



ICT Standards Research – Quo Vadis?

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Abstract Issues surrounding ICT standards and standardisation are becoming increasingly recognised as relevant for various policy domains. This paper identifies, and briefly discusses, some areas of standards research where major efforts will be required in the near future; research issues are identified. It also outlines the broader aspects of standards education, inter-disciplinarity, and the link between R&D and standardisation, all of which are in urgent need of attention.

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1. Introduction and motivation

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 from a document published by the European Commission (1996). ICT 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.

1.1 Terminology

‘Standard’ and ‘standardisation’ are tricky terms. They are even trickier when it comes to Information and Communication Technologies (ICT).

Think about it for a minute – what exactly establishes a ‘standard’? Are only specifications issued by one of the ‘official’ Standards Developing Organisation (SDOs)¹ really standards? Does it suffice if such an SDO just rubber-stamps a specification developed by a third party? 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 those Requests for Comments (RFCs) that have been published in the standards-series² 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.

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.

Similarly, for the European Commission a standard is defined as:

a technical specification approved by a recognised standards body for repeated or continuous application, compliance with which is not compulsory.

¹ That is, 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) or BSI (British Standards Institution) at the national level.

² 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.

These definitions restrict what is colloquially referred to as a standard to those issued by ‘recognised bodies’. What exactly establishes a ‘recognised body’ remains unclear. Nevertheless, let’s use this definition for the purpose of this paper.

1.2 *What exactly is standards research?*

Standard 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 some consider their everyday work research topics. 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 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:

(a) *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 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, will not be elaborated any further here.

(b) *Research about standards* This is what this paper is all about. The broad variety of aspects that make up research about, for instance, 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 and/or usability.

In fact, I would argue that it should be in virtually everyone's interest to learn as much as possible about how standards emerge, why they emerge the way they do, what exactly shapes them, which impact they (or their absence) may have, and about other questions and issues that surround ICT standards and standardisation.

1.3 *Why is standards research important?*

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 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 World Wide Web Consortium (W3C), the Organization for the Advancement of Structured Information Standards (OASIS), 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 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 stan-

dards 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 underestimated 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 other hand, 'standards' setting industry consortia pop up at an almost alarming rate. Why? 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 could not 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? Bluetooth³ and Asynchronous Transfer Mode (ATM),⁴ for instance, never really lived up to the high expectations that initially surrounded them (in my humble opinion), despite the fact that both the ATM Forum and the Bluetooth Special Interest Group have scores of corporate members.

Standardisation may 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, social, and political consequences of standardisation. Pros and cons of joining the standardisation bandwagon versus 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 of 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 common perception, but is it true? Should we really leave it

³ A standard for short-range wireless communication.

⁴ A low-level communication technology, designed to support high-bandwidth multi-media communication.

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 do not expect this paper to answer these questions. Rather, the remainder of the paper will elaborate on some of the aspects touched upon above. In section 2 the paper will discuss some areas of ICT standards research that I believe will become of interest to policy makers in the near future (some of these already are). Subsequently, section 3 will discuss some aspect of what might be termed ‘research environment’. Finally, section 4 will provide some concluding remarks.

2. What needs to be done?

In the following, those standardisation-related issues will be discussed which I believe will become increasingly pressing over the next couple of years. This ‘top-ten-list’ is highly subjective, and most definitely not complete in that other topics of equal or greater importance have been left out. Topics that will not be addressed individually include, for example, IPR issues in standardisation, how to do a cost-benefit analysis for standardisation and the use of standards-based systems, how research can contribute to a mutually beneficial relationship with China in standards setting, and how to finance standardisation. At least some of these aspects will, however, be covered in other contexts.

The topics discussed below are of interest not only for researchers; almost all of them will need to be addressed by policy makers as well. In fact, I am not certain which group will be more interested in them, and in some cases a topic as such may well be more important for policy than for research. However, policy makers should be informed by research, so the interests of the two groups should overlap. Come to think of it – this may indeed be the greatest challenge: to convince policy makers that it is worthwhile to take into account standards research’s findings at least for innovation policy and research policy, and probably for policy making in other sectors as well (such as, for example, environment and security and/or safety). The individual topics are listed in no particular order.

2.1 Open standards

This should – hopefully – be a rather short-term issue; after all, it has been comparably extensively analysed (see e.g. Krechmer (1998) and (2006), Jakobs (2006), No-Rest (2005), de Vries (2006), West (2004)).

Indeed, the term ‘open standard’, albeit widely used, has not really been clearly defined (in fact, there are numerous definitions). It therefore holds

competing connotations for different actors. Its basic idea draws much on the implicit opposition to the situation of a pure market standard. An open standard means that the involved actors deliberately set about to codify the standard as non-proprietary knowledge, that in effect no individual commercial interests control the resulting products, and that in fact the open standard is made accessible and usable to all interested parties on reasonable and equal terms, even where proprietary technologies are implied (see, for example, Glinstedt (2003)).

Recently, the discussion gained new momentum through the 'quasi-official' definition provided by the European programme on 'Interoperable Delivery of European eGovernment Services to public Administrations, Businesses and Citizens' (IDABC). According to the IDABC European Interoperability Framework (2004),

... the following are the minimal characteristics that a specification and its attendant documents must have in order to be considered an open standard:

- The standard is adopted and will be maintained by a not-for-profit organisation, and its ongoing development occurs on the basis of an open decision-making procedure available to all interested parties (consensus or majority decision etc.).
- The standard has been published and the standard specification document is available either freely or at a nominal charge. It must be permissible to all to copy, distribute and use it for no fee or at a nominal fee.
- The intellectual property – i.e. patents possibly present – of (parts of) the standard is made irrevocably available on a royalty-free basis.

Unfortunately, this definition causes problems. For one, it includes the hardly comprehensible limitation of restricting intellectual property to patents. After all, other forms of Intellectual Property Rights (IPR; e.g. copyrights and patents) are also relevant in the software context. Furthermore, trademarks play an important role e.g. for e-catalogues. In general, any initiative to define open standards as royalty free should analyse thoroughly the consequences of, and discussions after, the unsuccessful attempt of the European Telecommunications Standards Institute (ETSI) to change its licensing scheme to allow for compulsory licensing (Iversen, 1999). While consumers and users may benefit in the short run, the incentives to invest in R&D would dry up in the long run. The United States even complained that such a rule would lead to the expropriation of its knowledge assets.

The absence of a requirement for due process from the definition is also surprising. It is one of the cornerstones of all SDOs' processes, and also included in the processes adopted by many consortia. Due process is more

than just ‘an open decision-making procedure available to all interested parties’, in that it also includes the existence of an appeal authority.⁵

In particular, however, the discussion about this definition evolved around the requirement of IPR being made available on a ‘royalty-free’ basis. In practice, this excludes the products of the vast majority of both formal SDOs and industry consortia from the list of producers of open standards. With very few exceptions (the World Wide Web Consortium (W3C) being a very prominent one) standards setting bodies (SSBs; i.e. both formal SDOs and standards consortia) typically ask for any IPR to be included in a standard to be made available on a (fair), reasonable and non-discriminatory ((F)RAND) basis. A recent study revealed that it remains rather unclear even for those managing SDOs how this rule is actually implemented (Blind et al. 2002). As a general rule it is reported that the license should not be higher than 1% of the final product price. The latter requirement is also likely to deter IPR holders from participating in standards setting. Even applying FRAND leads to this ‘adverse’ selection process (Blind and Thumm, 2004). IPR holders may well consider other avenues more worthwhile following in order to reap the benefits from their IPR.

A well thought-through definition of an ‘open standard’ is all the more important as it is likely to have repercussions on future policy decisions in Europe. In particular, whether or not the output of a given SSB is considered as ‘open’ will need to be based on a thorough analysis of this SSB’s process, and matched onto the definition of what exactly establishes an open standard. Such a matching exercise, which must not be influenced by the ‘nature’ of the SSBs (i.e. consortium or SDO), could then result in a ‘White List’ of SSBs that produce potentially policy-relevant deliverables (i.e. which could be referenced in public procurement, or integrated in the regulatory framework).

Research issues

- Which characteristics constitute an ‘open’ standard (to settle this question for once and all)?
- Which impact do an SSB’s characteristics (e.g. IPR policy, process, level of consensus, etc) have on its success in the market?

⁵ Historically, the definition of due process has included notice and hearing, allowing the defendant to speak and state his/her case, the right of appeal, judicial process, fairness, reasonableness, impartiality, equality, common law and settled usage (the acid test of due process), and equal protection of the law.

2.2 Standardisation, innovation, and IPR

Views on the nature of the relation between standardisation and innovation vary considerably. I remember that my first application (in 1998) for funding for a Conference on 'Standardisation and Innovation in IT' was turned down not least because of an evaluator's comment that the processes of standardisation and innovation are not inter-linked. This was the only occasion that I came across the view that these two processes are not related. Indeed, and despite the fact that both processes, as well as their relations, have been discussed extensively, it seems that the true nature of their relation is still unclear. Allen (1992) identified an innovation/standardisation cycle, where, after suitable experimentation, consensus is established about the (network) technology of choice. However, these cycles are distinct; standardisation is not seen as a contributor to innovation. Keeping this cycle model, Allen (2001) describes standardisation and innovation as 'Yin and Yang', 'tensioned opposites containing seeds one of the other'. Along similar lines, Branscomb and Kahin (1996) described the dual-faced nature of standards – they are critical to market development, but may threaten innovation and inhibit change once accepted by the market. A similar, albeit somewhat more 'optimistic' view has been discussed by Mansell (1995), who notes that standards-making is an important component of the innovation process. This view is corroborated by Swann (2000), who observes that standardisation enables innovation, and that it may also act as a barrier to undesirable outcomes (in the case of well-designed standards, that is). Likewise, (NSSF, 2003) reports that enterprises using standards as knowledge input are more likely to innovate than those who do not.

A rather different link between standards and innovation has been identified by Blind et al. (1999). They find that technical standards are also an appropriate indicator for the stock of results of research and development activities, and for the technological capability of an economy. In other words, not unlike patents standards may be used as an indicator of the ability to create innovations. These findings were re-enforced by a recent survey on the impact of ICT and e-business standards. One outcome of this survey was that standards structure markets by opening up new options in developing innovations (No-Rest, 2006).

The term 'innovation' is typically seen in a macro-economic context (as also exemplified by the above). Using a slightly broader notion of this term, Jakobs et al. (1998) compared and linked the processes of standardisation, innovation, and implementation. Both standardisation and implementation were found to be potential loci of innovations. This is largely due to the necessary co-operation between vendors and users (on whose sites the technology is to be implemented) during both processes. Along

similar lines, Williams (1999) argues that only standards enable 'configurational technologies'.⁶ The highly complex ICT systems of today are not monolithic, but created through a combination of simpler, standardised components, followed by a configuration of the overall system to meet an organisation's specific needs. This 'pick and mix' approach leads to local innovations, and would not be possible without agreed standards. That is, here as well standards are seen as an enabler of innovations.

In the context of innovation and standardisation the critical issue of intellectual property right (IPR) needs to be addressed as well. After all, for many companies, especially large vendors and providers, contributing to standards normally implies forfeiting certain IPRs, and thus running the risk of losing a source of revenues.⁷ On the other hand, the temporary monopolistic position gained through IPR may well cause negative effects on competition in the long run. Moreover, IPR is likely to negatively influence the diffusion of knowledge (Blind et al. 2002).

A different type of relation between IPR, innovation, and standardisation is reported by Blind (2006). He shows that companies with strong portfolios of relevant patents are less likely to participate in standards setting than those without such IPR. This is a problem in several respects – new standards may need to find work-arounds to avoid conflicts with IPR holders, the absence of important players may lead to inadequate standards, and the information flow from research to standardisation is further hampered.

Research issues

- What exactly is the relation between standardisation and innovation?
- How can framework conditions in standards setting be changed to also attract IPR holders (without discouraging others)?
- What can be done to improve the link between R&D and standardisation?

2.3 Co-ordinating standardisation

Over the last couple of years the standardisation environment in the ICT sector has seen significant changes. Arguably the most important development has been the proliferation of standards consortia, largely created

⁶ See Fleck (1994) and (1995) for a discussion of configurational technologies.

⁷ The importance of this issue was recently highlighted by ETSI's effort to introduce a new IPR policy, designed to restrict IPR for patents essential to certain 3GPP standards (3GPP is a collaboration agreement between ETSI and several other SDOs to develop a third generation mobile phone system specification).

out of frustration about the 'formal' standards setting process, and typically driven by one, or a group of, major industry players. At least in the early days of this development consortia were widely considered as being more efficient, and more oriented towards the needs of the industry.

Faced with the new competition, the established SDOs 'fought back'. The so-called 'New Deliverables' were their major 'weapon' here. That is, in order to better compete with consortia, and in what must be considered an attempt to mimic the rules and processes of the major consortia, most SDOs introduced 'lightweight' processes, leading to specifications with a lower required level of consensus. These specifications do not go through the full consensus forming process as the formal 'norms' do, and are thus more akin to the deliverables of the consortia. Typical examples here include ISO's 'Technical Reports', ETSI's 'Technical Specifications', and the CEN/ISSS 'Workshop Agreements'.

On the other hand, the processes of some of the major consortia (most notably OASIS and the W3C can hardly be distinguished any more from those of the SDOs. In fact, in a way the W3C's requirement for royalty free licensing of IPR that is incorporated in a standard is surpassing those of all formal SDOs (which typically require 'reasonable and non discriminatory' licensing). In consequence, we can observe a convergence of the two formerly separated 'standards worlds'. This is not to say that competition has stopped, but it is becoming increasingly hard to distinguish consortia and SDOs based on their processes and outputs.

Still, the current environment forces companies with a business interest in the ICT sector (i.e. primarily large vendors and service providers, but also leading-edge users) to participate in a vast variety of SSBs.⁸ This is certainly an undesirable situation, and a higher level of co-ordination between consortia, and between consortia and SDOs would be highly desirable. The latter could, for example, be achieved through an adequately flexible and speedy transposition process of consortia specifications to full-blown international or European standards. In addition, a division of labour between SSBs should be considered more seriously. That is, long-lived 'infrastructural' technologies could be dealt with by the SDOs through their 'traditional' process, and more short-lived other technologies could be within the realm of consortia and the SDO's New Deliverables.⁹ The sequentiality of infrastructure and subsequent applications and services would also have to be taken into account in the

⁸ For example, HP and Sun each are involved in around 150+ SSBs (Updegrave, 2003).

⁹ Obviously, it will not always be clear from the outset which standards will be long-lived and which ones will not. Likewise, the distinction between 'infrastructure' and 'application' is increasingly blurred (see, e.g. No-Rest (2005)). Nonetheless, it may be assumed that even an imperfect division of labour would significantly improve effectiveness of the system.

standardisation activities of SDOs and consortia and their co-ordination efforts.

To summarise: competition between SSBs prevails – this holds for both consortium vs. consortium and consortium vs. SDO. Policy makers need to do something about it by encouraging both camps to improve co-operation or at least co-ordination.

Research issues

- How many standards development institutions are too many?
- How can co-ordination and co-operation between SSBs be achieved without violating the free market of standards setting?
- Is this ‘free market’ actually desirable, or are regulatory interventions preferable, to better enable interoperability through standardisation?

2.4 Standardisation and technology assessment

The shaping process begins with the earliest stages of research and development. (Williams, 1992)

In a way, ICT standardisation itself represents a form of technology assessment. At least implicitly IT standards include statements about e.g. economic and societal implications of the technology they specify. And by their very nature they frequently establish trajectories which future developments are virtually forced to follow.

Technology Assessment (TA) typically takes as its starting point technical artefacts and systems that have already been implemented.¹⁰ However, at least in case of networked systems – such as ICT systems – it would certainly make sense to have a closer look at the actual origin of a technology, i.e. its design stage. Whilst this may be next to impossible for proprietary developments, the work done within standards bodies’ committees and work groups is pretty much open to external analysis (at least in principle). Strange enough, so far this route has hardly been explored.

Constructive Technology Assessment (CTA) strives to identify and exploit the opportunities for constructive, active influence on technical development processes. That is, ‘CTA is built around the attempt to anticipate effects or impacts of new technologies or new projects with a strong technological component’ (Schot and Rip, 1997).

CTA aims to actively influence technological developments from its

¹⁰ The OTA study on ‘Global Standards: Building Blocks for the Future’ (OTA, 1992) is a notable exception.

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 of 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 (2003)). 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 cannot only be applied through legislation, but also through other channels. A standards setting body could well be one such channel. Also, CTA aims at involving all stakeholders in the technical development process (in one way or other). At least in theory pretty much the same holds for standardisation. And even in real life we can easily find committees where vendors, service providers, and users jointly develop standards specifications. And we can also identify areas where 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). Stakeholders¹¹ 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.

Research issues

- How can standardisation be incorporated into (C)TA activities?

¹¹ Particularly including scientists, whose contributions may be of particular importance for 'learning'.

2.5 *Inclusion of all stakeholders*

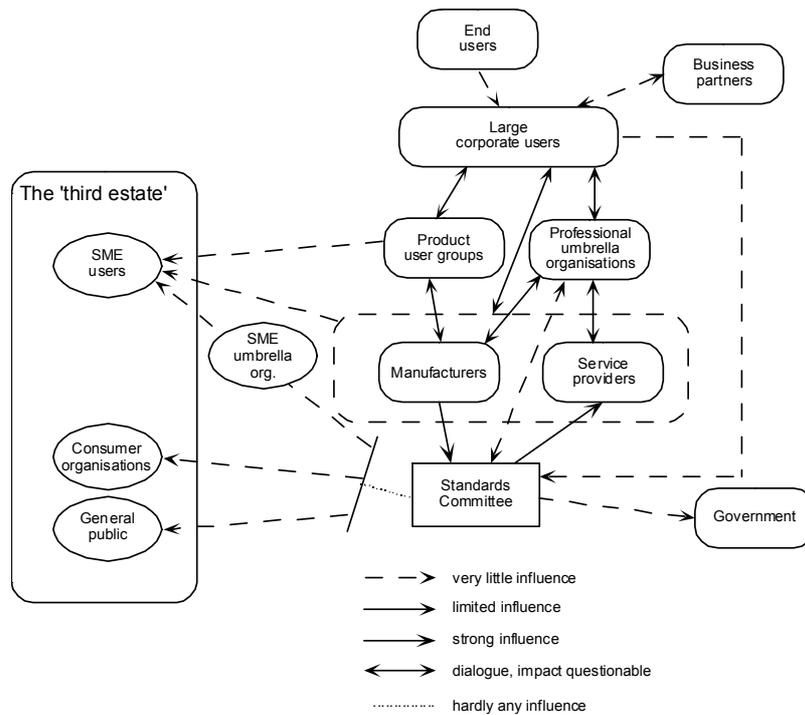
In one way or another, ICT standards affect almost everyone. Accordingly, one could argue that almost everyone should have a say in the standards setting process. Yet, recent studies show that this is hardly ever the case (if at all). Rather, the working groups and committees of the various standards setting bodies are typically dominated by large, multinational vendors and service providers (see e.g. Jakobs et al. (2001) and (2005), Updegrave (2006)). Accordingly, in the vast majority of cases the resulting standards tend to reflect their needs and requirements, as opposed to those of user companies, consumers, Small and Medium-sized Enterprises (SMEs) (the 'Third Estate'), and policy makers (see Figure 1).

In fact, the importance of the involvement in the standardisation process of stakeholders beyond the seriously large players is nicely illustrated by the case of the Manufacturing Automation Protocol (MAP).¹² The failure of this potentially very useful multi-million dollar initiative may not least be attributed to the complete absence of SMEs in the standardisation activity. The extremely complex specifications were done solely by very large companies, for which this complexity apparently was not such a big problem. Unfortunately, they failed to realise that the situation was very different for their SME suppliers. For them, the specifications were way too complex to be implemented and managed. Eventually, the whole initiative collapsed.

However, some earlier research by Jakobs (2001) suggests that the popular (among SDOs) unconditional 'call for users' may at least be questionable, if not counter-productive. Users' major task in standardisation is the contribution of real-world requirements, which then establish the basis from which standards can be developed. Yet, 'requirements' is a very broad term that not only refers to the technical domain, but is also closely linked to the particularities of the respective local environments. In each such environment very specific requirements and processes have developed over time. These, in turn, stand in the way of a straightforward installation of an IT system. It is here where long-standing, time-honoured traditions characterise the setting, and where technical systems as well as production and business processes have been designed to optimally meet the demands of this specific environment. A new system to be implemented here will have to be customised, as have been the other artefacts.

¹² An initiative started by General Motors and other large companies in the mid-eighties to provide for interoperability of IT systems in production environments (see e.g. Ioannou and Dwyer (1988)).

Figure 1 Relations between stakeholders in the standards setting process (from Jakobs (2005))



Accordingly, contributing only functional and technical requirements does not suffice. Rather, organisational and other non-technical needs have to be considered, and user representatives need to be in a position to identify these needs. Thus, it does not make too much sense for users to send only technical people to the committees. Rather, corporate strategists and managers also need to get involved, to make sure that the non-technical issues are adequately covered as well.

However, given the huge variety of business sectors, organisational forms and business philosophies, the many different intra- and inter-organisational interdependencies, and all the differences that come with varying company sizes, not to mention regional or national differences in culture and legislation it is most unlikely that coherent requirements will ever materialise, apart from maybe some very generic ones. That is, thanks to this context-specific – and thus very diverse – nature of most user requirements in standardisation an increased number of users is not a desirable goal per se. Yet, on the other hand it has to be made sure that all stakeholders have an adequate say. Accordingly, new mechanisms need to

be introduced into the standards setting process to overcome this situation.

Research issues

- How important is user participation in standards setting? How to determine which stakeholders should be present at which standardisation activity? How to ensure their participation?
- Is democracy in standards setting necessarily a good thing?
- If democracy in standards setting is to be achieved, how can barriers to entry be removed?

2.6 *Open standards and open source*

This is a bit of an uneasy relation. For one, the nature of the relation is far from being clear. For some, they are the same (Walli, 2005). For others, open standards are nothing more than enablers, as they form the basis of the communication mechanisms necessary for the development of open source software (OSS; see e.g. Stoltz (1999)). Non-standardised terminology is another contributing factor – as might have been expected the term ‘open’ means different things to different people. Some equal ‘open standard’ with ‘royalty free licensing and sublicensable patent licenses’ (Rosen, (2004).¹³ That is, the term ‘open’ is reduced to licensing aspects, whereas the characteristics of the process as such (like, e.g. due process, consensus, etc), which are crucially important for the standardisation community, do not play a role at all (see also sect. 2.1).

This diversity of views and definitions is largely due to the fact that both communities – OSS developers and standards people – do hardly share any common background. Quite the contrary – what is now frequently referred to as ‘the OSS movement’ originally started out as ‘an open source development model’ (Cargill, 2005). The original idea behind OSS was a distributed software development model, i.e. a new way of writing code. Only at a later stage a link to standards setting was established, primarily due to common IPR-related problems.

I would argue that OSS development and standards setting are orthogonal processes. An (open) standard is developed through whichever process the originating SSB has adopted. The implementation of this standard may then be done through the open source development process. At least in this case the processes are also successive, and only slightly overlapping.

¹³ See Tsilas (2005) for a discussion of this.

Moreover, by its very nature OSS is in a continuous state of flux – after all, under open source license agreements developers are free to modify code and to add new code to existing OS software (in some cases with certain restrictions). Releases of OSS occur at more or less arbitrary points in time. Standards, on the other hand, are by and large static, or perhaps semi-dynamic.¹⁴

Nonetheless, OSS can add value to open standards. For one, as both share the ‘open’ characteristic, open source implementations of open standards could meet many governments’ desire to move away from proprietary systems (see, e.g. Coallier and Gérin-Lajoie (2006), Simon (2005), Centeno et al. (2004), Kovacs et al. (2004)). Likewise, both serve as co-ordination mechanisms. Moreover, a well-managed OS development process could contribute to quicker updates and faster adaptation of standards-based software. Also, both share the problem of how to deal with IPR issues. Here, mutual learning is likely to benefit both communities.

Accordingly, the basic problem to be solved seems to be this: how can the two communities be brought together? Currently, the difference in views on IPR licensing is the major dividing factor. The various variants of what is basically a royalty free licensing model that are currently deployed in the OSS context¹⁵ are in stark contrast with the (F)RAND model favoured by all but a few SSBs. However, developments in both communities are under way that may eventually establish a basis for common ground. In the standards setting arena, the European Interoperability Framework’s OSS-influenced definition of an ‘Open Standard’ (IDABC, 2004) might be a first step (see sect. 2.1 for a critique of other aspects of this definition, though). Similarly, the ‘Creative Commons’ flexible licensing approach of ‘some rights reserved’ (Brown, 2005) could perhaps find its way into the world of standards setting.¹⁶

Research issues

- How to establish a common ground to bring together the OSS community and the world of standards setting?
- Which common IPR models could be deployed?
- Could, and should, OS implementations be incorporated into the development process for open standards?

¹⁴ See Egyedi and Heijnen (2005) and Egyedi (2006) for more details on the dynamic aspects of standards and standardisation.

¹⁵ See e.g. Moran (2003) or Hecker (2000) for more information.

¹⁶ For more information see <http://creativecommons.org/>.

2.7 *Standards and enterprise interoperability*

During the last two decades, the business world has undergone significant changes. For some organisations, doing business globally has become critical to their survival, and others discover new opportunities by focusing their business in a local setting. In this process of change, ICT plays a significant role both enabling and triggering the re-organisation of business activities. In fact, ICT became ubiquitous, invading all aspects of business domain.

In such an increasingly networked world, it is absolutely essential to communicate and collaborate. To this end, enterprise interoperability (EI) is a *sine qua non*. ICT and e-business standards aim to ensure interoperability between different IT systems both within and between organisations. In fact, 'enterprise interoperability' has become a bit of a buzzword in European IST¹⁷ research; significant efforts have gone into interoperability research in FP6, and this is likely to continue in FP7.¹⁸

In addition to standards, however, seamless communication and integration of data and information, as well as synchronised inter-organisational business processes, also require proper applications, shared understandings, adequate business processes, etc. Legacy applications, for example, often stand in the way of inter-organisational co-operation. Few such applications were designed to interoperate with others.

Today, research, technology development, and standardisation activities in the field of EI still remain largely both fragmentary and fragmented. Many groups are developing their own solutions, most of which fail to lead to practical solutions in the market. At the same time, the number of both standards and standards setting bodies proliferate. In particular, the number of sector-specific standards is increasing dramatically. While standards with such limited scope of application do have their merits (largely in terms of simplicity and implementability, which in turn are of considerable importance especially for SMEs; see e.g. Egyedi et al. (2003)), specifications that are applicable only in one specific sector introduce additional interoperability issues when co-operation with firms from other, related sectors is required. The proliferation of consortia, developing specifications that compete or at least overlap in scope is further contributing to interoperability problems (see also 2.3 above). Such more or less isolated

¹⁷ Information Society Technologies, one of the Priorities of the European Framework Programmes for Research and Technological Development (FP6: 2002 – 2006; FP7: 2007 – 2013).

¹⁸ The European i2010 Strategic Framework (EU, 2005) also recognises the importance of enterprise interoperability. Basically, this framework represents the link between high-level strategies and the FPs.

initiatives lead to islands of interoperability, lacking in critical mass and wider application, and are likely to further compound problems (Cabral et al. 2006).

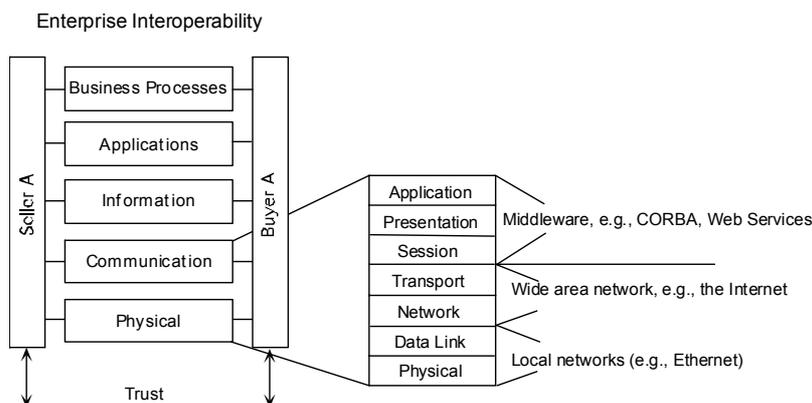
From the standards research perspective, enterprise interoperability represents a major challenge and exhibits very similar characteristics. Both have very similar goals, are highly interdisciplinary (and sometimes suffer from this), and are beginning to get the necessary level of recognition from research policy makers (EI still faring much better, though).

Figure 2 below depicts the different layers that together constitute EI. Standardisation efforts have been under way for all layers. Historically, standards setting started at the bottom layer, and has now reached the top-most layer, 'Business Processes'. Here, it remains to be seen if standards are an appropriate means to enable or support interoperability. While standards for certain 'standard' processes (such as, for example, invoicing, procurement, etc. i.e. those processes that cannot be linked to any competitive advantage) will be useful, other such processes may well be a source of a company's competitive advantage. In these cases, standardisation will at least be problematic. Moreover, I would argue that such business processes are far too heavily influenced by specific local actualities and conditions, subject to local cultures, values and beliefs, and entrenched in potentially unique environment for standardisation to make much sense. The same holds, perhaps to slightly lesser degree, for applications as well.

The degree to which infrastructure standards affect businesses (beyond interoperability) is another aspect in need of further analysis. Frequently, even large users are happy to leave particularly the standardisation of elements of the ICT/e-business infrastructure to vendors and service providers (see, e.g. Jakobs (2000)). Yet, also such technical standards play a crucial role in shaping not only the future form of the technology (Williams et al. 1993) but also nature and functioning of the organisation and the relationships between organisations (Tapscot, 1995). Consequently, the infrastructure standards affect the way in which organisations interact and do business electronically. For example, whereas the standards for RFID¹⁹ products would be 'communication' standards (in Figure 2), they have been essential in enabling organisations such as, e.g. WalMart and the US DoD (Department of Defence) to integrate their respective global supply chains. In fact, these integrations were triggered, and indeed enabled, by the increased availability and maturity of standards-based RFID tags and readers. Here, elements of the ICT infrastructure, and the standards upon which they are based, have been instrumental for the design and imple-

¹⁹ Radio Frequency Identification.

Figure 2 The constituents of enterprise interoperability



mentation of scalable e-business systems (Su et al, 2001), and for interoperability between enterprises within supply chains.

Research issues

- When is standardisation useful, and when should other means to achieve interoperability be deployed (e.g. gateways or agents)?
- What needs to be standardised (technologies, processes, etc), and at which level (international, regional, sectoral, bi-lateral, etc)?
- How, and to which degree, do infrastructure standards have an impact on e-business beyond interoperability?

3. How to go about it

So far, we have only looked at content-related issues, i.e. *what* will need to be done. However, the *how* must not be ignored. By its very nature research into ICT standards and standardisation needs to be done from different angles, and involves a multitude of disciplines. These include, among others, economics, management, business studies, sociology, technology studies, computer science, telecommunication engineering, and law – you name it.

This simple observation raises two important questions:

- How can future standards researchers (and practitioners) be adequately trained?
- How can researchers from these very diverse disciplines be brought to co-operate?

In the following, these questions will be briefly discussed.

3.1 *Standards education*

We need to start early. In order to raise interest in issues related to standards and standardisation (i.e. setting, doing research about, incorporating into policy, etc) there is an urgent need to do something about education in this field. Typically, ICT standards are touched upon in tertiary education in the technical disciplines (engineering, computer science, etc), and occasionally in the social sciences (economics, technology studies, etc). And with very few exceptions that's pretty much it.²⁰ One of the important contributing factors here seems to be that standardisation is more about 'doing', like setting standards, managing them, etc than it is about 'understanding' (e.g. why they emerge the way they do, of their impact, etc. (Holler, pers. com.).

On the one hand, this is surprising. Organisations active in the ICT sector are likely to benefit considerably from employees better educated in all matters relating to standards and standardisation – after all, 'without standardization there would not be a modern economy' (Surowiecki, 2002). On the other hand, the topic is not exactly sexy; standards are widely considered as boring, old-fashioned, and an obstacle to innovation. Older engineers, no longer capable of keeping up with the pace of new technical developments being sent to standards setting bodies is another popular perception.

A recent survey on (tertiary) education in standardisation found that especially business schools tend to ignore the topic altogether, with a slightly better situation in computer science departments (Borde, 2004). This is quite surprising, as the business and economic aspects of standards are considerably more important than their technical nuts and bolts. Anecdotal evidence suggests that computer science and engineering courses limit their teaching to the technical contents of some important standards, and do not address the broader implications of standards. Obviously, this lack of adequate exposure to the economic, social, and other non-technical aspects of technical standards has major ramifications for standards research. For one, it is extremely difficult to find students who are interested in writing a thesis on a standards-related topic, and knowledgeable enough to do so with a reasonable time frame. This, in turn, contributes to a lack

²⁰ To the best of my knowledge, the situation is not any better in other sectors (e.g. environment, health and safety). Also, in these sectors standards tend to be less voluntarily (i.e. they are heavier regulated).

of PhD students, a subsequent lack of professors, and so on.

It is highly unlikely that any top-down initiative will lead to better standards education. Thus, a bottom-up approach is called for. That is, it is up to scholars and lecturers to specify curricula, and up to the universities to actually adopt them. A first step that could be achieved with an acceptable level of effort would be to offer a course on ICT standardisation as an additional course which should be made compulsory optional for as many relevant 'traditional' subjects as possible. To further reduce the associated development workload per head, an e-learning course would be a realistic option.²¹

A similar case can be made for continuous learning. Companies that develop IT systems, as well as user companies, need managers and engineers with an adequate knowledge about standards and, among other aspects, who is developing them, how to effectively and efficiently contribute to standards setting, and about the potential implications to be associated with using standards-based systems versus proprietary ones.

3.2 *Interdisciplinary research*

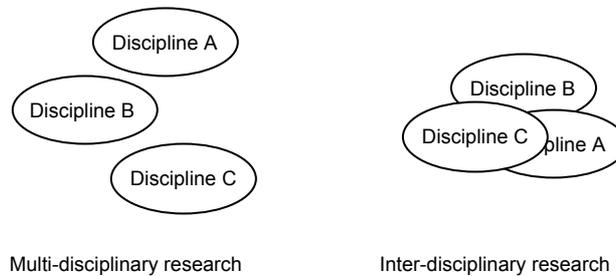
Standards research is multi-disciplinary by its very nature. Disciplines represented include, among others, economics, business studies, technology studies, telecom engineering, management and organisational studies, information systems, and computer science. Yet, individual disciplines will always only be able to address part of a problem, and will hardly ever get the full picture. Accordingly, to fully understand the various problems and issues associated with standards research it will become necessary to improve co-operation between the contributing disciplines – i.e. to move from multi-disciplinarity to inter-disciplinarity. With multi-disciplinary research, each discipline works in a self-contained manner and there is no integration across disciplines. With inter-disciplinary research the contributions of the various disciplines are formally integrated (see also Figure 3).

Given the complexity of the topic, I am convinced that we will have to move to more inter-disciplinary research, where the individual disciplines can inform each other and where, I'm sure, research will yield an outcome where the whole is greater than the sum of its parts.

Also, despite the considerable variety of disciplines involved in standards research, some are suspiciously absent. Most notably, this holds for

²¹ A course currently being developed at the Helmut-Schmidt-University and partners would fit the bill. For more information please see <http://www.asia-link-standardisation.de/>.

Figure 3 Multi-disciplinarity vs. inter-disciplinarity



lawyers, but also for, e.g. communication studies and psychology. As policy makers (research and innovation policy spring immediately to mind) will more frequently – and possibly more desperately – look at standards setting for information and guidance, the importance of also incorporating at least the legal aspects into standards research will increase likewise.

3.3 Linking research and standardisation

I have said above that this paper is all about research *about* standards (as opposed to research *for* standards). This section is a bit of an exception.

Standards are a proven mechanism for technology transfer, fostering the diffusion and utilisation of technology. Thus, standards may be considered as an important aspect of various fields of policy, like innovation, trade and environmental policies. They also play a vital role in the European market by promoting competitiveness and interoperability of products and services. They also serve to protect consumers and the health, safety and environment of citizens. The development of new and improved European standards requires high quality technical information. It is therefore important to ensure that standards are developed in an objective and timely manner and that their usage is free from obstacles. Otherwise, there is a risk that interests at national, industrial, or technical level will bias standards in their favour, or delay their implementation. This creates a fundamental inter-dependency between the standardisation and research communities. Standards are the bridge between the technical domain and the economic, social and regulatory framework. Research can support the development of new and improved standards through the provision of objective technical information.

The need for a closer link from research to standardisation has also been recognised by the European Standards Organisations (ESOs) (such as CEN, CENELEC, and ETSI):

In the ICT domain, the link between R&D and standardization is of particular importance; standardization is in a position to leverage the consensus reached within an R&D project at the European and/or international level ... (ICTSB, 2005).

Figure 4 shows the relation between research and standardisation in technology transfer. While the non-existence of a direct link from research to standardisation may be a slight exaggeration, it is certainly in need to major improvements (as are some of the other links depicted there).

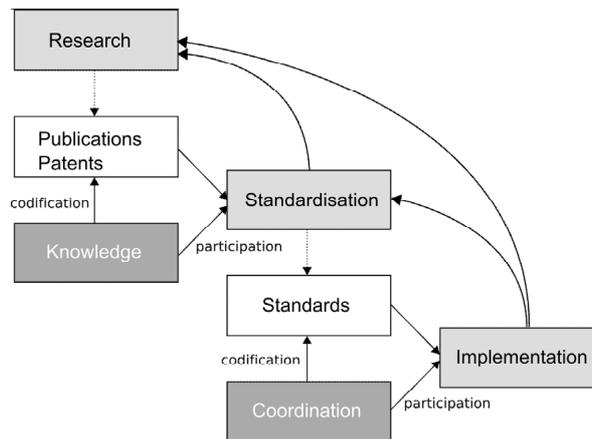
The missing – or at least very inadequate – link between research and standardisation raises a number of questions. According to Interest (2005), these include:

- What are the similarities and differences regarding the realms of research and standardisation?
- Is there an institutional misfit between research and standardisation?
- What role do actor structures (like, e.g. networks) play regarding the link between research and standardisation?
- Does the trend towards the capitalisation of scientific knowledge in the form of IPR protection influence the link between research and standardisation?
- Are there disincentives for researchers to join standardisation?
- Do researchers from different disciplines or different organisational contexts perceive standards and standardisation in different ways, and is this a function of their 'distance' to industry?
- Do researchers from different contexts perceive the 'closure' element of standardisation as hampering or enabling for their work?

Answers to these questions are crucially important especially in the ICT field. As it currently stands, many publicly funded R&D projects fail to generate any impact simply because their findings do not make it back into the public domain (from where the funding came in the first place). In many cases, standardisation would be a very appropriate vehicle here.²² Here, the funding organisations should revise their policies, e.g. by also taking into account, through co-funding, the time it takes to turn R&D results into standards.

²² The Copras project (<http://www.w3.org/2004/copras/>) represents an attempt to improve the situation. It aims at helping IST projects to identify their potential for standardisation, and assists them in actually contributing to standards.

Figure 4 Research and Standardisation in a Simple Technology Transfer Model (from Interest, 2005)



4. Concluding remarks

This paper has touched upon some issues in the realm of IT standards and standardisation that I consider worth discussing. Many 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 at the references 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 few 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 for standards research appears to be on the rise, at least at the European level. The odds are that we will see more interesting research in this domain in the not-too-distant future.

There is, however, one impediment to such research. In fact, it is a virtually common theme in the discussion of the individual research areas above – misunderstandings, lack of communication and of co-operation. Many different research disciplines contribute to standards research, and while this clearly enriches the work and makes it more beneficial, it may also turn research into some sort of minor nightmare. Your fellow researchers do not really understand you (and vice versa), you do not know

where to get funding from (this seems to be improving, though), or where to publish your findings (while in theory inter-disciplinarity is something valuable and needs to be supported, mono-disciplinary research is still the norm, to a considerable degree our whole research system is based on it, and it shows²³).

In any case, I do not think that doing the actual research will prove to be the toughest challenge for those who believe that research on ICT standards and standardisation is valuable. Rather, I believe that convincing policy makers to actually take into account the findings, and to listen to those who do standards research will be much harder. Prior to that, however, researchers will need to think about how they can make their voices heard. Not least due to the inter-/multi-disciplinarity of the field, no entity exists that would take up this cause, and to which policy makers would listen. To this end, standards researchers should try and join forces with one of their main potential beneficiaries – the ESOs.

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²³ See II-FP5 (2002) for an extensive discussion about the problems of inter-disciplinary research.

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