Information Technology Standards, Standards Setting and Standards Research

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Abstract

Following a fairly lengthy introductory chapter offering some thoughts on various bits and pieces relating to IT standardisation the paper provides some background descriptive information on the 'standardisation universe'. This is followed by a discussion of three emerging domains of future standards research which are of particular relevance for the user community. A brief outlook into the future eof standards research concludes the paper.

1 By Way of Introduction

"Standards are not only technical questions. They determine the technology that will implement the Information Society, and consequently the way in which industry, users, consumers and administrations will benefit from it."

You can hardly put it more to the point than this quote taken from a document published by the European Commission on 'Standardization and the Global Information Society'. Information and Communication Technologies will have a profound impact as the major enabler of the move from an industrial society to the information society to the knowledge society. Yet, this transition will only take place reasonably smoothly if adequate standards are in place, which take into account not only the technical aspects, but also the characteristics of the specific environment within which they will have to function.

Even if we disregard social, moral and religious rules for the moment, standards – in a very general sense – have been with us for quite some time: about 5,000 years ago the first alphabets emerged, enabling completely new forms of communication and information storage. Some 2,500 years later, the first national, coin-based currency, invented by the Lydians, established the basis for easier inter regional and even international trading. The industrial revolution in the 18th century and, more so, the advent of the railroad in the 19th century resulted in a need for technical standards, which was once more reinforced when mass production generated a demand for interchangeable parts. In parallel, the invention of the electric telegraph in 1837 triggered the development of standards in the field of electrical communication technology. In 1865 the International Telegraph Union – to become the International Telecommunication Union (ITU) in 1932 – was founded by twenty states. The other major international standards setting body, the International Organization for Standardization (ISO), was established in 1947.

These days, a web of SDOs (Standards Developing Organisations), i.e., the likes of e.g. ISO and ITU at the global level, ETSI (European Telecommunications Standards Institute) and PASC (Pacific Area Standards Congress) at regional level, and ANSI (American National Standards Institute) and BSI (British Standards Institution) at the national level issue what is commonly referred to as 'de-jure' standards – although none of their standards have any regulatory power. Likewise, a plethora of industry fora and consortia (a recent survey found more than 250), such as, e.g., the WWW consortium, the ATM forum, and the Open Group, to name but a few of the longer standing ones, produce so-called 'de-facto' standards.

As a result, there exists an almost impenetrable maze of what is generally called 'standards', ranging from company specific rules, over regional and national regulations, up to globally accepted standards. Moreover, one may distinguish between different types of standards: there are voluntary, regulatory, de jure, de facto, pro-active, reactive, public, industry, and proprietary standards; this list is by no means exhaustive.

As Andrew Tanenbaum put it: *"The nice thing about standards is that there are so many to choose from."*

Every ICT[1] system, from the most complex corporate infrastructure of some globally operating company down to the humble PC on the desk back home incorporate and observe scores of standards. There are standards for operating systems, programming languages, user interfaces, communication protocols, disk drives, cables and connectors, etc, etc.

In fact, these systems not just implement standards, they are actually shaped by them to a considerable degree. If you stop and think about it, you will realise the enormous importance of IT standards for businesses, and even for the individual. Yet, standardisation still appears to be the most under-estimated and under-valued activity in the realm of IT. Typically, it is considered a necessary evil at best, and unless a company has really strong business interests in a specific sector it can hardly be bothered to actively contribute to standards setting at all.

On the one hand, that is. On the other hand, 'standards' setting industry consortia pop up at an almost alarming rate. How comes? Or, more precisely, why do companies spend considerable amounts of money to become a 'premium' member of a consortium, while at the same time they couldn't care less about related activities going on within, say, ISO?

Common wisdom has it that consortia move faster, are more flexible and more business-oriented, and that they are thus destined to come up with really useful solutions very quick. But is this true? Bluetooth[2] and ATM[3], for instance, never really lived up to the high expectations that initially surrounded it (in my humble opinion); despite the fact that both the ATM Forum and the Bluetooth Special Interest Group have scores of corporate members .....

The desire to make sure that the 'right' standard emerges normally lies at the heart of firms' involvement in the standards setting process, be it in the 'official' process or in consortium-led activities. Yet, what exactly characterises the 'right', or at least a 'good' standard is far from being clear. One author associates a good standard with the attributes 'speed' and 'meet technical requirements'. Whilst these characteristics are valuable for winning stakeholders' support, this is a surprisingly narrow focus.

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[1] Information and Communication Technology.

[2] A standard for short-range wireless communication.

[3] 'Asynchronous Transfer Mode', a low-level communication technology, designed to support high-bandwidth multimedia communication.

Clearly any technical specification should meet technical demands, the issue of speed, however, is popular, yet questionable. Moreover, meeting organisational and, particularly, societal requirements should clearly play a role in standards setting as well. Regrettably, though, trying to prevent standards from coming into being may also be a motivation for participation.

These days, standardisation is becoming all the more important with the increasing economic and corporate globalisation. At the same time, standardisation politics change. Strangely, national interests are becoming more important. A domestic standard successfully introduced into the global arena will not least boost the prospects of the domestic economy. Accordingly, governments now have a vested interest in pushing such standards to support domestic firms. These firms, in turn, will look to standards setting for several reasons which are typically, though not necessarily, related to their own economic well-being. Standardisation may thus to some degree be seen as an interface between technical and non-technical (e.g. economic, organisational or social) considerations. Standards are not only rooted in technical deliberations, but also result from a process of social interactions between the stakeholders.

That is, you also have to think about the economic consequences of standardisation. Pros and cons of joining the standardisation bandwagon vs trying to push a proprietary solution need to be considered by companies. Standards based products or services may imply price wars and lower revenues, but may also open new markets and widen the customer base. Offering a proprietary solution may yield (or keep, rather) a loyal customer base, but may also result in a technological lock-in and, eventually, marginalisation for the vendor or service provider. In fact, the economics of standards seems to be the best researched aspect.

There are other, maybe more theoretical questions surrounding standards. Do they really hamper progress and stand in the way of technical innovation? A very popular perception, but is it accurate? Should we really leave it to the market – and its hype – alone to decide about winning technologies? Technology studies tell us that this would be unwise, but are they correct?

Now, please don't expect this paper to answer these questions – it won't .....

Rather, the remainder of the paper will elaborate on some of the aspects touched upon above. I will first give an introduction to the very diverse world of IT standards and standardisation, focussing on the formal Standards Developing Organisations (SDOs). This will be followed by an introduction to the still somewhat exotic, but interesting, highly relevant and increasingly recognised domain of IT standards research. A brief outlook will conclude the paper.

2 IT Standards And Standardisation

IT Standards setting is typically considered a necessary evil at best or, rather more frequently, as a complete waste of valuable resources, and as something hampering progress.

Yet, once you come to think of it – not very much would function without common standards (using this term rather loosely for the moment). This holds for the world at large – just think about language, currency, paper size, and it holds especially for the IT domain. I don't know how many standards are implemented in a normal PC, but my guess would something in the high two-figure range. And standards become even more important for communication systems. Whereas a stand-alone PC could work without standards, the telephone network and the Internet can not.

Thus, it seems a little strange that standards, and standards setting, would have to lead such a rather marginal existence. It seems even stranger when you consider the costs: it has been estimated that the costs for the development of an average IT standard amount to about $ 10,000,000 [Spring 95] – and that is only one standard. Another estimation says that development cost for a 'major international telecommunications standard' may amount to some 1,000 person-years of experience, twenty person-years of actual effort, plus $3 million [OTA 92]. JTC1[4] alone has been producing between forty and fifty standards per year over the last decade.

2.1 Terminology

'Standard' and 'standardisation' are tricky terms. They are even more tricky when it comes to information technology. Think about it for a minute – what exactly establishes a 'standard'? Is a specification rubber-stamped by of one of the 'official' standards setting bodies a standard? Or is the degree of usage of a system or a product the decisive factor – is, for instance, MS-Word a 'standard', or SAP/R3? Do industry consortia actually issue 'standards'? And what about the Internet – are the RFC[5]s published in the STD[6]-series standards? Ask any three people and the odds are that they will come up with at least four different opinions.

As does the literature. For instance, Webster's New Universal Unabridged Dictionary defines a standard as *"An authoritative principle or rule that usually implies a model or pattern for guidance, by comparison with which the quantity, excellence, correctness etc. of other things may be determined"*. The Oxford English Dictionary says a standard is *"The authorized exemplar of a unit of measure or weight; e.g. a measuring rod of unit length; a vessel of unit capacity, preserved in the custody of public officers as a permanent evidence of the legally prescribed magnitude of the unit"*. These definitions already hint at a major dilemma in the theory of standardisation: there is no generally agreed upon definition of what constitutes a standard, and the definitions that do exist cannot really be meaningfully applied to the IT domain.

The definition adopted by ISO says that a standard is a document, "*established by consensus and approved by a recognized body, 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.*"

This definition restricts the scope of what is colloquially referred to as a standard in two ways: firstly, it limits the sources from which a standard may emerge to a 'recognised body'. Whether or not this includes specifications issued by industry fora may be a question for debate. Secondly, standards are said to be established 'by consensus'. This bit excludes legislation from being seen as standards. Yet, at least to me, this also excludes many fora. I suppose others would beg to differ here.

And if you can argue so splendidly about the definition alone .....

2.2 Formal Standards Developing Organisations

The following section swill briefly describe the three major global players in the world of IT standards. Of these, ISO is a global private sector standards authority,

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[4] 'Joint Technical Committee 1', the 'joint IT arm' of ISO and IEC (International Electrotechnical Commission).

[5] 'Requests for Comments'. This is a series of documents describing a broad variety of respects of relevance to the Internet. They are typically produced by the IETF (Internet Engineeriung Task Force), the Internet's standards setting body.

[6] The documents of the STD-series are the actual standards that pretty much govern the Internet and describe its functionality. All STD documents are RFCs, but not vice versa.

ITU a global governmental standards authority, and the IETF a global independent consortium (well, actually, I think they are somewhere in between a consortium and a formal SDO, on their way to becoming the latter).

2.2.1 The International Organization for Standardization (ISO)

The International Organization for Standardization[7] (ISO) is a global, non-governmental federation of national standards bodies from about 120 countries. ISO was established in 1947, with the mission *"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"*. Prior to that, standardisation was done under the auspices of either the International Electrotechnical Commission (IEC), created in 1906, in the electrotechnical field, or by the International Federation of the National Standardizing Associations (ISA), established in 1926.

Following the break in standards activities caused by World War II, ISO was founded by twenty-five countries. Its work commenced in 1947, with the first standard published in 1951.

Membership in ISO is on a per-country basis, with one organisation – typically the respective national standards body – representing its country. There are full members, correspondent members (which do not actively participate, but are kept fully informed), and subscriber members which normally represent those countries that cannot afford one of the other categories. Depending on a full member country's interests its representative may decide to become a P(articipating) member or an O(bserving) member in a committee, or no member at all. P-members participate actively in the work, with an obligation to vote on all questions formally submitted for voting within the technical committee or subcommittee, and, whenever possible, to participate in meetings. O-members follow the work as an observer, and therefore receive committee documents and have the right to submit comments and to attend meetings (but not to vote).

The actual standardisation work is almost fully decentralised, and performed by 225 TCs, their respective Sub-committees (SC) and Working Groups (WG), with a total number of more than 2,900. The more than 30,000 individual participants come from the respective national member bodies, which are also in charge of providing secretarial services for the committees and groups. In general, participation within any TC or SC is open to every national member body and to all A-liaisons (as e.g. ITU-T Study Groups). Development and revision of standards are carried out as 'projects' within an committee. Typically, a project is assigned to a Working Group (WG) comprised of individually appointed experts. It should be noted that *"The experts act in a personal capacity and not as the official representatives of the P-member or A-liaison organisation by which they have been appointed."*. ISO itself – being very much a meta-organisation – primarily provides for a central co-ordination entity, does the final editing of documents prior to publication, and maintains an overall schedule.

The stages of ISO's standards development process ar esummarised in Table 1.

Stage #	Project stage name	Associated document	Abbrev.
0	Preliminary stage	Preliminary work item	PWI
1	Proposal stage	New work item proposal	NP

[7] 'ISO' is not an acronym, but a word derived from the Greek word 'isos', meaning 'equal'.

2	Preparatory stage	Working draft(s)	WD
3	Committee stage	Committee draft(s)	CD
4	Enquiry stage	Draft International Standard	DIS
5	Approval stage	Final DIS	FDIS
6	Publication stage	International Standard	IS

Table 1: Project Stages and Associated Documents

In the so-called 'Fast track procedure', a document is submitted directly for approval as a DIS to the ISO member bodies (stage 4). If the document has been developed by an international standardising body recognised by the ISO Council (as e.g. ITU-T), it can be submitted for approval as an FDIS (stage 5), without passing through the previous stages.

JTC 1

To adequately deal with all aspects of information technology ISO and IEC jointly established JTC1[8] in 1986. In September 2003, 23 countries actively participate in the work of JTC1 (P-members), another 43 are O-members.

JTC 1 has developed its own set of procedures and guidelines, taking into account the special circumstances of, and requirements on IT standardisation. The rules specifying the steps towards an international standard differ slightly from those adopted by the remainder of ISO.. The most important difference, however, has been the implementation of a Transposition Procedure for Publicly Available Specifications (PAS). Based on the fast track procedure, this is an even more extensive policy for proprietary specifications to be transposed into international standards. As with the fast track procedure, this reflects the recognised need for a speed-up of the standards setting process, and even more so, the fact that considerable expertise – and almost readily usable specifications – may be available from companies or consortia. The procedure works as follows:

An organisation wishing to have one of its proprietary specifications transposed into an international standard (termed the 'PAS originator') first applies for recognition as a 'PAS-Submitter' to the JTC 1 secretariat. This application includes information on the specifications to be submitted and on the PAS submitter. Upon approval, the PAS submitter gains the right to submit specifications for an initial period of two years. The remainder of the procedure follows the fast track procedure as described above. A set of criteria has been developed by which the submitted document will be judged regarding quality, consensus and alignment.

2.2.2 The International Telecommunication Union (ITU)

The International Telegraph Union, the predecessor of the ITU, was set up as a treaty organisation in 1865 by twenty European countries. At the same time, the first International Telegraph Convention was signed.

Following the invention of the telephone in 1876, the Telegraph Union began to cover international legislation in this area as well. The invention of wireless telegraphy in 1896 triggered the initiation of the first International Radiotelegraph Conference, held in 1906. This was the first Plenipotentiary Conference through which the work of the Union – and later of ITU – has since been directed. The International

[8] Joint Technical Committee One.

Telephone Consultative Committee (CCIF) was set up in 1924, followed by the establishment of the International Telegraph Consultative Committee (CCIT) in 1925, and in 1927 the International Radio Consultative Committee (CCIR) was founded. In 1934, the Union's name was changed into 'International Telecommunication Union' (ITU), which became a specialised agency of the United Nations in 1947. The International Telephone and Telegraph Consultative Committee (CCITT) was founded in 1956, through the merger of the CCIT and the CCIF.

In late 2003, the ITU comprised of 189 Member States, over 650 members (scientific and industrial companies, public and private operators, broadcasters, regional/ international organisations), and over 50 associates. However, the right to vote is restricted to one representative per Member State, i.e. almost exclusively to the respective national PTTs[9] or, for some countries, to one of the respective national Recognised Operating Agencies (ROAs, e.g. AT&T in the US). Other companies, notably those referred to as Scientific or Industrial Organisations (SIOs), need to be approved by their respective governments, and only have a right to participate and to contribute to the technical work, but are not allowed to vote.

As another result of the increasingly competitive standardisation environment the goals identified in the ITU strategy document include adoption of a market-oriented approach to standardisation, among others through delivery of high-quality products (i.e. recommendations) on time and enhancement of participation and involvement by non-administration entities and organisations.

The Telecommunication Standardization Sector (ITU-T)

All technical and organisational work on standardisation is done within ITU-T. The quadrennial 'World Telecommunication Standardization Conferences' (WTSC) as the top-level decision making organisational institution approve the technical programme of work, which is subdivided into 'Questions', each of which identifies a rather broad work area.

The technical work is done in Study Groups (SGs). These are groups of experts from administrations, the public sector, and private organisations. Membership in study groups is limited to representatives of ITU Members. During the current study period (2001 – 2004), thirteen Study Groups (SGs) are active.

SGs are established by the WTSC which also assigns to them the Questions to be studied. That is, rather than addressing a specific topic to be standardised a SG has to deal with pretty broad Questions each of which may cover very diverse topics. The SGs produce draft recommendations within the scope of the questions assigned to them. These are to be approved by a qualified majority of members of the WTSC. Until 1992, this resulted in the well-known four-years study periods. Following the reorganisation of ITU in 1992, in order to speed up and streamline the process, this strict formalism was abandoned; recommendations may now be decided upon through correspondence between two Conferences in which case 70% of the replies received must indicate approval. Similarly, new Questions can be identified between WTSCs.

Both, representatives of member countries (typically from the PTT or an equivalent organisation) and other organisational members (e.g. from SIOs) may participate in the technical work at SG level and submit contributions. However, representatives of organisational members need to be approved by their respective member country.

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[9] Post, Telegraph and Telephone administration.

Every SG is headed by a chairman and a (possibly several) vice-chairman, who are appointed by the WTSC, based on their technical and management skills.

2.2.3 The Internet Engineering Task Force (IETF)

The Internet's standardisation process has changed over the years, from very informal ad-hoc implementations driven by a few enthusiasts to a reasonably – some would say overly – formal procedure today. There are, however, quite a few things that survived this transformation, most notably the openly available Request for Comments (RFC) series of documents, which provides a forum for discussion on new protocols, mechanisms, and ideas. RFCs are not necessarily, but approved Internet standards remain part of this series as well.

The Internet Society (ISOC) oversees growth and evolution of the Internet and the social, political, and technical issues that arise from its use. The Internet Architecture Board (IAB), is responsible for *".. oversight of the architecture of the worldwide multi-protocol Internet"*. The IAB is also responsible for approving appointments to the Internet Engineering Steering Group (IESG). The IESG, in turn, charters the IETF's Working Groups, where the actual technical standardisation work is done. A working group may be established through the initiative of an Area Director (AD), or it may be initiated by an individual or a group of individuals.

The process has been designed to provide quick solutions to immediate problems. Obviously, this approach tends to produce specifications with a possibly somewhat limited scope. However, extension mechanisms exist in most specifications, enabling integration of, or co-existence with, future standards. Its goals include

- technical excellence,
- prior implementation and testing,
- clear, short, and easily understandable documentation,
- openness and fairness,
- timeliness.

'Membership' in WGs is open to all interested individuals, with e-mail distribution lists being used as the major communication medium. In fact, an IETF 'member' is someone whose address appears on one of the IETF's distribution lists. In addition, there are three annual IETF meetings. A 'rough consensus' of all WG members is required before a specification can proceed on the standards track (as opposed to 'consensus' required by ISO and ITU). In particular, there is no formal voting procedure. If 'rough consensus' cannot be achieved, the IESG will undertake to solve the problem. If this fails, the IAB will be the final authority for an appeal and may, for instance, establish a new working group to consider the matter.

To become an Internet Standard a specification has to be made available for comments as an Internet Draft for a certain time, typically resulting in a number of revisions. Eventually, the specification may be submitted to the IESG for elevation onto the standards track. Upon approval the specification is published as a 'Proposed Standard' in the RFC series. It remains at this level for at least six months, thus allowing sufficient time for public consideration and, very likely, revision. After this period, if at least two independent and interoperable implementations exist, the specification is considered generally stable. Upon approval the procedure outlined above is repeated, and the specification will become a Draft Standard for at least four months. Finally, when significant operational experience has been gained, the specification is raised to the Internet Standard level. If a specification fails to reach this level after two years, it will be reviewed and possibly withdrawn. All decisions

relating to advances along the standards track, including final approval and withdrawal, are under IESG responsibility.

2.3 Participating in IT Standardisation

Over the last three decades, the world of IT standardisation has become extremely complex. Figs. 1 and 2 give an impression of the situation in the seventies and today (both are not complete, though).

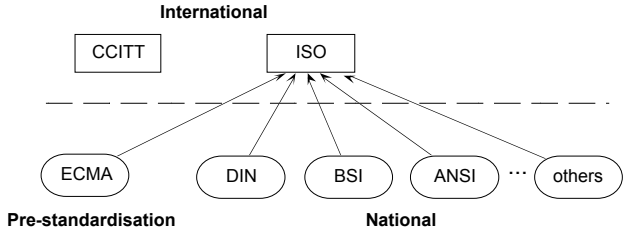

Figure 1: The IT standardisation universe in 1970 (excerpt)

In addition to the new formal largely regional Standards Developing Organisations (SDOs; ETSI, T1, etc) which have been established over the last decades, a considerable number of industry fora and consortia have been founded as well (W3C, OASIS, etc; a recent survey found around 250 such entities [ISSS 03]).

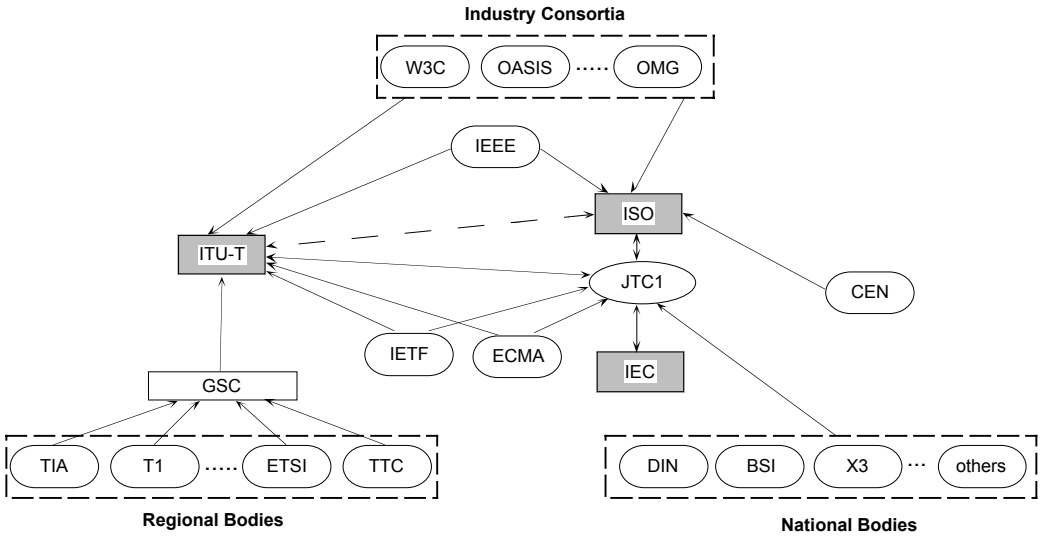

Figure 2: The IT standardisation universe today (excerpt)

This complex environment represents a major obstacle for those who are considering active participation in standardisation. Questions they need to address include why, how, where, and when to participate.

At first glance, "Why participate at all?" seems to be a very valid question. After all, standardisation is a costly business and time consuming, and the return on investment is uncertain in many cases. This is not normally a major problem for large vendors and manufacturers, who may want to push their own ideas, prevent success of competing specifications, or who are just driven by the desire to gather intelligence in the work groups.

Things look very different for user companies and SMEs. They cannot easily commit considerable resources to activities with very intangible direct benefits. Yet, all users

need to recognise that they will suffer most from inadequate standards. Such standards will leave them struggling with incompatibilities, which at the end of the day may well drive them out of business. On the other hand, they will reap major benefits from well-designed standards addressing real needs. In addition, at least large and/or well-off users may find a standards committee a very suitable platform for co-operation with vendors and manufacturers. Here, technical requirements can be mapped onto system capabilities at a very early design stage (in fact, this is rather more a pre-design stage), thus making the process far more efficient.

Accordingly, users who participate in standards setting will be driven by the wish to

- **Avoid technological dead-ends**
  Users want to avoid purchasing products that eventually leave them stranded with an incompatible technology. A number of issues need to be considered in this context. For instance, it has to be decided if and when a new technology should be purchased, and which one should be selected. Too early adoptions not only bear the risk of adopting a technology that eventually fails in being successful in the market, but also ignore the considerable time and money that have gone into the old technology. It has to be decided if and when to switch from a well-established technology to a new one. Investments in the old technology need to be balanced with the prospective benefits potentially to be gained from this move. On the other hand, late adopters may lose competitive advantage while being stuck with outdated technology.
- **Reduce dependency on vendors**
  Being locked in into a vendor-specific environment is increasingly becoming a major risk for a user, despite the advantages that can be associated with integrated proprietary solutions. In particular, problems occur if a vendor misses an emerging development, and its users are forced to switch to completely new (and different) systems; a very costly exercise. Accordingly, standard compliant products from a choice of vendors appeal to the users, who can pursue a pick-and-mix purchasing strategy, and also stand to benefit from price cuts as a result of increased competition.
- **Promote universality**
  Ultimately, users would like to see seamless interoperability between all hardware and software, both internally (between different departments and sites) and externally (with customers and business partners). With the ongoing globalisation of markets this can only be achieved through international standards. Clearly, this holds especially for communications products. Ideally it should not matter at all which vendor or service provider has been selected; interoperability should always be guaranteed. This implies that user needs and requirements are met by the standards (and the implementations). In addition to seamless communication – and the business value that lies herein alone – there is another major economic benefit to be gained: the costs of incompatibility may be tremendous. For instance, in 1980 half of General Motor's automation budget went into the design of specific interfaces between incompatible machines, a situation that would not have occurred if adequate standards had been available in the first place.

The next issue to be considered is "how to participate". In general, there seems to be consensus that large users, especially those with an urgent need for standardised systems or services should participate directly in the technical work. In fact, some do. However, especially for smaller companies, there are obvious barriers to this form of participation which are largely rooted in the lack of sufficient financial resources and knowledgeable personnel. Here, participation via umbrella organisations would be

an option, as would be participation at national level with a mandate for the national representatives to act as the voice of these SMEs in the international arena.

Considering the complexity of the IT standardisation universe, "Where to participate?" is another relevant question. Equivalent systems may well be standardised in parallel by different SDOs and consortia, and participation in all these work groups is well beyond the means of all but the biggest players. The correct decision here is crucial, as backing the wrong horse may leave a company stranded with systems based on the 'wrong' (i.e., non-standard) technology. This holds for both users and manufacturers.

Especially users should also ask themselves "When should we participate?" In most cases 'the standardisation process' is viewed as an atomic entity, which cannot be subdivided any further. Yet, the standards life cycle depicted in Fig. 3 suggests otherwise. Participation in profile development, for example, would be the option of choice if interoperability of implementations were to be assured. On the other hand, there is little point in specifying a profile for a base standard that does not meet the requirements in the first place.

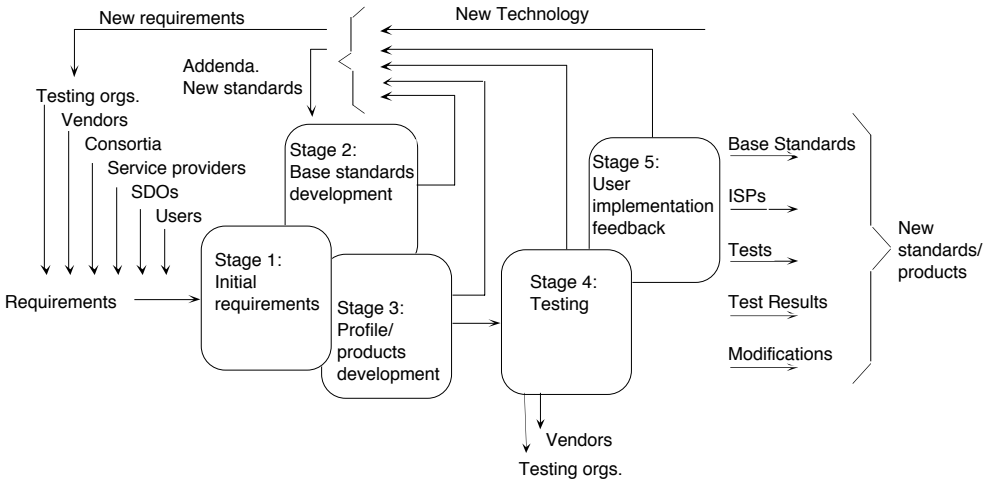

Figure 3: Summary of the comprehensive standards life cycle
(according to [X3 93])

2.4 Stakeholders and their Relations

The procedures adopted by the individual standards setting bodies suggest that the degree of control over, and influence on the standards setting process is about equally distributed between the different stakeholders (including e.g. vendors, service providers, and users). This, in turn, yields the model of the standardisation process as depicted in Fig. 4. It shows the 'ideal' situation, with all stakeholders having a (more or less equal) say in the standards setting process. It assumes that interested parties meet, compile and review their – possibly only anticipated – needs and requirements, define the best technical approaches and mechanisms realistically feasible, and eventually come up with a standard that should survive in the market and should pretty much suit all needs.

Indeed, this model reflects the technocratic view apparently quite popular with the standards setting bodies themselves. It can easily be derived from the descriptions of their rules and processes. Unfortunately, it does not capture reality as non-technical (i.e. organisational or social) aspects are ignored. In particular, it does not assume

any links or interrelations between the different stakeholders apart from the common work in a committee.

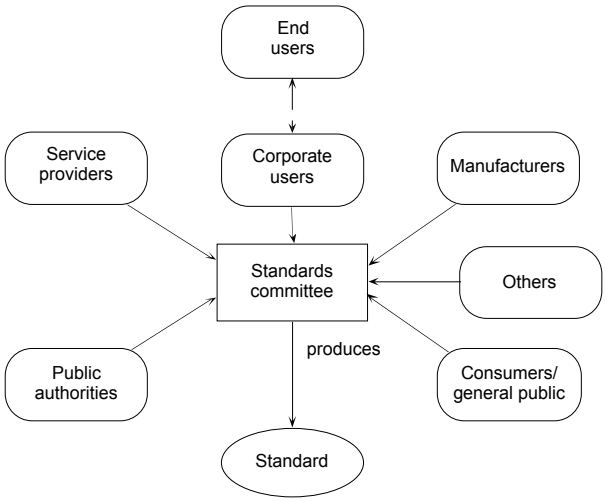

Figure 4: The naive idea of an ideal standards setting process

However, this ideal scenario is far removed from reality – at least according to some earlier research (see e.g. [Jakobs 99]). In fact, it appears that so far development IT standards has almost exclusively been technology driven; with standards produced solely reflecting providers' and implementers' priorities like, for example, manageability rather than usability. This can largely be attributed to the fact that relevant standardisation committees have typically been dominated by vendors and service providers (see also [Jakobs 01] for a more elaborate discussion). Accordingly, a more realistic model is called for.

The major stakeholders in the overall standards setting process can easily be identified. As depicted above, they include manufacturers, service providers, users, and others. Little, if any, mention is typically made of consumers and the general public.

Obviously, there are also relations between these various stakeholders outside the standards setting process, the most obvious one being customer – supplier (i.e. users of services – users of standards). Those relations may well have considerable impact on both sides' activities and conduct in standardisation. For instance, it would seem that users talk directly to their system vendors and/or service providers, and rather buy products that more or less meet their immediate needs than get involved in setting standards that may eventually fully meet their requirements. Surely users want the immediate benefits of currently available systems rather than forego these in favour of possibly better future systems.

Fig. 5 depicts the actual situation more realistically. Deliberately or not, manufacturers and service providers act as a sort of 'buffer' between corporate users and standards committees.

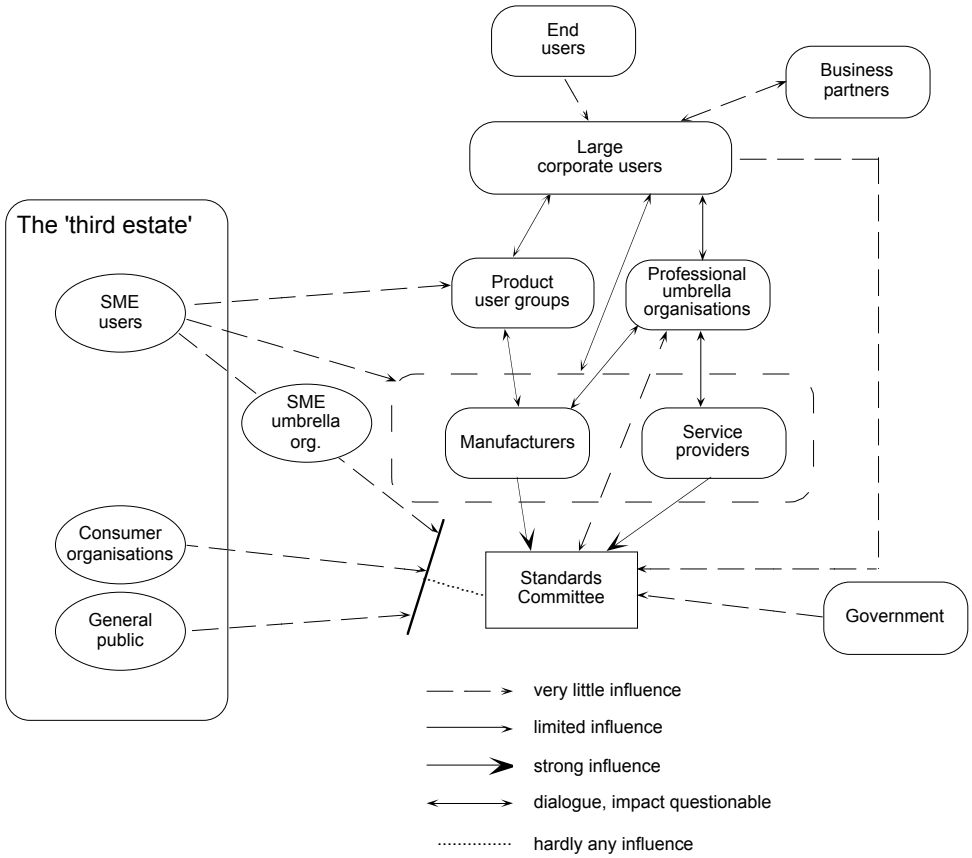

Figure 5: A more realistic view of the relations between stakeholders in standardisation

Those entities that form the 'third estate' are a different case altogether. They are largely separate from the stakeholders of the commercial world, with SME users located somewhere in between. Although they represent the vast majority of standard users these groups have extremely little say in the standards setting process. This holds despite the fact that organisations such as ANEC[10] for the consumers and NORMAPME[11] for SMEs are actively participating in selected standard working groups on behalf of their respective constituencies.

Moreover, it seems that many members of standards working groups consider 'technical sophistication' a major pre-requisite for participation in the standards setting process. People perceived as lacking this attribute are likely not to be taken very serious. This attitude on the side of the committee members further hampers successful representation of these groups of stakeholders, as they will in many cases not have adequate resources.

3 Standards Research in Information Technology – Three Examples

Standards setting is one thing, research into standards and standardisation is something quite different. I recall some old hands, people who have spent much of their professional life working hard to specify useful standards, being more than surprised to learn that their everyday work is considered a research topics by some. Standards researchers are still a fairly small community, but it is growing in both size and importance. For instance, government agencies are becoming more and more

[10] The 'European Association for the Co-ordination of Consumer Representation in Standardisation'.
[11] The 'European Office of Crafts, Trades and SMEs for Standardisation'.

aware of the fact that research into standards and standardisation may well yield valuable information and insights for future policies. Most notably perhaps, the European Commission (EC), which has always been a champion of (European) standards, is increasingly spending money on research into a variety of standards-related aspects.

Actually, the widely used term 'standards research' is a bit ambiguous. It may refer to both

- Research *for* standards
  This has become an increasingly important aspect over the last couple of years. Among others, the European Commission is extremely keen to enable a smooth transition of R&D work into the standardisation domain, as well as improved knowledge transfer between these domains. Yet, the current situation is still less than optimal, with very little incentives for researchers to actually go that extra mile and, for instance, adapt their results to the needs of the standards setting process. To change this situation a number of both current and soon-to-be projects have been / are being set up at both national and European level. Yet, as this aspect is pretty much concerned with purely technical research, to will not be elaborated any further here.
- Research *about* standards
  This is what this section is all about. The broad variety of aspects that make up research about IT standards include, but are certainly not limited to, computer science, information systems, management, business, social sciences (especially science and technology studies), economics, engineering, political science, public policy, sociology, law, communication, and human factors/usability[12].

Here, I will focus in the latter. In particular, I will try and concentrate on three emerging aspects which I feel are of specific relevance with respect to adequate influence of all stakeholders in the standardisation process.

3.1 Social Shaping of Technology

Research into the 'Social Shaping of Technology' (SST) largely emerged as a response to technological determinism. SST acknowledges that technology indeed has an impact on its environment, but that at the same time it is framed through technical, but rather more through e.g. organisational, societal, cultural and economic factors. In particular, SST attempts to unveil the interactions between these technical and social factors. Abandoning the idea of inevitable technological developments implies that choices can be made regarding, for instance, the acquisition, the use and particularly the design of technological artefacts. There may be a broad variety of reasons upon which these choices may be based. In an organisational context this may include purely technical reasons, as e.g. the need to integrate legacy systems, but decisions may also take into account company particularities, as for instance organisational or reporting structures. These choices, in turn, may lead to different impacts on the respective social or organisational environments.

Technological artefacts embody, and thus transfer, their respective environment of origin. *"The shaping process begins with the earliest stages of research and development"* [Williams 92]. Especially since the advent of pro-active standardisation technological systems have increasingly been rooted in standards activities rather than, possibly modified, already existing products (as it is the case in reactive standardisation). As a consequence, it will no longer suffice if users talk to, and co-operate with, their

[12] Please see the 'Further R eadings' section for a list of books which, between them, thoroughly cover all these aspects.

vendors during implementation. Instead, co-operation will have to start far earlier. That is, accepting the above notion that shaping of technology starts at the earliest possible stage implies that users will have to look closer at standards committees if they do not want to risk being eventually stranded with a technology incapable of meeting their needs.

Standards emerge through the co-operation and joint efforts of different individuals in technical committees and work groups. Whilst in theory these individuals act in their capacity as 'independent experts', their views, beliefs, and prejudices have to a considerable degree been shaped by the environment within which they live and, especially, work.

Various factors that may shape technology are also likely be channelled into the work groups of the international standards setting bodies. The respective corporate environments of the committee members' employers, for instance, will play a major role in this context. The different visions of how a technology should be used, and the ideas of how this can be achieved, are both formed by these local environments. It will exert a significant impact on the work of the committees. This holds especially in the case of anticipatory standards, which specify new services from scratch, and thus offer the opportunity to incorporate to some (a considerable?) degree the particular presumptions, views, and ideas of the members of the originating committee (and their respective employers).

A reactive standard will likewise transpose the environment from which it emerged; this will be the corporate environment (using this term very loosely) of its inventor (i.e. typically a manufacturer or a service provider) who originally specified the system upon which the standard will be based. Thus, this company's visions will implicitly be embodied in the standard specification, together with the individual ideas of its representative(s).

Thus, studying what shaped a particular technology in the first place offers a chance to proactively manipulate that very impact expected to result from this particular choice. At the same time this capability should also contribute to the prediction – and thus prevention – of undesirable side effects potentially resulting from a new technology. Technology tends to have other effects besides those actually intended, these effects need to be explored as well.

3.2 Constructive Technology Assessment and Standards Setting

Constructive Technology Assessment (CTA) aims to actively influence technological developments from its earliest stages. Especially in IT most new systems emerge from standardisation processes (using this term loosely). One of the more noteworthy recent developments here was the move from reactive standardisation, i.e. basically the rubberstamping an existing technology and the elevation of it to the status of an 'international standard', to pro-active standardisation. This is pretty much based on anticipated future needs and requirements, and maybe even on future technologies. That is, standards setting may in fact be considered as the earliest stage of a technical development process [Jakobs 03]. Accordingly, this would be the best place for CTA activities.

CTA's 'technology forcing' strategy aims at applying external pressure on a technical development. It has been realised that this pressure can not only be applied through legislation, but also through other channels. A standards setting body could well be one such channel.

Also, CTA aims at ideally involving all stakeholders in the technical development process (in one way or other). Pretty much the same holds for standardisation, at

least in theory. And even in real life we can easily find committees were vendors, service providers, and users jointly develop standards specifications. And we can also identify areas were standardisation is actually driven by large users (e.g. smart cards).

Deep and broad learning is another aspect crucial to CTA. This requires a wide variety of stakeholders to be involved in the design of a technology, and the recognition, and indeed incorporation, of their needs into the systems to be standardised. Pretty much the same holds for standards development. This again suggests that working groups could be an ideal platform for CTA-related activities.

Finally, CTA needs an institutionalised forum for its discussions and its learning activities. Again, a standards committee could well be considered a natural such forum. The committees are all established within a lasting organisational structure (at least those of the formal SDOs). Stakeholders meet there anyway, and the learning activities are an integral, and necessary, part of standards setting activities. In fact, 'consensus conferences', which are a typical tool for CTA, very much resemble a standards committee, with respect to both its task and its make up.

From the above it may be concluded that standards working groups should at the very least be considered as a platform by the (C)TA community. Yet, we must not ignore the potential problems that have to be associated with the deployment of standards groups for CTA purposes. For one, whilst in theory all stakeholders have an equal say in these groups, in practice they are typically dominated by vendors and service providers, respectively. In particular, users and the general public are hardly ever represented at all in most of these groups.

All in all, further research into the relations between TA and standards setting in the IT domain seems to be a route worth exploring.

3.3 Standardisation Processes

'Slow', 'cumbersome', 'compromise laden', and 'hidden agendas' are popular attributes when it comes to characterising the formal standardisation processes in the ICT domain. Such perceptions were also one of the major reasons for the wave of newly founded standards consortia and industry fora which began to emerge in the late eighties.

The idea behind virtually all these consortia is that companies who are prepared to pay serious money for the privilege of being a consortium member, and who pay the staff that actually does the specification work, have a genuine interest in a fast and efficient development of the standards, thus overcoming the major problem faced by the formal SDOs (i.e., speed).

Enthusiasm about the effectiveness and efficiency of these consortia continues, despite a number of obvious drawbacks. In many cases the membership fees imply that only a select few large companies (typically vendors, manufacturers, service providers, etc) have the right to contribute and/or vote, thus leaving out especially SMEs and user companies. Obviously, 'consensus' here only refers to those actually involved in the activity. It would be interesting do an objective study to see if the benefits offset these drawbacks.

'Speed' is indeed an interesting aspect. While it would in many cases be desirable to speed-up the standards setting process, this does not necessarily hold for others. For example, it appears questionable whether speed should be of crucial importance for infrastructure standards (such as, e.g., ISDN and, indeed, the Internet). Here, the risk of spending billions on an inadequate technology alone should make sure that consensus and meeting identified requirements should be higher on the list of

priorities than speed. Moreover, as Sherif pointed out, the formal SDOs have considerably streamlined their processes. ITU-T, for instance, is now well capable of passing a recommendation within 18 months [Sherif 02].

The process deployed by the IETF has been dubbed by many as 'the best in the business'. This evaluation is typically motivated by the process' informality and flexibility, its approach to tackle small pieces at a time and to provide for interfaces between them, yielding quick results, and, most notably, by its credo of 'rough consensus and running code'. Yet, a recent survey of IETF working group members found a considerable number of deficiencies [IETF 03]. Many of these result from the fact that the process has never been designed to cope with the massive financial stakes many companies now have in Internet protocols and services. Similar concerns were also voiced in an earlier study [Jakobs 00]. It seems to be fairly obvious that the IETF's standards setting process is in need of a major overhaul.

4 Brief Outlook

This paper has only touched upon some issues in the realm of IT standards and standardisation that I consider worth discussing. Many more important and interesting aspects have not been addressed. Those who want to get a more complete picture of the actually quite fascinating domain of ICT standards research should have a look the 'Further Readings' section below.

Research into the various aspects of IT standards and standardisation has been around for quite a while now. However, until not too long ago it led a rather shadowy existence (with some exceptions). More recently, interest seems to be on the rise, though. More and more ICT conferences include sessions or tracks on standards research, and special journal issues on related topics appear much more frequently. At least as important is the fact that funding is for standards research appears to be on the rise, at both national and European level. The odds are that we will see more interesting research in this domain in the not-too-distant future.

I think we will also notice another trend – increasing inter-disciplinarity. Standards research is multi-disciplinary by its very nature anyway, but individual disciplines will always only be able to address part of the problem, and hardly ever get the full picture (see also Fig. 6). Accordingly, to fully understand the various problems and issues associated with standards research efforts will become necessary to improve co-operation between the contributing disciplines.

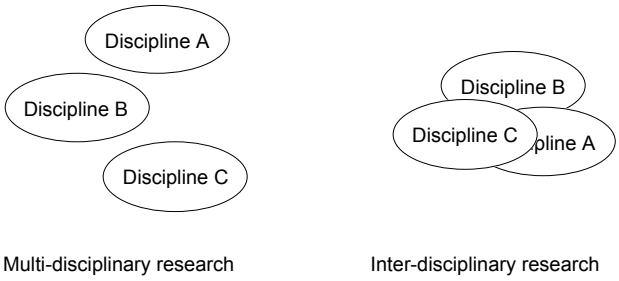

Figure 6: Multi-disciplinarity vs inter-disciplinarity

On a different note, I believe that we will continue to see SDOs adapt and streamline their processes. Also, as resources are getting scarcer, co-operation between SDOs on the one hand, and SDOs and consortia on the other will become closer. Moreover, I suspect that, because of the same reason, the role of the national SDOs will be questioned. They may have to re-position, and possibly re-invent, themselves.

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6 Further Readings

This is a list of books which look at various aspects relating to IT standards and standardisation, plus a brief summary of my personal views for each of them. The list is most definiteyl not complete.

In addition to the books listed below, the proceedings of the SIIT (Standardisation & Innovation in IT) conference series make for an interesting read. For more information on these events, and on how to obtain/download the proceedings, please see:

http://www-i4.informatik.rwth-aachen.de/~jakobs/siit99/Proceedings.html

www.siit2001.org

www.siit2003.org

Bolin, S. (ed.): The Standards Edge. Bolin Communications, 2002, 534 p.
This is a compilation of largely previously published papers which offers a very good overview of some important aspects of the field. It is structured into five sections, including 'How standards are created', 'Maximising Standards Investment', 'Influencing IPR policies', 'Government impact on standardisation', and 'Standards at work'.

Bekkers, R.: Mobile Telecommunication Standards. Artech House, 2001, 627 p.
A very thorough book. The book covers the GSM, UMTS, TETRA, and ERMES standards, by looking at institutional practices of the relevant SDOs, economic aspects, and IPR issues. The reader gets a good understanding about development and prospects of these standards, some of which are among the most important ones in recent IT standardisation.

Spivak, S.M.; Brenner, F.C.: Standardization Essentials - Principles and Practice. Marcel Dekker, 2001, 316 p.
Standardization Essentials only partially fulfills the promise of its title, offering a view (although a good one) of just similarity standardization. It does not address unit of measure standards and the related metrology (e.g., calibration) issues, and addresses only slightly compatibility standards and the related communications issues.

K. Geihs, W. Knig, F. v. Westarp (eds): Networks - Standardization, Infrastructure, and Applications. Springer 2001, 207 p.
All in all, this book is a mixed bag. There is something in it for many, but I doubt that a lot of readers will find all, or even a majority of the papers, of value. This is not to say that these papers are bad, far from it, but they appeal to very different communities. Very few lawyers will want to know about QoS issues in mobile networks, and computer scientists will only rarely be interested in accounting problems. More specifically, from a 'standards researcher's' point of view only three papers are of interest

Jakobs, K.: User Participation in Standardization Processes - Impact, Problems and Benefits. Vieweg Publishers, 2000, 250 p.
The book focuses on the role of users in IT standards setting. It argues that the very popular call for increased user participation in standards setting is likely to be counter-productive.

Jakobs, K. (ed): IT Standards and Standardization: A Global Perspective. Idea Group Publishing, 2000, 264 p.
This is an informative collection of 15 papers by a well-balanced mix of authors from companies, academia, and other organizations. Extensive references are provided. The chapters can be grouped into categories. There are five overview chapters, two chapters that discuss intellectual property rights, and three chapters discuss networks. Finally, five chapters give specific examples of standardization. However, the book only provides a snapshot, addressing various standards-related topics from different angles.

Brunsson, N.; Jacobsson, B.; et al.: A World of Standards. Oxford University Press, 2000, 188 p.
This isn't really a book about standards. Well, maybe it is, but in this case it is considerably stretching the meaning of the term - which in itself is remarkable given the fact that 'standard' has traditionally been used extremely loosely. For the authors, standards cover - among other things - etiquette, football rules, management

practice, how contracts should be worded, and the requirements that potatoes should fulfil. They can be established by, for example, management gurus, consultants, pressure groups, academic researchers, standard-based organizations, international governmental or non-governmental organizations, and fashion designers.

de Vries, H.J. : Standardization - A Business Approach to the Role of National Standardization Organizations. Kluwer, 1999, 320 p.
The extensive documentation on the NSOs role and services, which reflects the significant experience and knowledge of the author in the field, gives a complete overview on the present SDOs situation but this picture remains focused on the traditional context of formal standardization. No doubtfuture research will provide contributions for complementing this analysis in the new competitive context.

Schmidt, S.K. and Werle, R.: Coordinating Technology. MIT Press, 1998, 365 p.
Very interesting book. Yet, it looks at the standards setting process very much from a social sciences perspective alone, choosing X.400 as one sample standard. Also, it focuses pretty much on the actual process.

Cargill, C.F.: Open Systems Standardization - A Business Approach, . Prentice Hall, 1997, 314p..
This book appears targeted towards those active in the standards professions. It first explores the basis for standardization and discusses the need for open systems and the concomitant need for open standards and open organizations. It then provides an insider's view of the operation of a company standards department, a detailed explanation of how a standardization development organization (SDO) operates, and explains the operation ofdifferent SDOs. This section also offers a business-oriented view of standards, the effect of standards on the product life cycle, and business expenditures on standardization. Finally, the book describes the operation of the major international SDOs, consortia, Regional Standards Bodies, along with IETF, ANSI, IEEE and US governmental standards bodies.

Krislov, S.: How Nations Choose Product Standards and Standards Change Nations. University of Pittsburgh Press, 1997, 264 p.
The book compares and contrasts the United States, the EC, the former Eastern bloc, and Japan-to link standard choice with political styles and to trace growing internationalization based on product efficiency criteria.

Egyedi, T.M.: Shaping Standardization: A study of standards processes and standards policies in the field of telematic services. Delft University Press, 1996, 308 p.
This is a very interesting book, but not commercially available.

Hawkins, R.W. et al. (eds): Standards, Innovation and Competitiveness. Edward Elgar Publishers, 1995, 269p.
Really good articles on economic and policy aspects of IT and environmental standards. Yet, also limited in scope, leaving out all other aspects of standards and standardization. The mixture of environmental and IT standards appears a little unusual.

Kahin, B.; Abbate, J. (eds): Standards Policy for Information Infrastructure. MIT Press, 1995, 653p.
Very American in terms of both authors and topics addressed. Covering a wide range of issues, but many articles are less interesting for Europeans.

Grindley, P.: Standards Strategy and Policy: Cases and Stories. Oxford University Press, 1995, 300p.
This book draws very broad inferences from its case studies which may or may not fit a wider variety of standardization situations. The overall scope of the book is somewhat limited, in that it focuses on cases alone, assuming that what applied in a few high profile cases will necessarily provide a blueprint for future strategic action. In particular, it ignores practical aspects of standards strategy and management.

Libicki, M.C.: Information Technology Standards - Quest for the Common Byte. Digital Press, 1995, 400 p.
The book covers six major areas of concern to the computing industry and includes their development, their benefits and drawbacks, the federal role, and their futures. He also sketches their histories, both technical and political. The futility of prescribing standards against the stream of public needs is frequently evident.Because of its breadth, this book cannot provide details about the various standards thrusts, but Libicki manages to describe crucial conceptual features lucidly.

Cargill, C.F.: Information Technology Standardization - Theory, Process and Organizations. Digital Press, 1989, 235p.
This is almsot a classic in the field – a good introductory book that focuses on the more 'formal' aspects of standards. It does not cover the telecommunications aspects as well is sometimes outdated in part.

The papers published in the – sadly discontinued – ACM StandardView journal provide interesting insights. Online versions of the papers are available through the ACM Digital Library at

http://portal.acm.org/portal.cfm (access restrictions apply).

Plus, the 'International Journal on IT Standards & Standardization Research' (JITSR), semi-annually publishes relevant papers. Further information may be found at

http://www.idea-group.com/journals/details.asp?id=497