scanned, lower estimates assume digital content has been compressed.

Storage Medium	2002 Terabytes Upper Estimate	2002 Terabytes Lower Estimate	1999-2000 Upper Estimate	1999-2000 Lower Estimate	% Change Upper Estimates
Paper	1,634	327	1,200	240	36%
Film	420,254	76,69	431,690	58,209	-3%
Magnetic	4,999,230	3,416,230	2,779,760	2,073,760	80%
Optical	103	51	81	29	28%
TOTAL:	5,421,221	3,416,281	3,212,731	2,132,238	69%

Source: *How much information 2003*
<http://www.sims.berkeley.edu/research/projects/how-much-info-2003/execsum.htm#summary>

How much information ?

Table 4.3: Annual production of hard disks: units shipped and total storage capacity

Year Disks	Sold (Thousands)	Storage Capacity Sold (Petabytes)
1992	42,000	
1995	89,054	104.8
1996	105,686	183.9
1997	129,281	343.63
1998	143,649	724.36
1999	165,857	1394.60
2000	200,000 (IDEMA)	4,630.5
2001	196,000 (Gartner)	7,279.14
2002	213,000 (Gartner projection)	10,849.56
2003	235,000	15,892.24
TOTAL	1,519,527 (1.5 billion drives)	41,402.73 (41 exabytes)



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Source: *How much information 2003*

<http://www.sims.berkeley.edu/research/projects/how-much-info-2003/execsum.htm#summary>

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How much information ?

Table 1.13: The size of the Internet in terabytes.

Medium	2002 Terabytes
Surface Web	167
Deep Web	91,850
Email (originals)	440,606
Instant messaging	274
TOTAL	532,897



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Source: *How much information 2003*

<http://www.sims.berkeley.edu/research/projects/how-much-info-2003/execsum.htm#summary>

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ICT Drivers

- Moore's Law is still holding, at least till the end of the decade.
- Nanotechnologies ICT commercial applications may appears on the market around the middle of the decade.
- While some ICT markets are maturing and becoming commodities, new technologies are continuing to appears.
- The consumer market appears to now be a significant driver for ICT.

Markets Size (10⁹ US \$)

ICT Vendor 2002

Telecommunications equipment	380
Computer Systems Hardware	240
Software Licenses	70
Project Oriented IT Services	250
Semiconductors	150
Support/Management IT Services	350
TOTAL	1 440

Reference: R.Fulton, COM-15-1667, Predicts 2002 – What's Ahead for the IT Industry, Gartner Research, Research Note, 2002-01-08
http://www.adabasnatural4ever.com/industry_news/media/predicts_2002_whats_ahead_for_the_it_industry.pdf

'OFFSHORE' Outsourcing Information Systems

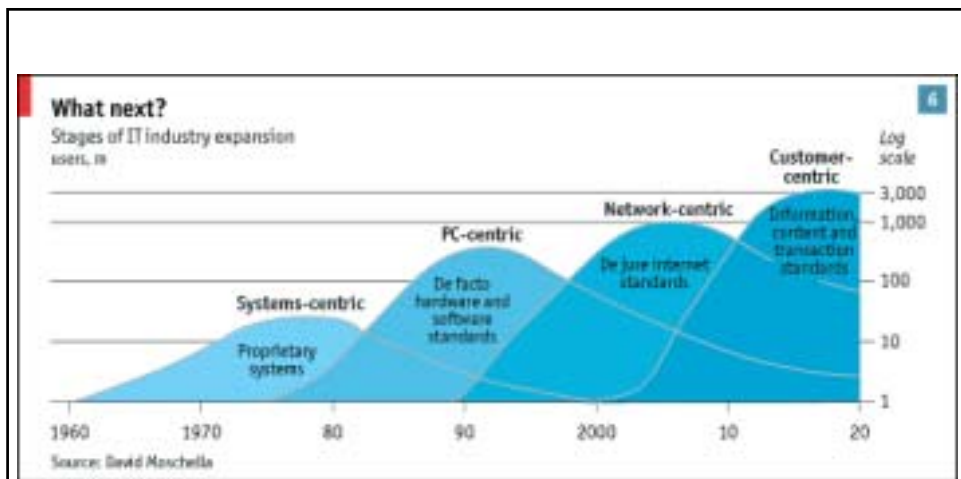
LEADER	India
CHALLENGERS	Canada, China, Czech Republic, Hungary, Ireland, Israel, Mexico, Northern Ireland, Philippines, Poland, Russia, South Africa
UP-AND-COMERS	Belarus, Brazil, Caribbean, Egypt, Estonia, Latvia, Lithuania, New Zealand, Singapore, Ukraine, Venezuela
BEGINNERS	Bangladesh, Cuba, Ghana, Korea, Malaysia, Mauritius, Nepal, Senegal, Sri Lanka, Taiwan, Thailand, Vietnam

The offshore IT race. SOURCE: CARTNER INC as quoted by the Globe and Mail in IT jobs contracted from far and wide, North American companies are saving money by 'offshoring', John Saunders, The Globe and Mail, 2003-10-14, <http://www.theglobeandmail.com/servlet/story/RTGAM.20031014.grjobs14/BNSStory/insider>

Computer Game Market (billions of \$ US)

	2000	2001	2002	2003
Games Software	13	15	17	19
Cinema box-office receipts	18	18	19	20
DVD/Video	18	21	26	30
CDs	35	33	32	32

From: Console wars, Jun 20th 2002, The Economist http://www.economist.com/displayStory.cfm?Story_ID=1189352



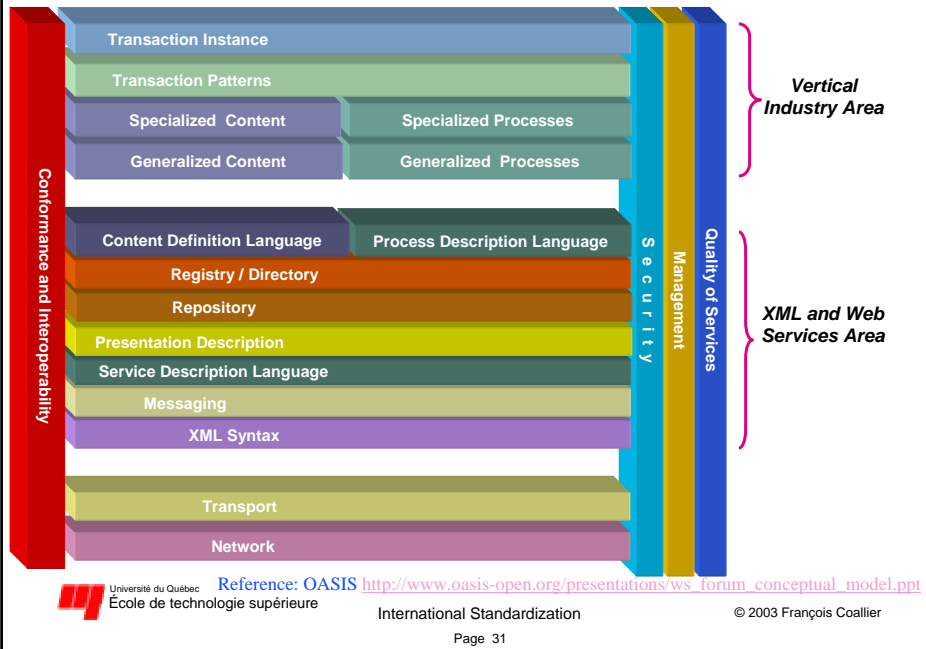
From: *The fortune of the commons*. In *Coming of Age - A Survey of the IT Industry*.
The Economist, May 8th 2003

Web Services

Web Services [1] describes a standardized way of integrating applications over an Internet protocol backbone. The Internet core specifications include Http, URI and MIME. The Web Services core specifications include XML, SOAP, WSDL and UDDI. Used primarily as a means for businesses to communicate with each other and with clients, Web services allow organizations to communicate data without intimate knowledge of each other's ICT systems behind the firewall. Web services thus share business logic, data and processes through a programmatic interface across a network.

[1] Definition inspired from http://www.webopedia.com/TERM/W/Web_services.html

OASIS B2B Conceptual Model (2003)



Systems Integration



From « When computers learn to talk: A Web services primer », S. Patil et S. Saigal, The McKinsey Quarterly, no 1, 2002, Web exclusive



Software and Systems Engineering Trends

■ Technology

- Software engineering is getting more mature

■ Markets

- A lot of software is bought – not developed
- Some Software Systems development and maintenance services are becoming commodities, other remain high value add
- The Internet is making geography less relevant for some Software Systems development and maintenance services

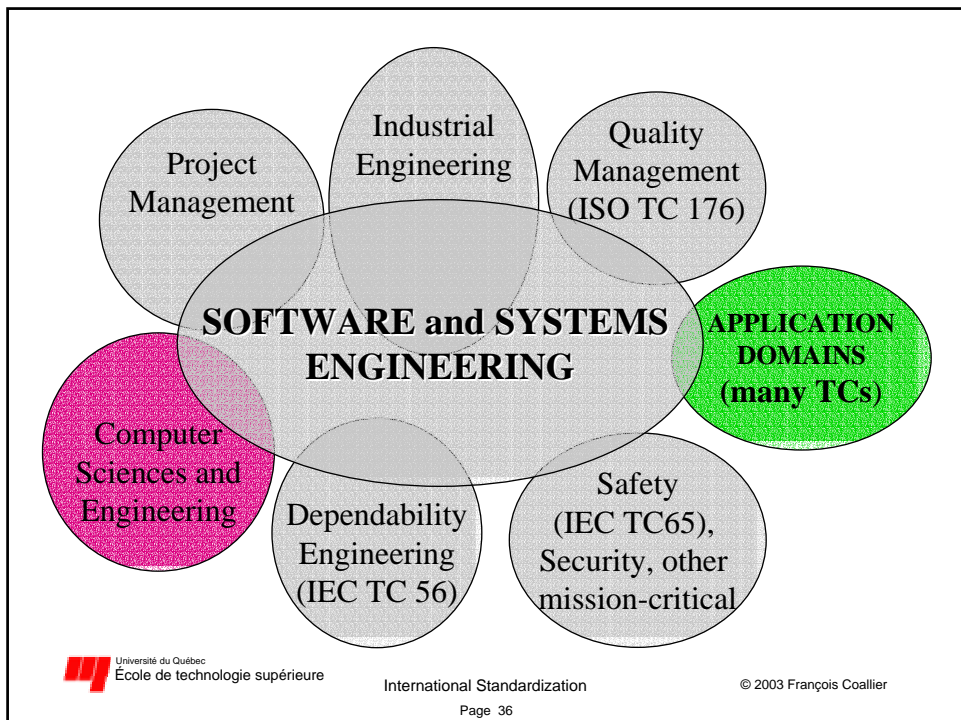
■ Standards

- A growing international consensus on software and systems engineering good practices is formalized.

JTC 1/SC7

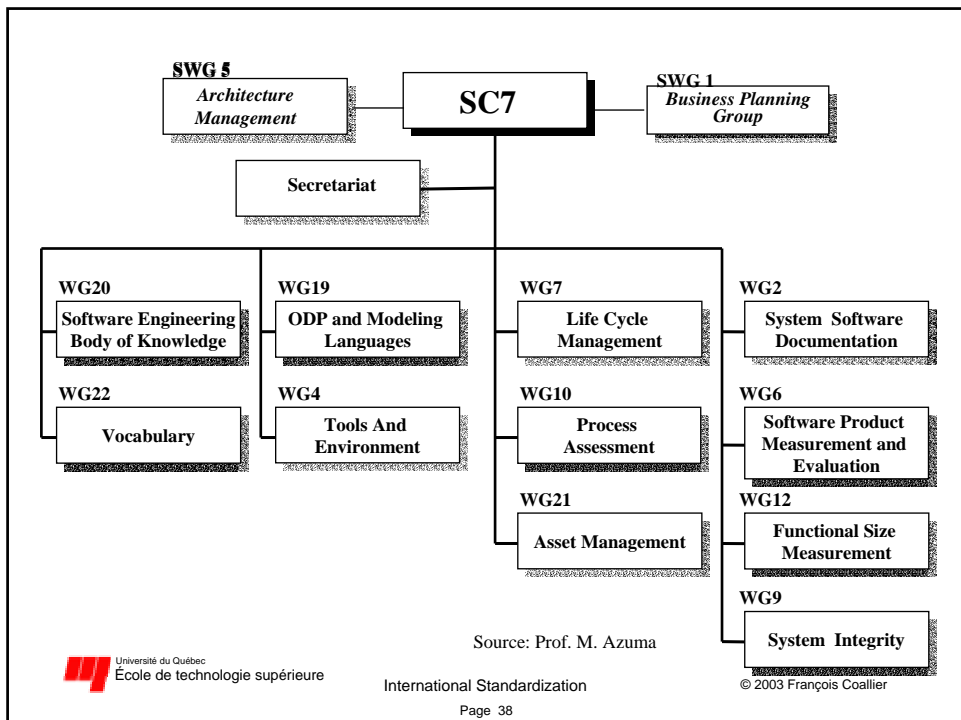
JTC 1/SC7 MANDATE

*Standardization of processes,
supporting tools and supporting
technologies for the engineering of
software products and systems*



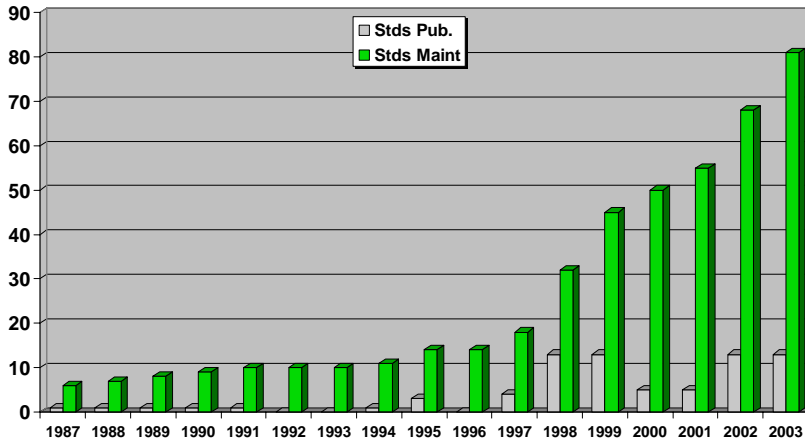
SC7 Program of Work

- Software and system engineering processes
- Software system products
- Enterprise architecture
- Software engineering environment
- Software and system engineering formalisms
- Software engineering body of knowledge
- Management of software assets



SC7 Production (est.)

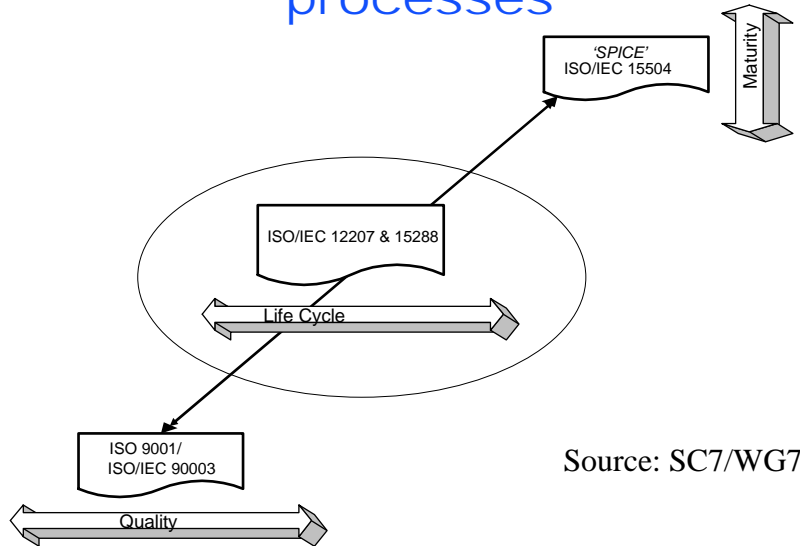
(No new NWI assumed - exclude dependability, include PAS)



Software and system engineering processes

- **Standards which describe good software and system engineering practices, as well as standards to consistently assess organisational software and system engineering practices against a given benchmark**
- **18 published standards**
- **9 active projects**
- **Key standards:**
 - **ISO/IEC 15288 - Systems Life-Cycle Processes**
 - **ISO/IEC 12207 - Software Life-Cycle Processes**
 - **ISO/IEC 15504 series – Process Assessment**
 - **ISO/IEC 90003 – Guidelines for the application of ISO 9001 to software**

Software and system engineering processes



Source: SC7/WG7



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Software system products

- **Standards which allow purchasers and buyers to size and document software products as well as to express, measure and evaluate the quality of the software that is produced and its contribution to the final product or application system**
- **17 standards**
- **16 active projects**
- **Key standards:**
 - **ISO/IEC 9126 set on Software Products Metrics**
 - **ISO/IEC 14598 set on Software Product Evaluation**
 - **ISO/IEC 14143 set, 19761, 20926, 20968 and 24570 on Functional Size Measurement**

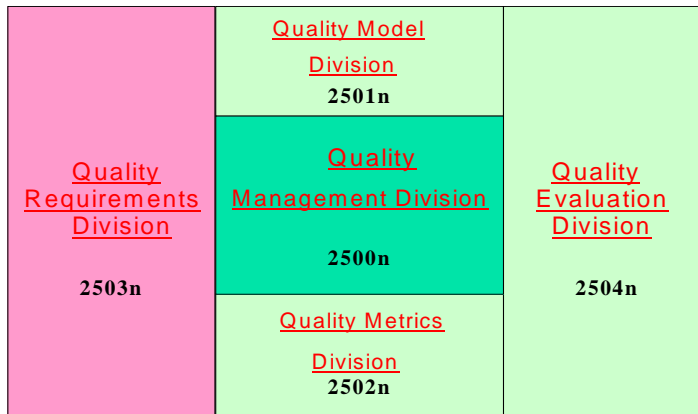


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Source: SC7/WG6

Enterprise architecture

- In partnership with the Object Management Group (OMG), we are developing and are improving on Open Distributed Processing (ODP) standards to integrate IT and business system definition and provide the software and system engineering tools to implement enterprise information systems
- 11 standards
- 10 active projects
- Key standards:
 - ISO/IEC 14750 ODP – Interface Definition Language
 - ISO/IEC 14771 ODP – Naming framework
 - ISO/IEC 14753 ODP – Interface references and binding
 - ISO/IEC 14752 ODP – Protocol support for computational interactions
 - ISO/IEC 13235 ODP – Trading Function
 - ISO/IEC 14769 ODP – Type repository

ODP Standards

■ Goals of ODP standards

- **portability of applications despite heterogeneity**
- **interworking between ODP systems**
 - exchange information *meaningfully*
 - use functionality *conveniently*
- **distribution transparency**
 - hide the consequences of distribution for applications

■ Reference Model for Open Distributed Processing

A *specification framework (and standards framework)* covering all aspects of distributed systems

- “enterprise”, system, technology
- **comprehensive and coherent object-oriented modelling concepts**
- **Viewpoints and viewpoint specifications:**
 - enterprise
 - information
 - computational
 - engineering

ITU-T Rec. X901-904|ISO/IEC 1746 Parts 1-4

Source: SC7/WG19

Software engineering environment

■ Standards which make it easier to use software engineering environments and to re-use and re-deploy the data contained in them

■ 2 standards

■ 1 active project

■ Key standards:

- **ISO/IEC 14102 Guideline for the evaluation and selection of CASE tools**
- **ISO/IEC 14471 Guidelines for the adoption of CASE tools**

Software and system engineering formalisms

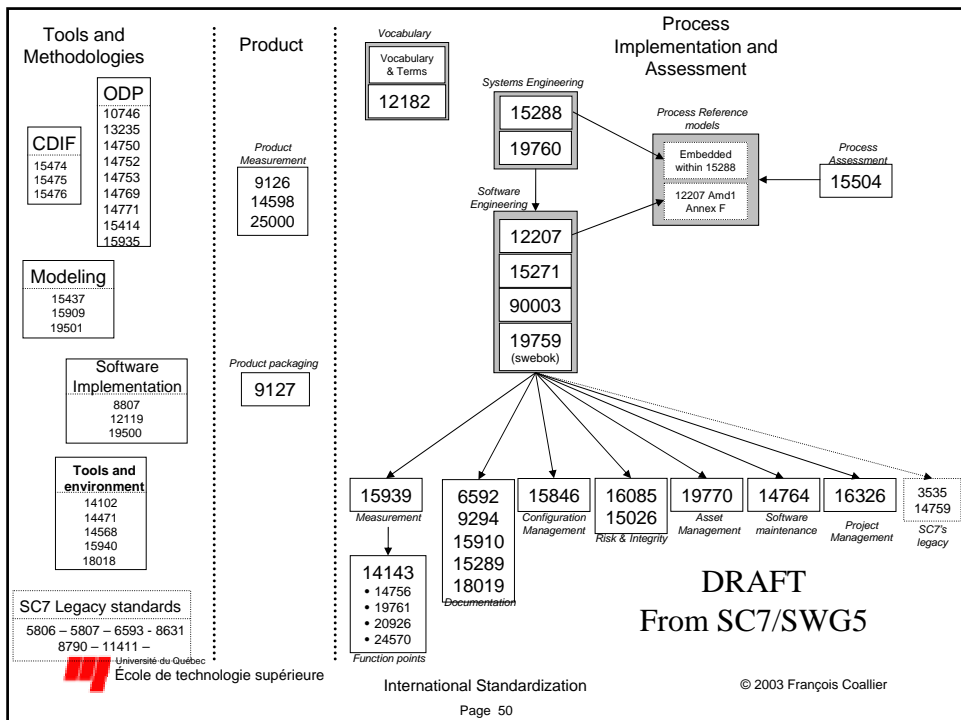
- **Standards for formal representations and modeling of software and systems**
- **5 standards,**
- **1 active project**
- **Key standards:**
 - **ISO/IEC 19501 Unified Modeling Language (UML)**
 - **ISO/IEC 11411 Representation for human communication of state transition of software**
 - **ISO 8807 and ISO/IEC 15437 LOTOS**

Software engineering body of knowledge

- **We are working with the Institute of Electrical and Electronics Engineers Computer Society on their guide to the Software Engineering Body of Knowledge (SWEBOK), with the objective to publish it as a ISO/IEC Technical Report**
- **1 active project**
 - **ISO/IEC DTR 19759 SWEBOK**

Management of software assets

- We are working on the development of a standard that will describe the basic requirements of a software asset management environment
- 1 active project
 - ISO/IEC CD 19770 Software Assets Management



SC7 Evolution

What's next

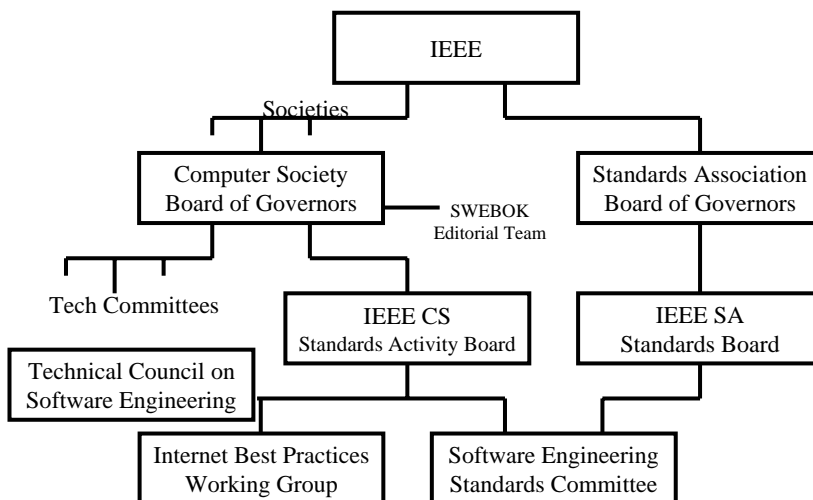
- **Completion of program of work**
- **Development of systems engineering standards**
- **Harmonization of process standards**
- **Partnering with IEEE Computer Society, INCOSE and ITU-T**
- **Harmonization and consolidation with IEEE Software and Systems engineering standards**
- **Expansion and rationalization as required**

IEEE Backgrounder

- **IEEE is the world's largest organization of technical professionals-- about 382,000 individuals.**
- **It publishes 1/3 of the world's technical literature in its areas of interest.**
- **With about 100,000 members, the IEEE Computer Society is the largest of the 36 Technical Societies of the IEEE.**
- **IEEE CS originates all of the Information Technology standards approved by the IEEE.**
- **All IEEE standards are initiated, approved and published by the IEEE Standards Association**

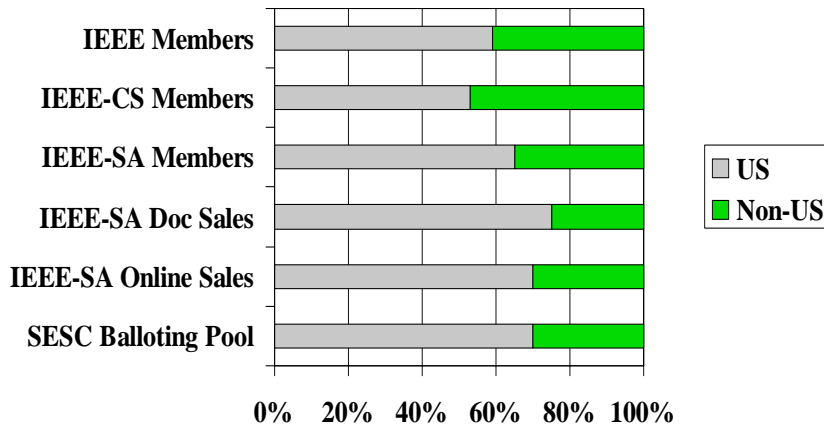
Source: James Moore – IEEE-CS Liaison Officer

Responsible Parties in IEEE



Source: James Moore – IEEE-CS Liaison Officer

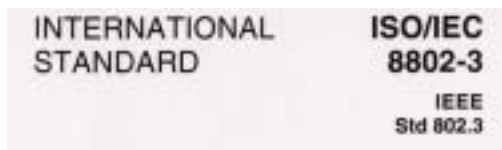
IEEE has an International Membership



Source: James Moore – IEEE-CS Liaison Officer

IEEE Standards

- IEEE standards are created by forming a consensus of individual technical professionals. *(In a few cases, organizational/corporate balloting is used.)*
- IEEE-SA has a long history of international coordination on the content of important standards, e.g.:
 - ISO/IEC 9945 standards (POSIX) are identical with IEEE 1003 standards.
 - ISO/IEC 8802-3 standards (LAN/MAN) are identical with IEEE 802.3 standards.



Top right corner of cover page of ISO/IEC 8802-3

Source: James Moore – IEEE-CS Liaison Officer

IEEE has already adopted several SC7 standards

- **IS 12207, Software Life Cycle Processes (IEEE/EIA 12207.0)**
 - **Supplemented with guides to data and process implementation**
- **IS 12119, Software Packages--Quality and Testing (IEEE 1465)**
- **IS 14102, Guidelines for Evaluation and Selection of CASE Tools (IEEE 1462)**
- **IS 14143-1, Functional Size Measurement Concepts (IEEE 14143.1)**

These standards were all adopted with minor changes to normative content.
Current procedures virtually guarantee capricious differences.
The coordination procedure should address this problem.

Source: James Moore – IEEE-CS Liaison Officer

IEEE CS standards cover some areas with no SC7 standard

- **Terminology**
 - **610.12: Glossary**
- **Reuse:**
 - **1420.1, 1420.1a, 1420.1b: Libraries**
 - **1571: Processes**
- **Risk management**
 - **1540: Software Risk Management Process**
- **Systems engineering**
 - **1362: Concept of Operations**
 - **1233: Requirements Specification**
 - **1220: Systems Engineering Process**
 - **1228: Safety Plans**
- **Software acquisition**
 - **1062**
- **Software architecture description**
 - **1471**
- **Software testing**
 - **829: Test Documentation**
 - **1008: Unit Testing**
- **Internet best practices**
 - **2001: Web Page Engineering**
- **SWEBOK**

Source: James Moore – IEEE-CS Liaison Officer

Subject Areas of Cooperation with IEEE-CS

- **General terminology and concepts**
- **Quality management**
- **Systems engineering**
- **Product quality**
- **Life cycle processes**
 - **Life cycle process framework**
 - **Maintenance process**
 - **Measurement process**
 - **Risk management process**
 - **Supporting processes**
 - **Process assessment**
 - **Process construction**
- **Safety**
- **Documentation**
- **Functional size measurement**
- **CASE tools**
- **Notations**
- **Software Engineering Body of Knowledge (SWEBOK)**
- **Internet best practices**
- **Other**

Source: James Moore – IEEE-CS Liaison Officer



INCOSE

The International Council on Systems Engineering is a not for-profit membership organization founded in 1990. INCOSE is an international authoritative body promoting the application of an interdisciplinary approach and means to enable the realization of successful systems.

In some 10 years since its foundation, its growth has exceeded 4000 members and 33 chartered chapters worldwide (with a dozen more on the way)

<http://www.incose.org/>



INCOSE

- To provide a focal point for dissemination of systems engineering knowledge.
- To promote collaboration in systems engineering education and research.
- To assure the establishment of professional standards for integrity in the practice of systems engineering.
- To improve the professional status of all persons engaged in the practice of systems engineering.
- To encourage governmental and industrial support for research and educational programs that will improve the systems engineering process and its practice.

<http://www.incose.org/>

15288/12207 Harmonization

ISO/IEC 15288 & ISO/IEC 12207

→ Nov 2005

ISO/IEC TR 19760 & ISO/IEC TR15271

→

ISO/IEC 15939

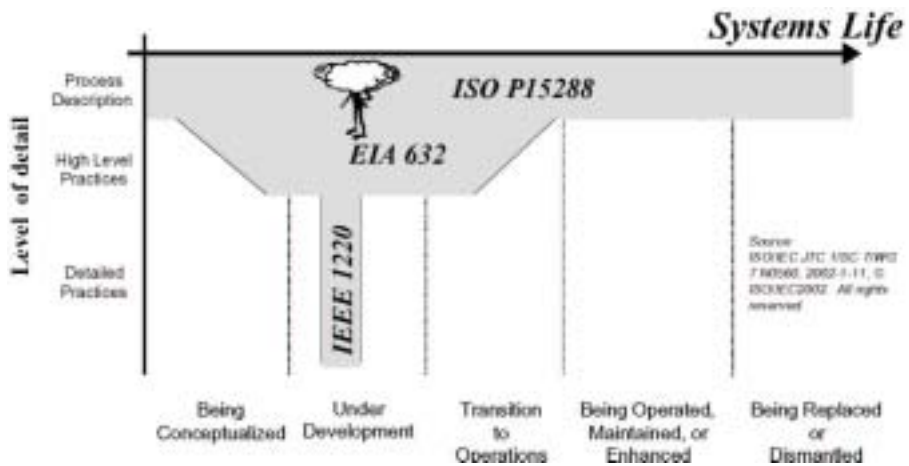
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Others

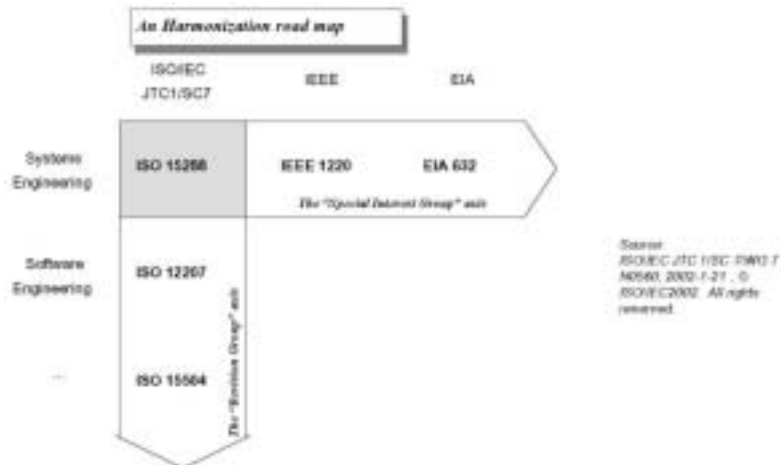
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Source: D. Thiele

Harmonization



Harmonization



SC7 Standards and the Global ICT Market

Markets Size (10⁹ US \$)

ICT Vendor 2002

Telecommunications equipment	380
Computer Systems Hardware	240
Software Licenses	70
Project Oriented IT Services	250
Semiconductors	150
Support/Management IT Services	350
TOTAL	1 440

Reference: R.Fulton, COM-15-1667, Predicts 2002 – What’s Ahead for the IT Industry, Gartner Research, Research Note, 2002-01-08
http://www.adabasnatural4ever.com/industry_news/media/predicts_2002_whats_ahead_for_the_it_industry.pdf

SC7 Standards Strengths

- **Represent broad international consensus**
- **Document recognized ‘Good Practices’**

SC7 Standards Coverage

STRENGTHS

- **Life-Cycle Processes**
- **Product Metrics**
- **Process Metrics**
- **Formalisms**
- **Software Engineering Body of Knowledge**
- **Tools environment**

OPPORTUNITIES

- **Agile Processes**
- **Systems Engineering**
- **Software and Systems Assurance**
- **Re-use**
- **Systems Architecting**
- **Curricula**
- **IT Operations**

CONCLUSIONS

Conclusions

- **There is a substantive body of international standards Software and System Engineering,**
- **These standards that already influence professional practice.**
- **Software development and IT systems operations represent a significant, and growing, part of the Global IT market.**
- **These standards are thus important for international ICT commerce.**

Conclusions

- **International standardization can occur quite fast**
- **It is thus important to:**
 - **Know about existing international standards**
 - **Be aware of work in progress**
 - **Influence the work in progress**

WWW.JTC1-SC7.ORG