The Economics of Standards and Standardization in Information and Communication Technologies

Open Standards and Their Early Adoption

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Executive summary

Standards have proven themselves indispensable to the industrial revolution. How are standards developed today? What does the economics of standards tell about the impact of standards upon economic growth and productivity? Do standards influence industry innovation? How are the standardization processes in the field of ICT taking place? How and why do open standards differ from other types of standards? How may open standards influence ICT government policy and the reverse: How will government need to take action in the face of the international trend toward open standards in ICT?

Contents

I. Introduction to standards

The distributed and global nature of the modern IT environment implements digital products, distributed processes and control on the basis of interoperability and process quality standards. In service-oriented, highly industrialized countries, information itself is both a raw material and a product (Castells, 1996). This double important role of information in economic development means that institutions related to knowledge exchange may influence economic outcomes as much, or more than they may influence productive efficiency or innovation (Steinmueller, 2005, p.1).

In post-industrial service-intensive societies informational processes are so critical that governments need to take an active role fostering an information infrastructure that creates equal access and an even distribution of knowledge among citizens and businesses, and ensuring the security of this critical infrastructure (Castells 1996, GAO 2004). A modern society requires government efficiency and effectiveness that scales with citizen knowledge and competence and therefore requires standards for effectively implementing interoperability and interchange. The information infrastructure interoperability requirements are met by the adoption of broadly recognized standards that do not bias solutions towards specific implementations. Critical infrastructure protection comes with a government policy and action enforcing relevant standards (GAO 2004). Efficient government agency-to business, agency-to-citizen, and cross-agency operations are possible only through a policy formulation including relevant standards and their adoption in government operations ensuring all relevant stakeholders equal access on equal terms to government services each using their preferred standards compliant application.

Given the aforesaid importance of standards-related policy in development strategy formulation, it comes as no surprise that in recent years the topic of a New Information Society has been at the forefront of policy-makers agenda, and the critical importance of interoperability as the major condition for arriving to the New Society has been acknowledged (Council of the European Union, 2004). In the results of a EU public consultation on strategic issues,[1] it is stated that the following trends have been identified, amongst others:

> "Technological challenges: contributors highlighted the trend towards the convergence of networks (e.g. fixed and mobile) and services. Among other things, open standards were highly recommended to ensure interoperability, and the use of open source software is seen as a way of providing transparency and cost-effectiveness, particularly in public administrations."

1 See http://europa.eu.int/idabc/en/document/3956/194

In trying to reconcile the rhetoric of the EU policies with the economic realities of the everyday life, we must go beyond the slogans. How can open standards provide *more* transparency and cost-effectiveness to already cost effective public administrations in Denmark? How do different standards assure or contribute to the formation of *more* transparent and cost-effective information infrastructure and *more* efficient government? What does the economics of standards tell about the impact of open standards upon economic growth and productivity in general? What is the cost of providing *more* (of) open standards for government and industry? These questions are not answered in the strategy on a new information society. In order to properly examine the aforementioned issues, we need to understand the present state of affairs in international and national ICT standardization arena.

In this brief report, though we cannot enter into a substantiation of all arguments just as international research into (open) standards do not yet have all the answers.

Open standards and the public good

Within the field of information and communication technologies the extensive use of proprietary and industry standards is increasingly seen as jeopardizing productivity gains from ICT investments in non-IT industries. An open standardization process resulting in open standards has been suggested as a way to enhance interoperability and secure more productivity gains from the use of ICT (Fomin, 2005). Meanwhile, international standardization bodies have been active in promoting many new ICT standards which do not completely conform to the criteria of openness as defined by scholars and standardization stakeholders alike (e.g., the EU IDABC agency). We therefore need to set forth criteria for distinguishing between open and “less open” or “insufficiently open” standards to address the present state of affairs in the standardization arena.

To measure the degree of openness of standards, a range of criteria on the nature of participants and conditions for the access to the standards' documentation are of principal importance. From this point of view, we can divide standards into three groups: Industry standards formed by one or more companies (in consortia) - usually non-nominal fees apply for access to specifications. International standards formed by international standardization bodies making specifications available at a nominal fee on a non-discriminatory basis. And thirdly, open standards that are the outcome of an open standardization process and with reasonable and nominal fees for obtaining specifications.

Another way to approach the openness issue is provided by the user perspective. According to Krechmer (1998):

1. The formal SSOs, as organizations representing the **standards creators**, consider a standard to be open if the creation of the standard follows the tenets of open meeting, consensus and due process.

2. An **implementer** of an existing standard would call a standard open when it serves the markets they wish, it is without cost to them, does not preclude further innovation (by them), does not obsolete their prior implementations, and does not favour a competitor.
3. The **user** of an implementation of the standard would call a standard open when multiple implementations of the standard from different sources are available, when the implementation functions in all locations needed, when the implementation is supported over the user's expected service life and when new implementations desired by the user are backward compatible to previously purchased implementations."

These are the very different views from the creators, implementers and users of standards on what is an Open Standard. Their combined, reasonable, but not simple expectations translate into ten rights that enable Open Standards (Krechmer, 1998):

1. Open Meeting - all may participate in the standards development process.
2. Consensus - all interests are discussed and agreement found, no domination.
3. Due Process - balloting and an appeals process may be used to find resolution.
4. Open IPR - IPR related to the standard is available to implementers.
5. One World - same standard for the same capability, world-wide.
6. Open Change - all changes are presented and agreed in a forum supporting the five rights above.
7. Open Documents - committee drafts and completed standards documents are easily available for implementation and use.
8. Open Interface - supports migration and allows proprietary advantage but standardized interfaces are not hidden or controlled.
9. Open Use - objective conformance mechanisms for implementation testing and user evaluation.
10. On-going Support - standards are supported until user interest ceases rather than when implementer interest declines (use)."

Since this is an ideal of the standardization process and its implementation we rarely find all criteria for openness met in practice. Reconciling the aforementioned criteria to the real life practices can be done by a comparison to the principles of the open source development, as stipulated by Bruce Perens:

- *Availability* is addressed by Open Documents.
- *Maximum end-user choice* is addressed by Open Use.
- *No royalty* is addressed under Open IPR.

- *No discrimination* is addressed by Open Meeting, Consensus and Due Process.
- *Ability to create extension or subset* is addressed by Open Interface.
- *Ability to prevent predatory practices* is addressed by Open Change.

The six principles proposed by B. Perens map fully onto eight of the ten rights of Open Standards proposed. B. Perens does not directly address the desires for or against One World or the end user right of On-going Support. This is one affirmative test of the completeness of the rights of Open Standards proposed.

There is a number of complimentary, if not competing approaches to standards and standardization, to the one of an institutional one looking into the standardization bodies, which follow different ways of standards development. Second, a technical approach to standards defines them in terms of "any set of technical specifications that either provide or are intended to provide a common design reference for a product or a process" (Soininen 2005) (quality, minimal conformity, reference standards). A functional approach to standards stresses a complete set of impacts and conditions derived from the chosen disciplinary framework. Market (self-)regulation *(de facto* vs. *de jure* standards), diffusion of innovation (network externalities, complementarities, and switching costs), and finally a politics of standards (standards as a form of regulation) – all are well known perspectives on standards and their effects.

In a rating of major standardization bodies, Krechmer (2005) finds no complete and full implementation of the open standard definition listed above in 10 criteria. Yet, the ideas behind the 10 criteria all resolve around the question: How do we obtain a true and true pure public good? Asking for a pure public good means to install a non-market process of market creation that is unbiased, sustainable and responsive to all self-selected and self-appointed stakeholders in the very formation of that market. Ideally, a standard circumscribes the implementation of those devices and services (software) that implement the standard specification in a market. Standards are not these implements but their precondition so the formation of a market that relies upon a standard will exhibit an approximation of the perfect marketplace. A vast economic literature on markets has assumed market existence whereas institutionalist and transaction cost economics have identified why markets may not come into existence (e.g. Arrow 1974, Coase 1937, Williamson 1975, 1985). In a innovation rich economy market formation is a sequel to growth and economic welfare.

Understanding the role of standards and standardization as the backdrop of the established economic theories, one must distinguish between three different stages of standards creation and implementation: (1) standardization bodies or (vendor) companies setting up a working group on developing a standard; (2) implementation of a standard in a product, service or a process by a vendor or an organization; (3) end-user adoption of a standard embedded in a product, service or a process where standards are a sort of meta standard.

In order to analyse the impact of standards, we first have to specify, which of these three stages of standards development/adoption we are addressing. Policy measures aimed at influencing the adoption of standards by end-users thus presume the two other stages to have been completed. Regardless of the stage chosen for analysis, the economic impacts of standardization will be traced to such problem areas as industry innovation, interoperability, trade, end-user benefits from enhanced product quality, security, safety, and usability. Finally, the impact of standards upon labour productivity is of a key concern. The impact of standards is not limited to ICT industry implementation, since it is of significance to all non-ICT industries as well.

Open standards and the market regulation

“The specific functions that standards fulfil are very diverse. Two of the most important are providing compatibility and information. It is through sharing a common standard that anonymous partners in a market can communicate, can have common expectations on the performance of each other’s product, and can trust the compatibility of their joint production. Thus, standards are necessary for the smooth functioning of anonymous exchanges – and therefore, for the efficient functioning of the market” (WTO Annual Report 2005, p. xxiv).

A standard has its greatest impact if available at the time when vendors are ready to implement and launch applications that rest on this standard. On the temporal dimension, there are early and late standard's adoption to the market. Under the market (self-)regulation mechanisms, the case of standards early adoption is possible when a standard offers advanced and/or superior features when compared to those in present products and processes. If standard is a product of the anticipatory standardization process (a process leading to the creation of standard ahead of the standard-based product development), it will have better chances for early market adoption, because the standard-based products will usually offer superior performance . In the case of the late adoption, on the other hand, a standard developed after market products with comparable performance became well established, faces a hard time to win over vendors unless there are market imperfections like a high concentration ratio or a strong lock-in to other vital components of an ICT system that entice some vendors to grab for the new opportunity to relaunch their products. Regardless of the adoption time, standards adoption to the market implies vested interests of national governments, industrial conglomerates and groups, professional associations and alliances, and the major standardization organizations. To reach a consensus of all affected/interested parties on the early adoption of open standards may be difficult due to uncertainty and inconclusive evidence of vendor profit opportunities and standard-stemming benefits for each of the stakeholders.

As the backdrop of the aforesaid, the purpose of adopting open standards is a critical need for interoperability while avoid the monopolization of the markets. Thus, we can achieve interoperability and the associated gains of information access and coordination capabilities either by accepting one operator and one (industry) standard or, we can intervene in markets in ways to assure the advantages of interoperability supported by an open standard established without furthering particular industrial interests but aiming at the establishment of a level playing field.

The process of establishing standards is decisive to this purpose. Open standards mean respecting and assuring conditions required to avoid pitfalls of direct or indirect bias to particular industrial interests and national interests serving the same particularistic purpose, including avoiding patent constraints on implementations of a standard (Soininen 2005). While this is the ideal demand, limited resources and diverging incentives for participation in standardization may derail efforts or even block for standard development. The use of a standard is better assured if all interested parties have had access to voice their concerns and offer their amendments that are taken seriously by consensus requirements. Access fees to standardization bodies therefore must be negligible, and so must be implementation royalties, if any.

Open standards and the government policy

An increasing interest in open standards across governments may be traced to the understanding of the huge economic impact a *lack* of open standards may have upon national economies and government budgets in particular. The sheer size of the information technology markets representing a growing share (more than 10%) of the global economy attests to the economic magnitude of standards' influence on products. Practically all IT products implement one or more standards -- *de facto* or *de jure* -- due to the component nature of all IT hardware and the OSI (Open System Interconnection) reference model for system-to-system communication of software and hardware interfaces.

Returning to the global rhetoric on the “informatization” of societies, a failure-prone interoperability of documents encapsulating various formats and security attributes is on the agendas of policy-makers in the European Union, in the U.S., and across the world for the reason that the digitalization of governments' documents and procurement processes must come with politically acceptable (and affordable) long-run costs. Avoiding relevant open standards altogether seems to be out of the question. We suggest that the government policy must tackle the open standards issue from the following angles:

1) The consideration of whether or not to take an active part in bringing about open standards (policies) where they are lacking but needed for governments' ICT operations.
2) Developing strategy for most effective timing for open standards' adoption (early vs. late) depending

on the chosen industry.

3) Conformance clauses in public ICT procurement.

4) Discriminating against non-compliant ICT products (for whatever reason that may be conjectured) in order to properly assess the timing issue presented in clause 2) above.

These issues are considered in some detail in section IV of the report.

Beneath follows a review of some of the standards and standardization issues and challenges that governments, IT industries and non-IT industries face in these years in the field of information technologies standardization.

II. Standards and standardization

Industrial markets and global trade are the result of standardization

The industrial revolution created the conditions for booming economies in many countries of the world. The growth of national economies as local markets became regional and eventually national realized by new means of transport (roads, steam trains, harbours, and steam boats), new means of energy (steam, later electrification, diesel engines, turbines etc.), and new means of communication (telegraph and telephony). Industrialization therefore developed a range of interdependencies due to an increased division of labour but in particular due to the network effects of power supply from utilities, telecommunication networks, industrial standards and governments active in promoting their industries internationally. World Exhibitions inaugurated a new export promotion strategy of governments. Technological progress meant agreement between industrialists - at some point in the technological development - to certain standards that were required to connect machines, to apply utensils, to rig boats and vessels, and to connect private, local operating telephony networks into national networks. Extraction industry and refineries processing raw material basically introduced high level inter-industry standards to imitate the assembly line speed of operations and later automated these into machine-intensive production lines as standardization of materials and machines allowed for it. In brief, the industrial revolution would not have succeeded without a concomitant standardization taking place. Many of the standardization bodies around to day trace their origin to the early days of industrialization.

Standards are associated with many more aspects than facilitating the interoperability within industry and services. On the basis of recent studies World Trade Organization in their World Trade report (WTO 2005) identified the following drivers of standardization: Technological change, rising incomes and global integration. The world economic development thus feeds back upon technological development making standards a still more important feature of all economies. WTO writes: “We live in a world profoundly reliant on product standards. They affect our lives in ways we sometimes do not even notice, but they can

have far-reaching implications for economic activity, including trade. ...The need for product standards is not a new phenomenon. In biblical times, the lack of a common (standardized) language wreaked havoc at the Tower of Babel. In more recent times, during the great Baltimore fire of 1904, fire fighters called in from neighbouring cities were unable to fight the blaze effectively because their hoses would not fit the hydrants in Baltimore." (op.cit. p.xxiv)

Technological change disrupts more or less intentionally existing technological systems. In the most advanced and in newly developed countries industry and government agree upon innovations as a driver of economic growth and welfare. For advanced countries, innovation has become the driver of competitive advantage while in newly developed countries opportunities for development derive from export industries using equipment imported for this purpose or for better meeting the needs of the masses as all these countries have large, needy populations.

Unequally distributed rising incomes in the export-driven economies of the developing nations daily face the clash between pre-standardized local produce and products and the highly standardized products coming from the world market. The global standardized products are often more attractive and much cheaper than the local produce due to economies of scale of the (standard-based) mass production.. Standards in the developing world are a sign of transition from low quality, traditional goods to the world of commodities and standard products. Export led growth has been decisive to all newly industrialized countries in the world. The choice between the conformance or non-conformance to relevant standards the export markets are willing to buy, is the choice between the growth in incomes and poverty for the developing nations.

Global integration, first launched as a vision by OECD in the 60's "adjustment assistance measures" policies for industrial countries to cut trade barriers, while never really taking off, now has in a decade or two evolved into a serious challenge to industrial, affluent societies. Newly industrialized countries the size of China, India, Brazil and Indonesia change world trade patterns to such an extent that the developing nations now claim almost a third of world trade (WTO 2005).

The exclusive dominance of the Western world is shaken. Penetration of markets in the industrialized world has been facilitated by extensive use of the established international standards that - being fulfilled - ensure the full impact of cost advantages. The industrial products that flow into Western markets fit the measures and regulations applied in these countries. Standards for measuring size and applying these ensure a complete substitution of Western products in light industries and surprisingly fast also in high-tech industries like computers and networks.

WTO explains the impact of standards, reviewing their economic functions, as the following: first, standards allow for exchange between anonymous (market) economic agents; secondly, standards facilitate compatibility between products; thirdly, standards facilitate technological diffusion; fourthly, standards solve coordination problems in case of network externalities; and finally, standards solve important market failures derived from imperfect information and negative externalities.

Along with the development of a global economy, standardization shows no tendency to loose pace, on the contrary, standards seem to have become a driving force of furthering economic development. To ascertain if this has been the case, a major study has been undertaken by German and English economists providing results that corroborates this view showing that standards may be held accountable for as much as 13% of the rate of growth of productivity in the economy in the latter third of the last Century in Britain and in Germany – the rate ridiculed by some as far too small, since no growth without standards in the industrialized world would be possible at all.

Trends in scope and role of national bodies in standardization

Standardization takes place at no less pace to day than it did in the days of the industrial revolution.
“By the end of 2004, the International Organization for Standardization (ISO) had published some 14,900 international standards. Perinorm, a consortium of European standards organizations, maintains a database of around 650,000 standards (national, regional and international) from about 21 countries (WTO 2005, p.xxv).” The United Nations' International Standards Organization alone had 14.900 standards per December 2000.

International standards agencies have been impelled to speed up the process of standards approval to be responsive to an increasing innovation activity in more and more markets. A case for a new type of government involvement has been aired with the dependency of the global economy on *international* rather than national standards. Analysts of ICT standards find today's standardization converging on international standards giving national bodies of standardization less of an independent role to play but a more important one in promoting participation in international standardization bodies. Standards in ICT must be international to make sense in a global economy, the argument goes. This is not surprising, as about 80% of global merchandise trade is affected by standards and by regulations that embody standards (Kammer 2000). Assessment of the U.S.–European economic relationship reveals over $200 billion in transatlantic trade attributable to standards (Kammer 2000).

The environment, where the pace of technological innovation is quickening, the trade volumes are growing

faster than national economies. The traditional international standard setting processes have recently earned a reputation of “slow”, “cumbersome”, and “non-transparent” (Jakobs 2003). As a response, standards development increasingly is taking place in a variety of venues. Consortia, such as W3C,[2] and forums, such as 3GPP and 3GPP2, are important contributors to the development of a global ICT environment outside the formal (national or international) standards development system. A consortium has been defined as “an alliance of commercial interests, funded by fees, following a rule-based decision process, producing usually free and accessible outputs, active in dynamic technology markets focussing on the development markets for complementary goods” (Hawkins 2004). It is noticed that “some consortia follow a closed shop strategy and strong IPR protection of their output.”

The trend of globalization and the raise of dominance of industry consortia and fora suggests that the ICT standardization is converging on international standards giving national standards organizations (NSOs) less of an independent role to play. However, there are several important issues, which make NSOs increasingly important in promoting (participation in) the international standardization bodies and processes.

A “one-fits-all” policy is inadequate

Development of national or international standards must meet both societal and market needs. Global standards, despite their growing importance, do not always fit the national characteristics. Different countries still have (and will continue to have) different needs, perspectives and values, which are best served by national organizations. Specifically, the NSOs' role is to devise and promote technical solutions that reflect national interests. This is done by providing accreditation for participation in international SDOs, and by supporting public organizations’ and SMEs participation in the standardization and standards dissemination processes.

The problem of SMEs and public institution's participation

The process by which standards are produced are invisible to most consumers, including SMEs, which are the major contributors to the GDP. SMEs and consumer associations have neither expertise nor financial support to participate in national or international standards development processes (McSweeney 1998). The increasing rate of innovation failures, the positive results of technology standardization when research institutions and end-users were involved (Fomin 2005) and, finally, the central need for sustaining an even distribution of knowledge in the society, all prompt for inclusion of voices otherwise excluded. An open

2 World Wide Web Consortium

standardization process acknowledges this and therefore draws the attention to subsidize standardization to avoid high fee and other barriers to participation.

The problem of coordination of standardization venues

Coordinated policy development is required among the national industry, national standards development organization, the national government, and voluntary standards bodies to avoid stalemate of or inconsistency in standardization scope. Deciding which fora gather which stakeholders, including vendors, with which interfaces, reflects the presence of integration problems that are part of the open systems interconnection framework, i.e. the general systems interoperability requirement standard. The very number of committees reveals the risk of branching into incompatible standards requirements risking non-adoption or the opposite, to embark upon a road of very general specifications to harbour all interests at the expense of a level of specifications that allows for application compatibility and interoperability.

At the same time, National Standards Strategy must recognize the importance of fora and consortia to meet the needs of different industry sectors. The resolution of a coordination problem between national and international standards is only possible through actively involving SMEs and public research institutions in standards policy formulation processes, which, in turn, requires government’s funding to support such participation.

The coordination problem derives also from different incentives for standardization reflected in the way new consortia get started and financed to acquire strong positions through new market creations reflecting market players' strategy to take a market lead position.

III. ICT standardization and its economic impacts

Information technologies standardization bodies and processes

Narrowing our analysis to the information and communication technologies we encounter not only one but numerous standardization bodies. Besides national standardization agencies there are the now more than 140 years old International Telecommunications Union's technological branch, the ISO of the UN, and the European standardization bodies CEN and CENELEC alongside vendor and industrialist driven bodies or consortia like OASIS, W3C, etc. A CEN consortia survey disclosed that more than 400 fora are relevant to the adoption of standards in ICT (Keith Dickerson, British Telecom, Sept. 2005). In ICT the role of consortia

is controversial because these are vendor industry driven and are easily subject to the suspicion of being biased to the advantage of their participants. Gaining access to a consortium may be difficult and often requires high entry fees. To implementers (vendors) the advantages of consortia are to talk only to those that have a complementary interest in the standard and therefore being able to speed up the process of standardization. Where being first to market matters a consortium is the preferred venue.

Since the 1980s, there was a shift in the driving force for creation of technical interoperability standardization in the ICT domain from being driven by standard creators (agents motivated to develop new standards) to being driven by *standards implementers* (agents motivated to produce new products that embody a standard) (Krechmer 2006). In addition, the users of implementations standards (who usually do not participate in the IT standardization process) have a growing interest in seeing the concept of openness address their requirements (Krechmer 2006). This movement resulted in a *peculiar* character of the modern ICT world: due to the fact that virtually all producers in the ICT industry are now members of one open systems group or another, the users (in particular, government bodies both in Europe and in the United States) are becoming more and more insistent on open systems in their procurement specifications (see also Gabel 1991). As a result, producers can and do offer products conforming with open systems specifications (Gabel 1991, p.148).

Despite the trend to process and product openness, the stipulation of open standards has not acquired a complete following even in the official standardization bodies. A study of the major IT standardization bodies (Krechmer 2005) compared to consortia reveals the degree of conformance to 10 criteria of open standards of each body and the overall “openness” score (the higher the number, the more open the process is).

Table 1. Rating the ten rights of open standards at different SDO.

Table 3. Rating the ten rights of Open Standards at different SSOs.

Requirements	ITU (note 2)	ETSI (note 2)	IEEE (note 2)	ATIS T1 (note 2)	W3C	IETF	Consortia (note 3)
1 Open Meeting	1	1	2	1	1	2	1
2 Consensus (note 1)	1	1	1	1	1	1	0
3 Due Process (note 1)	1	1	1	1	0	0	0
4 Open World (note 1)	1	0	0	0	1	1	1
5 Open IPR	2	2	2	2	4	3 (note 4)	0
6 Open Documents	1	3	2	3	1	3	2
7 Open Changes (note 1)	1	1	1	1	1	1	0
8 Open Interfaces	note 5	note 5	note 5	note 5	note 5	note 5	note 5
9 Open Use	0	1	0	0	1	1	2 (note 6)
10 On-going Support	2	4	2	2	4	4	1
Score	10	14	11	11	14	16	7

Note 1: For Requirements 2, 3, 4 & 7: Yes = 1, No = 0
Note 2: The ITU, ETSI, IEEE, and ATIS are formal SSOs.
Note 3: This hypothetical consortium is modeled on the description found at ConsortiumInfo.org [21].
Note 4: The IETF IPR policy desires a royalty free model, but is flexible.
Note 5: Open Interfaces has only been applied to specific standards.
Note 6: Many consortia support plug-fests and conformance testing as part of their members desire to promote associated products.

In spite of the movement towards open standards processes we have seen vendor and industry driven bodies or consortia like OASIS, W3C, 3GPP(2), IETF emerging as “alternative” and often preferable bodies for technology standardization. In the ICT domain, where most systems emerge from standardization process, the move away from formal standardization processes reflects a trend in technology innovation of moving away from reactive standardization to a *proactive* (anticipatory) one (Jacobs 2003). *Anticipatory standardization* being the earliest stage of technological innovation and development (Jacob 2003), the existence of adequate national policies for early standards adoption and development becomes an important governmental issue.

Problems with fora and consortia

Despite the increasing popularity of industry fora standardization, the choice between the traditional SDO and consortia is not that straightforward. In some cases, like that of mobile communications, the U.S.’ followed laissez-faire policy of consortia standardization resulted in three competing cellular standards being adopted (and a market fragmentation as a result). At the same time, the European Union advocated a single European standard (GSM) through the formal de jure process, resulting not only in the world wide adoption of the GSM standard, but in the growth to global dominance of the European companies, Nokia and Ericsson, leaving the previous dominant player, Motorola (U.S.) in a lesser market role. As another example, the standardization process developed by IETF[3] has often been dubbed as “the best in the business”, but has recently shown a number of deficiencies, namely that there are issues stemming from huge financial stakes of involved companies offering Internet Protocol-based products and services (Jacobs 2003). Finally, similar to the traditional standardization bodies, fora and consortia, due to high membership fees, may effectively bar SMEs and consumer organizations from participation in the standardization process.

3 IETF – Internet Engineering Task Force, an informal organization overseeing the development of Internet protocols.

Problems with SDOs

The global and distributed nature of the ICT environment resulted in the fragmentation of standards development process beyond formal SDO/ informal consortia. There are, perhaps, too many formal standardization bodies, which may be overseeing development of similar and/or complimentary products (ETSI/CEN/CENELEC/ISO/IETF/ITU/W3C/etc.). Since there is no definite way to draw the borderlines and there are evidence of institutional rivalry between the SDOs the standardization process may be less than efficient.

Another problem is the pace of change in the standardization arena. JCT1[4] portfolio alone contains over 2,500 standards and technical reports, 65% of which are still active (Egyedi and Heijnen 2005), while the total number of communication and interoperability standards developed to date is difficult to estimate. In 1993, the General Assembly of ISO agreed to take measures to speed up the standardization process. The JTC1 members had had the option to use the "fast track" "submitting a document for approval as a standard directly to the top JTC1 level." (Rada in Jacobs 2000, p.24). Another measure allowed consortia to submit their standard proposals to ISO, even giving organizations the right to submit. This is the PAS process (publicly available specification) presented as "the transposition of PAS into international standards" (ISO/IEC 1995). The submission in September 2005 of an Open Document Format standard developed in OASIS to ISO reflects this very option of a consortia to take over the standardization process leaving ISO the role of a "filter" only while possibly speeding up the process.

The degree of standards stability and the standards development cycle by international standardization bodies such as ITU[5] reflect the pace of change in the ICT environment. The ITU's technical standards approval cycle has shortened from 5 years to just 8 to 9 weeks during the last decade. At the same time, a recent study revealed only 60% of ICT standards to be stable, while 27% being responsible for 90% of all the changes in standards specifications (Egyedi and Heijnen 2005).

ICT challenges beyond the industrial age standards

Are there particularities of standardization of ICT compared to the standardization of the industrial age

4 JTC1 – the Joint Technical Committee of ISO (International Standardization Organization) and IEC (International Electro technical commission) overviews development and maintenance of international ICT standards.

5 ITU – the International Telecommunications Union head quartered in Geneva, Switzerland is an international organization within the United Nations System where governments and the private sector coordinate global ICT networks and services.

products? Considering ICT, the numerous layers and their interfaces account for a high level of complexity. To manage the complexity testing “machines” are built to facilitate compatibility to product specifications and compliance to standard specifications. Yet, it is still not possible to built a complete testing machine since standards documents cannot (and should not) be a complete specification of all future product implementations. Compatibility and interoperability requirements imposed upon end-users (consumers) have been evoked as a strong reason for government to assure and support international standards organization to take precedence over consortia (vendor) standards if not as caretaker of the whole standardization process then at least as filters of standard proposals from consortia.

There are particularities of standardization of ICT compared to the standardization of the industrial age products. The distributed nature of the ICT, the numerous layers and their interfaces account for a high level of complexity. Standards, while contributing to the complexity of ICT due to their dynamic and non-transparency of the processes, as discussed above, nonetheless offer tools for complexity reduction through market regulation.

Steinmueller (2005) points at two mechanisms of using standards as a market regulation tool. First, licensable standards may allow the owner of standard’s specifications “to capture the definition of the technological trajectory, the direction and, to some degree, the rate at which future technological progress is made” (op.cit. p.26).

As an example, Microsoft can force the market to adopt new versions of its software due to compatibility issues between different components of Microsoft OS and applications. Second, the owner of an industry standard's IPR may be able to extend market power by licensing its standard vertically, that is to the market for components (op.cit.). As an example, the “compatibility” of Microsoft Windows and Internet Explorer vs. “non-compatibility” of the former with e.g., Netscape Navigator.

The basic point of these strategies is to give the standard’s owner an advantage over rivals in defining and implementing the next incremental step in technological advance (e.g., when to introduce the new version of MS-Office). “The strategy must be chosen so that the incremental benefits are sufficient to encourage an economically significant number of users to upgrade to the new ‘generation’ of technological solution after which network externalities may reinforce the position of the incumbent platform producer” (op.cit. p.26).

In markets, where open standards operate to reduce entry barriers for competitors, the network effects of complementary product and service suppliers may buttress the position of the dominant firm (Steinmueller 2005, p.28). Nonetheless, while one cannot be sure that open standards will increase competition in the short

run, they do provide assurance that long run market development will not falter as a consequence of technological mistakes made by the dominant firm, which is a desirable outcome from a social welfare point of view (op.cit. p.32).

The ICT domain represents complexity that goes beyond the imagination of the industrial world. The myriads of disparate information systems on firm, local, government, and global levels are made somewhat interoperable through the use of (open) standards. The recent report of the EC on challenges of eEurope (Council of European Union, 2004) emphasizes the challenge of achieving interoperability between the information systems due to the diversity of administrative law and practices between countries, identity management, reliability, security and other issues. As an example, 7 out of 10 local governments in Denmark reported to lack common public sector solutions and infrastructure, while roughly the same number were lacking common standards for data exchange (Ministry of Science Technology and Innovation, 2003).

While the lack of interoperability is difficult to quantify for economic assessment, one aspect of non-open standards is directly related to economic impact. That is the vendor lock-in: "the ability of proprietary software vendors to use their de facto standards for protocols and data formats to perpetuate their own software products in volume and over time" (Social Science Research Council 2005, p. 8). The use of proprietary standards (for example, for word-processing and spreadsheets, currently dominated by Microsoft's proprietary "Office" standards) forces not only consumers (citizens), but also administrations (government(s)), to lock-in to the software vendor (Microsoft), and as a consequence, being forced or enticed to undergo software and hardware upgrades at a pace more frequent than economically viable and/or justifiable, less so needed. For example, software and/or hardware upgrade by local municipality may force its residents and businesses to undergo the same upgrade in order to maintain access to the (on-line) services provided by the municipality.

Another difference between the industrial products and intangible ICT standards is that of a material nature and the rights of use. Investment in software is different from that of industrial products because of the following (Danish Board of Technology 2002, p. 30): (1) it is intangible and can be reproduced; (2) its lifetime is dependant on infrastructure evolution; (3) it doesn't have a value as a physical product, but as a right to be used; (4) it is well suited for opportunistic pricing, due to the cost of copying-distribution being zero, while the value of right of use varies depending on the needs/capabilities of its owners; (5) there are no "production" capacity limits once the software has been developed – it is only limited to the size of the market; (6) due to high profit margins and "unlimited" market, there is a trend towards monopolistic behaviour by producers.

The economics of maintenance is much more complicated than the economics of rights of use though the latter has imposed non-negligible administrative costs and complexity in some cases. Comparing standard compliant to non-standard software in network communication has proven the former dominant: The Internet has wiped out most non-standard computing networks. Yet, considering database software the proprietary standards remain in power, only yielding to the SQL standard of inquiry. Thus, standardization drivers are not working equally across the field of software but are very much subject to competitive strategies of large companies guarding each their market. Working around a software standard is an option when it is a high-level application closer to “end-users” than to “back-office” use as we see in browser software where the industry standard (Internet Explorer) is not (W3C) standard compliant. Pre-emptive specification of a standard will often be unobtainable since it may be in no vendor's interest to forego competitive advantages buried in subtleties in between the lines of a specification.

Costs of software use depend upon which contractual terms apply for the customer. A conclusive and preemptive copyright is imposed on every purchase of licensing software with strict, limited rights of use of proprietary software. Pricing of rights of use may be anything but transparent. A case is the famous “battle” in 2002-3 leading Microsoft to withdraw a pricing scheme that left most customers uncertain as to the price they should pay and, as a result, abandoning contracts with Microsoft. Less than a year later Microsoft released a new scheme.

When devising a policy for adoption of ICT standards, one must consider the life-span of those standards with regard to the evolution of ICT infrastructure, as well as with regard to emergence of new(er) standards with a greater value (offering higher productivity for the user), as well as such socio-economic issues as (re-)training.

Finally, compatibility and interoperability requirements imposed upon end-users (citizen) have been evoked as a strong reason for government to assure international standards organization procedures to take precedence over consortia (vendor) organizations' standards. This is in line with a call for open standards that harness the powers of dominant vendors in the middle to the long run.

The impact of ICT standards upon industry innovation

The nature of international ICT standards requires manufacturers of products and managers of processes to provide knowledge from their domains in the formulation of specification. The constraint of standards upon technological choice depends upon the process of their formulation (SDO or consortia) and their resulting specifications. Standards may thus allow for or constrain technological innovations according to their

specifications and accessibility, which depends upon the standardization processes and the dynamics of standards. ICT standards derived from (industrial) consortia may not have the same effects as those derived from open, public Standard Development Organizations (SDO) in particular in terms of effects of standards upon innovation. A systematic documentation of standards' effect on innovation is not available though the EU has surveyed the extend to which this is an issue to enterprises in general.

The EU surveys of innovation (CIS) reveals that standards play a limited role as a perceived barrier to innovation. Enterprises, having experienced barriers to innovation amongst those with innovation activity, mention economic factors over internal, and other factors, amongst which “insufficient flexibility of regulations and standards” is mentioned by 11% of the companies ranking this 5th most important factor. The same ranking of factors is obtained for enterprises without innovation activity.

Breaking up the data into industries, we learn that the selected segment of IT-industry has the highest innovation activity of all represented industries, namely 64% of companies in this group. Secondly, we want to know which kind of innovation activity they carry out and we learn that it is a mixture of process- and product innovation. Finally, directly questioned as to the hampering factors this segment of IT-industry came out low on such effects from inflexibility of standards and regulations. The economic factors and a lack of qualified personnel were the most hampering factors on innovation.

There are no data for Denmark on the hampering effects, so we cannot directly see the effect of standards upon the IT-industry in Denmark. However, the positive effects on innovation in the segment of the IT-industry for Denmark are available, showing that standards and regulatory means are not considered important among the surveyed companies.

Table 2. Enterprises with innovation activity (Denmark).

Table DK.7A

Enterprises with innovation activity: proportion that cited the following effects as highly important, 2000 (%)

	Total	Industry	Mining and quarrying	Manu-facturing	Electricity, gas and water supply	Services	Wholesale and commission trade	Transport and communi-cation	Financial inter-mediation	Computer activities; R&D; engineering and consultancy; technical testing and analysis
Product oriented effects										
Increased range of goods or services	17	15	5	15	0	21	21	16	24	23
Increased market or market share	14	12	5	12	0	17	23	12	14	10
Improved quality in goods or services	20	15	5	16	0	27	29	17	36	27
Process oriented effects										
Improved production flexibility	10	10	0	10	0	11	15	3	15	10
Increased production capacity	12	14	0	15	0	10	9	7	28	6
Reduced labour costs per produced unit	12	12	0	12	0	12	19	5	18	2
Reduced materials and energy per produced unit	7	5	0	4	46	11	13	4	11	10
Other effects										
Improved environmental impact or health and safety aspects	7	9	5	10	0	5	6	7	2	2
Met regulations or standards	12	9	5	9	0	16	25	10	5	4

Source: Eurostat, NewCronos (theme9/innovat/inn_cis3).

The table 2 above (table DK.7A) above indicates that IT-industry innovation is highly product oriented and quality improving with little effect on processes in Denmark. This concludes the examination of standards impact upon innovation at the general level and specifically for a segment of IT-industry.

Meeting regulations or standards in the IT-industry were perceived as highly important. On the other hand, the *hampering* factors of German innovation activities were foremost of economic nature though inflexible regulations and standards were cited in 26% of the innovative companies in the computer services industry. Concluding that standards may have some perceived impact on innovation may apply to German companies. Since standards are not the same as regulations there remains uncertainty as to the actual impact of standards but we can see that it is the fifth ranked factor after economic factors and lack of personnel as in the general case of all member states in EU.

In the study by DTI 2005 (DTI 2005, p. 37) they conclude on the impact of standards on innovation:

> "Given the preceding discussion, it is perhaps less surprising than it is at first sight, that Professor Swann finds – at both the level of the individual company and when aggregated to sectors – a positive correlation exists between standards as a constraint upon innovation, and standards as a source of information. It appears that 'effective' standards both provide relevant information and place constraints on innovation."

Fully aware of the CIS3 study the evidence in front leads the authors to caution any definitive conclusion on the matter on the basis of an industry wide examination of data. The IT-industry is distinct from others in regard to its fast development and therefore with relatively few public standards. The findings of a u-shaped correlation between standards and innovation may be relevant, suggesting that in a stage with few standards, they may hamper innovation due to lack of information, just as well as in a stage with very many standards, they may hamper innovation by the sheer problem of navigating between them. A "medium" number of standards is associated with the most positive effect upon innovation activities where both the number of standards and the median age of standards seem positively to influence innovation activities (op.cit. p. 38).

How ICT standards influence the economics of vendors and end-users

The 1990s boom in IT is still fuelling productivity growth in many parts of the economy (OECD 2001). Analysis suggests that industries producing or using IT equipment intensively contributed between 1/2-1 percentage points to the economic growth. The estimates for Denmark suggest that IT-using industries contributed 0.3 percent annually, while IT-producing – 0.2 percent to the total of 1.8 percent growth of real GDP (Haacker and Morsink 2002). It is impossible to narrow such impacts to solely ICT standards. Estimates of the economic impact of IT standards on Danish industry are not readily available. But comparative estimates for the U.S. economy reach $140 billion in annual cost savings by 2007, whereas the bulk $131 billion will come from non-IT industries, such as manufacturing, retailing, and financial services industries (savings form higher levels of internal and external database- and applications- integration, reduced paperwork, and E-cataloguing and product tracking) (Mullaney and Coy 2003).

Firms in most sectors in developed countries still face technological overcapacity. To survive, companies must keep wringing productivity gains out of existing technologies. These gains will probably be achieved through investment in software (and new ICT standards). For example in the US, General Motors used to spend $4 billion a year on new software and support – a figure cut by 25% by developing a web-based system that enables inter-operability of GM's more than 3,000 different software applications (Business Week Online 2003). Amazon, due to its conversion to the Linux operating system, expects to cut technology and content expenses by 20% in two years (Vogelstein 2003). As much as $10 billion in savings in retail is expected to come from an industry-wide effort to coordinate data sharing through adoption of common standards among stores and suppliers of consumer packaged goods (Mullaney and Coy 2003).

A key enabler for cross-industry savings is the development of Internet-based standards and protocols that enhance system-to-system interoperability and application service integration across organizational boundaries (Fomin et al. 2005). One direction in this area is the creation of new e-collaboration spaces within supply-chains which do not only automate transactions but provide a space for much broader and deeper electronic integration between supply chain partners (e.g., quality control, design modifications and forecasting demand information sharing). The adoption of such systems has been increasing due to their low cost compared to earlier EDI services, their flexibility, and the broad range of support functionality they provide (op.cit.).

Open standards consortia processes are driving the development of second-generation B2B platforms to follow first generation EDI services. These platforms include the standardization of business-related web

services at W3C and OASIS consortia where new business inter-operability standards drawing upon XML (Extended Markup Language) are being developed (Solomon and Simon 2001). Such standards cover SOAP (simple Object Access Protocol), WSDL (Web Service Description Language) and UDDI (Universal Description, Discovery and Integration). IBM and Microsoft have collaborated to develop a centralized UDDI registry services they offer to business partners for free. Also higher-level business transaction protocols and frameworks that are expected to replace earlier EDI ANSI X12 standards are forged through EbXML and Biznet consortia. These frameworks have been adopted in many emerging industry-wide e-market places as underlying standards including Rosettanet (electronics), Covisint (Car industry), and Esteel (steel industry), just to name a few. Though the development of these industry standards has been relatively fast, the adoption and impact of such technologies is still in early stages and uncertain. There remain unresolved issues related to cross-industry standardization, security and performance of such technologies, etc. Another challenge is the political and business problems in developing and maintaining industry wide e-market places (op.cit.).

The economics of ICT standards should be considered in terms of short and long run effects according to Knut Blind, Fraunhofer Institute on the 4th SIIT Conference Sept. 2005: The ICT standards contain information (knowledge), create compatibility, reduce variety, secure quality and decrease risk at the same time, which amount to an ambiguous effect. Considering the dynamic impacts we may in the short run expect increasing costs to technology vendors for complying with standards. In the middle term we expect increasing demand because of consumer acceptance and positive network effects while in the long run we expect market structuring effects, and in the case of open standards, in terms of a level playing field that allows global sourcing and catch up effects of less developed countries in global markets. Yet, we do not have studies documenting these effects and their overall size and impact.

We have few studies of the impact of IT standards upon the economics of vendors and end-users. In single case studies of standards' impact upon an industry and its companies we have found evidence that, since markets cannot provide for a perfect exchange of standards, we tend to see too little a supply if considering standards as public goods, while we tend to see more than required if treated as a complementary market creating competitive factors with first mover advantages and network effects. If both first mover and network effects are present we can safely assume a highly imperfect market will result providing a single firm a very dominant position with that technological trajectory. This is the case where standards are proprietary and therefore not subject to a public, open standardization process.

Society wide economic benefits from standards and ICT

Generalizing from industrial age, standards support economic growth because they allow for exploitation of

economies of scale, for example by standardization of components in order to solve the trade-off between variety of products and the exploitation of scale economies. Following these observations, standards are more important for mature than for emerging industries where innovation is a stronger driver of economic growth, though in the case of ICT, calling for a better connection between standardization and R&D-for-innovation to create dynamic effects.[6] The argument rests on product standards while standards for processes is a very new field where there is no studies on impact on industry and economy. Trade simplifications have often been cited as a basis for the unprecedented rate of growth in world trade since the Second World War. Today, simplifications of processing trade documents is a next big step that relies upon process standardization, which is undertaken in R&D projects under the auspices of the EU. Expectations of huge economic welfare benefits motivate EU to take further initiatives in this field. OECD is also looking into these issues.

Table II. Contributions of IT to GDP and Productivity Growth

Jorgenson and Stiroh [2000]; Jorgenson [2001]	1959–1973	1973–1995	1995–1999
GDP growth (annual rate)	4.32	3.04	4.08
Capital contribution (percent of total)	33	50	71
IT contribution to GDP growth (percent of total)	4	13	28
Productivity growth (annual rate)	2.94	1.40	2.11
IT contribution to productivity growth (percent)	6	27	42
Oliner and Sichel [2000]		1973–1995	1995–1999
GDP growth (annual rate)		2.99	4.82
Capital contribution (percent of total)		42	38
IT contribution to GDP growth (percent of total)		17	23
Productivity growth (annual rate)		1.52	2.67
IT contribution to productivity growth (percent)		31	41

Sources: Original studies, plus calculations by Bosworth and Triplett [2000] and the authors. These studies were selected for special focus because they are comparable in that they include similar time periods, the same methodology, and the same definition of IT to include computer hardware and software and telecommunications equipment.

When we address the economics of standards in information technologies we need to know more about the impact of ICT-producing and ICT-using industries on the economy in general. In recent years, several studies of the macro economic impact of ICT have appeared in the US in particular. These studies convey an interesting development in ICT contribution to growth in GDP and in contribution of ICT to growth in productivity over three periods of observations.

Table 3: Contributions of IT to GDP and Productivity Growth.

The table 3 above reveals a dramatic increase in the impact of IT upon the economy of the US (Dedrick et al.

6 "Battigalli and Maggi (2003) used the notion of incomplete contracts to explain the nature of international agreements on product standards. An incomplete contract is an agreement which is unable to specify each party's contractual obligation for every possible state of the world. This incompleteness arises in the case of product standards because it is impossible to predict what kinds of standards may arise in the future. Changes in technology, in consumer demand and in the degree of international integration will lead to the development of new product standards. Government regulations on standards are also likely to change depending on emerging public concerns. They argue that in these circumstances, the optimal set of international agreements on product standards would have a three-part structure: (i) provisions that specify standards for existing products; (ii) a non-discrimination (national treatment) rule; and (iii) a dispute settlement procedure." WTO 2005, p. 129, note 126.

2003). In the latter half of the 90s IT accounted for approx. 42% of the growth in productivity and approx 25% of the growth in GDP. Several more studies have corroborated these findings. They are astonishing as they witness a disproportionate share in the development of the US economy for half a decade. In view of the share in previous periods, there is a significant increase in IT impact over all three periods. Studies of the impact of IT show the same pattern in most industries. Further, recent studies indicate that the share of IT does not seem susceptible to changing business cycles. The Department of Commerce in the US released figures showing strong anti-inflationary impacts of IT in the US economy.

It is safe to say that IT producing industries and non-it industries all have benefited greatly from investments in IT. No modern society competing for welfare can afford to disregard their investments in IT. If they do there are strong evidence that it is at the peril of their rate of growth in the economy. Considering these findings in relation to Denmark we have no reason to believe that the Danish economy will not be susceptible to the same forces as those found in the US economy.

Statistics of the Danish IT industry and the rate of growth in IT investments from the Danish Statistical Office though less strongly backed by long term data has been estimated to corroborate trends in the findings in the US but at a lower level of significance.

> "I de sidste 15 til 20 år er der foretaget markante investeringer i IKT i det danske samfund. Investeringerne har gjort os mere effektive, og de har gjort det muligt at producere mere pr. arbejdstime. Arbejdsproduktiviteten er fra 1988 til 2000 i gennemsnit steget 2,7 pct. om året, hvoraf lidt mere end en femtedel kan tilskrives IKT-kapital. Det samlede bidrag fra IKT er endnu større, når indirekte effekter som ændret arbejdstilrettelæggelse regnes med." (IT Politisk redegørelse 2005)

The rate of growth in labour productivity has been as high in Denmark as in the US but the contribution from IT in the US has been twice that of IT in Denmark. We haven't achieved the full benefit from ICT, if measured by the US performance. Why we have not succeeded in that should be analysed further.

When we look into the impact of IT standards on the economy we have very few empirical studies available. What has been measured is the impact of public standards bodies catalogue of standards upon the growth in labour productivity over long periods. The recent publication of a DTI sponsored study of the UK showed that for the period of 1948-2001 for all BSI (British Standards Institute) a 0,05 annual increase in labour productivity accumulating to account for 13% of the total rate of growth in labour productivity in the observed period (CTI 2005, p.39).

A previous study of Germany arrived at the following impact of public standards on the growth of the labour productivity:

> "At the level of the whole economy, the only explicit attempt to measure the impact of standards for growth was carried out for Germany by Jungmittag et al (1999), who suggested that standards were responsible for a significant proportion of the growth in output of the German business sector between 1960 and 1996. For example, in the period from 1960 to 1990 (i.e. prior to reunification), the authors report that standards contributed an estimated 0.9 percentage points to an overall growth rate of output of 3.3% per annum. This was reckoned to be second in importance only to capital accumulation over the whole period – and more important than other sources of technological change such as domestic innovation and the direct payment for imports of technology from abroad." (DTI 2005, p. 47).

The study finds that public registered standards (excluding proprietary standards) in the whole economy contribute ¼ of total rate of growth in productivity over a 30 years period. In public standards, ICT standards form just a fraction of all and we cannot know how much of the standards impact may be due to ICT standards. One must note that there has been a dramatic shift in the ICT industry towards (more) open standards since the study was conducted (1990-1996). This would imply that the contribution of open standards to the productivity growth today may have increased proportionally.

The combination of *ICT* impact upon growth in productivity and the impact of *public standards* during the period since the Second World War may be either a multiplicative or an additive model of growth. We have no external validating surveys to lean towards deciding on either type of model. On the other hand, we are quite sure than in the last decade ICT has proven itself a major driver of growth in productivity in the US and statistics have indicated this to be the case for Denmark, too. Part of the effect should be attributed to standards though we cannot say exactly, which share.

Given the growth in international standards of ICT we are cautioned to find significant, though not yet measured, impact of ICT standards in the rate of growth in productivity between the minimum of that of *standards* in general which is 5% of the growth rate and the approx. 40% rate of growth due to *ICT* in the US. To assume that the two factors would have a negative compound effect may safely be excluded as the studies of the respective factors include the presence of the other in the output. The particular ICT segment of public standards, undoubtedly increasing its share over the period corresponding to the increasing ICT industry activities, may have had negligible impact in the early period and a pronounced impact in the latter, if we conjecture that ICT productivity impact on the economy reflects both its share in the overall economy (to make its presence in the statistics, now) and its actual productivity enhancing impact as end-users learn

better to take advantage of ICT in their business.

Thus, it is a bold statement that the economic significance of ICT standards presumably is between 5 and 40% of the growth in productivity during the last one or two decades in US and half of this in Denmark, namely that between 2,5% and 20% of the growth in productivity can be attributed to public ICT standards in the period. This is a conjecture based on circumstantial evidence since the models only measure the impact of public registered standards and not that of particular types of standards. If *industry* standards have been particularly pronounced in the ICT in that period we may not even have registered the *full* impact of ICT standards on productivity growth. What about the relative importance of open standards? Presently, we have no way of isolating the effects of open standards from all other standards in the field of ICT. Thus, we have no basis for distinguishing economic productivity gains from these kinds of ICT standards.

IV. Policy of standardization

In the previous section, we provided evidence of the significant economic impact of standards to economic growth. Impact of standards on rate of growth in innovation was examined based on a recent EU wide survey indicating that business attributed some importance of standards as a barrier to innovation but we have no statistical indications with which to back-up the perceptions. In this section, we examine policy issues of standardization.

Issues in standardization that government would be inclined to address are not limited to the institutional process of standardization but include competition policy and consumer protection measures to achieve workable competitive markets, secure and reliable products and incentives for innovation activities in the marketplace. Besides general competition and consumer protection policies there is a range of standardization issues where ICT standards have become essential to the long-run interests of government in securing and accessing electronic documents.

Avoiding relevant open standards altogether seems to be out of the question, in all governments leaving the core of the standard's issue as, one of

1) considerations of whether or not to take an active part in bringing about open standards (policies) where they are lacking but needed for governments' ICT operations.

2) timing for an open standards' adoption (early vs. late);

3) conformance clause in ICT public procurement (enforcing vs. avoiding/ignoring);

4) discrimination against non-compliant ICT products.

The first issue arise as a response to the digitalization of government documents and of government-to-business and government-to-citizen communication. In realization of the importance of standards to the ICT markets, governments find themselves as stakeholders with a long-term interest that may seem inconclusively addressed or subject to bias by other stakeholders that may jeopardize competition objectives of governments.

The second issue arises as governments acknowledge their responsibility for their own long-term interests. How can or how should governments position themselves in the standardization process? Participation as an end-user selecting amongst market products with a set of selection criteria has been the prevalent procedure. Yet, this strategy may not succeed if there is no opportunity for standard creators to develop standards meeting the long-term requirements of government since governments do not formulate them. It is only if governments have a formulated policy that standard creators can take stock of them and respond. Governments therefore cannot rely only at their role as end-users. They need to look at the early phase of standardization to make their requirements known and to look for ways how to guide and evaluate implementations to ensure that their requirements are met in the products. The latter may not be necessary before government decides to procure a product, though the means for assessing standard conformance

should be in place long before the procurement of products. Therefore governments need to address the third issue.

The fourth issue emerges as standard compliant products become available while proprietary products form the major part of the installed base of government ICT. How to deal with an installed base of non-compliant technologies cannot be dismissed as irrelevant as the very co-existence of proprietary and standard-compliant products may conflict with the objective of interoperability. Governments need determine a period of transition. It is rarely possible to determine transition for a single product at a time due to interchange of files and data and to process dependencies embedded in applications. Nor is it economically sound to adopt a mechanistic approach to transition.

Government participation in standardization

The distinction between standards and open standards in ICT has arisen partly because of an increasing impact of consortia standardization on general communication and interoperability requirements in society and in governments.

Studies show a relatively diminishing activity in (open) standardization bodies and a relative increase in closed standardization bodies (consortia) of overall activity in the field of ICT (Blind & Gauch 2005).

One explanation of the trend may be due to an increasing importance of IT standards upon interoperability and communications where consortia have been more numerous than international SDO, and another may be the relatively decreasing share of telecommunication standards with a traditional involvement of public owned service providers in telecommunications since 1998, now leaving governments and consumers with a lesser representation in total ICT standardization activities.

The legitimate objectives of these stakeholders may be achieved if engaging international standards organization where governments and consumers organization may have a say. The number of consortia relative to international SDO has been estimated by CEN/ISSS to 269 consortia according to their June 2000 list compared to the ETSI, CEN and CENELEC and the technical committees (TCs) of international standardization bodies (i.e. ISO and IEC) totalling 55 TCs in the ICT area (Blind & Gauch 2005). The number of consortia in the last four years have consolidated into some more than a hundred. The trend threatens the very objective of standardization: interoperability, since consolidation of consortia has a tendency to exclude small and medium sized companies from participation. Yet, we see international standardization organizations adopt a filtering role leaving the technical specification process to consortia. This may become a productive coexistence of standardization bodies, yet this challenges the ideal of an open standardization process.

These trends are a case for concern as the effect upon overall innovation capacity in the economy may suffer from “biased” standards even though accepted as international standards by the public bodies. In this way

standardization processes may come to halt SME innovation, jeopardizing the overall economic growth effects of standards.

The other side to the consortia standardization concerns interoperability, which is a prime end-user objective of standards. Where it is next to impossible to assure complete (i.e. conformance test) interoperability of a SW product with a proprietary source code, it is not equally strongly excluded to establish interoperability in between open source products, though there is no perfect “testing machine” available to guarantee complete interoperability. Unfortunately, the issue in the case of open source is often interoperability with a proprietary product where the inaccessibility of the source code constrains the testing.

Controlling which specifications find their way into a standard requires participation in the standardization process. If all relevant technical minded representatives should be assured access to participate we only know one model: Open standards, where there is no right to veto access of a participant nor an economic entry barrier. While government participation per se does not fulfil this objective, it is still a way to monitor and intervene in the process. A subsidy instead of participation buys the government legitimacy but no assurance of a useful specification of a standard enhancing interoperability. A truly free and open access would shift the governments' burden of ensuring interoperability to a wide range of interests. There is little we know in terms of predicting the output of such a policy.

Early adoption of open ICT standards

The economics of standards leaves little doubt that economic growth is well served by (some) standardization. The question is today, when, which and how much standardization serves the economic growth the best, and which standardization supports development of innovation capacity of the economy the best? Should standardization in ICT become an issue of high concern (again) to governments but avoiding the “nationalistic” bend that it has had previously? These are questions raised regarding adoption of a standard whether published by a consortia or later by an open standard organization.

Adoption of standards by business, government and organizations cannot be taken for granted. The reason is simply because producers of standards-compliant products need to adopt the standard in their product *before* it reaches the end-users as an alternative to non-standard compliant products. Therefore, an early adoption of standards means to select standards before they may have been proven able to gather a broad acceptance in the industry, as would be witnessed in several competing vendor products.

A model of early adoption should balance the trade-off of getting a good deal on a (proprietary) standard compliant product *today* (and becoming either locked-in or abandoned, i.e., becoming so called “angry orphan”) versus the *long term* effects of a broad adoption of an (open) standard by an industry and therefore also by its customers with a high degree of certainty. This is kind of a procurement -to-day versus an information-infrastructure policy of-tomorrow argument which is unbalanced and need to be separated into each their part.

Meeting proprietary or industry standard compliant products in the market expose the dilemma of coming *late* to standardization. Several types of standards may no longer be available so that the installed base in the overall economy is dominated by a single (proprietary) standard. If government needs adopt a competition policy view of this market there is reasons for concern. Therefore, policy intervention requiring steps by the incumbent to open up the specific standard for an inspection and change by a SDO technical committee that submits the (adapted) standard to an open standardization body would seem to be one option in conformance to the (fast track) PAS procedure of ISO. Another way for government to deal with late coming to the market would be to embark itself upon the development of an open standard following the rules of an open SDO.

Coordination of government standards policies would bring them a long way to ensure critical mass for a standard and therefore become a kind of self-fulfilling prophecy of a technological trajectory based on an open standard.

Presently, this is hard to achieve because many governments still seem to see themselves as protagonists of their own companies in a world market perspective rather than as the citizens' guardians of interoperability and competitive ICT markets. Pressures from government representatives in international standard bodies may turn the tide.

Conformance to standards in public procurement

Government specific interests in standardization of ICT have arrived late on the standards scene. Therefore, many proprietary products are installed in governments today. Coping with the co-existence of non-standard and open standard ICT requires certified third parties to apply conformance testing according to well established criteria based upon the open standard.

The ISO Strategic Plan 2005-10 stresses the aim of “one standard, one test and one conformity assessment procedure accepted everywhere” that seems to fulfil the very objective on managing co-existence of competing standards reliant products.

Only as far as such third parties are present in the marketplace will public procurement be able to manage in the heterogeneous market of competing products. Yet, one more condition applies to the issue of creating open standard compliant ICT products. Timing of the adoption of a open standards policy.

Standards that are the outcome of vested interest of consortia of industrial vendors have a rather straight forward economic rational: They are collective investments in setting technical specifications useful to the participants' product innovations and developments. The rent of the investments in these pre-competitive technical specifications will be appropriated by the partners according to market performance or eventually by mutual recognition of use of the technologies expressed in agreement on royalties on the innovations derived from the industrial standard. Patents are often found useful in protecting products following these standards.

In the case of coming late to a market, government therefore face problems of creating proper incentives to industry and government to smooth the process of adoption of a new, standard compliant ICT products.

Discrimination against non-compliant ICT products

When non-standard products are prolific in government there is a definite case for considering a migration policy. Migration from an industry standard to a standard compliant product depends – besides the very existence of a (mature) standard compliant product in the marketplace – upon the degree of exigency to embark upon a new technological track and upon a cost-benefits calculus of the migration of all partners to the transaction. These conditions vary across technologies due to their degree of penetration into government and the rate of penetration in dependent industries and amongst citizens as well as of the profitability of the corresponding, non-standard products.

On the part of government and other users, objective measures of usage, scope of usage, and prospects of usage can all be obtained in specific instances but will often make sense only if obtained for a domain rather than within a single office or department of an organisation or of government. Since the above, objective conditions do not pre-empt the factors determining ICT procurement decisions in practice, it may be necessary to adopt economic measures that will reveal the relative strength of hard-to-quantify objective factors' impact on cost-benefits of adoption of a standard compliant product. Economic measures would then enters into the calculus representing the degree to which non-standard compliant products could be discriminated against in a tender. Degree of discrimination would mean that the non-compliance could be tolerated at a price for a limited time period after which the vendor would have to offer a smooth transition according to contract, meaning having conversion tables or other technical equipment ready-made for the purpose of a smooth migration.

Since these, and other measures, that combine incentives to both vendors and buyers in terms of in calculating their respective transitions to a standard compliant ICT product, would lower barriers-to-change more than if left in the open, how to manage the migration phase for ICT vendors and the users. To industry, this would mean a phasing out of (profitable) products that are bound to loose in the market anyway, only given sufficient time. In particular, government bodies will have the powers required to conduct a coordinated and flexible transition to open standards not only in government but where relevant also in society.

Open Standards for Danish government and industry

What are the options for the Danish industry and government to participate, influence and take advantage of open ICT standards now and in the future? How will open ICT standards influence Danish government policies and procurement guidelines? How will Danish ICT-industry respond to new, open standards and what will be the impact on its markets? Will Danish non-ICT industry change their ICT-architecture and

procurement policies adopting open standards?

Bringing a Danish perspective into the analysis would seem to be a fruitful way to follow up on many questions on promoting and adopting open standards.

Conclusion

This report does not provide final answers to any of the issues raised though consenting to the view that open standards will remain on the agenda of the ICT industry and of governments. Many ICT products increase their value to users significantly when they become truly interoperable. In a global economy the obstacles to a true interoperability are formidable, yet in practice the ICT industry has proven itself capable of delivering products meeting the criteria. Governments should not perceive the issues presented here as faraway opportunities but surely within the orbit of today's policy.

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