# To Select or Not?

# Dealing with Competing Standards in Public IT Procurement

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# Management Summary

This report addresses the problem how governments should deal with competing standards, that is, two or more functionally equivalent standards, in the context of public IT-procurement. The focus is on (open) committee standards. The research questions are

> *In the context of public IT procurement, should governments choose between standards that have the same functionality? If so, what factors should be taken into consideration?*

The study has been funded with research grants from the Dutch Standardisation Forum, a forum involved in drawing up lists of selected ICT-standards for government organisations, and the Open Forum Academy, a platform for stimulating research and discussion on open standards and interoperability. This report aims to contribute towards discussion about competing standards and help those concerned with public IT procurement and procurement policy account for their decision(s). To this end it synthesizes scientific literature from different disciplines, in particular, economic, innovation and technology management studies. It interrelates the partly disparate themes of market impact of standards, standards wars, standards dynamics and converter solutions.

## *Select or not?*

The economic functions of committee standards and their effect on the market constitute the theoretical fundament of this report. The literature mentions the informative function of standards (e.g. increasing market transparency and reducing transaction costs), the compatibility function (e.g. positive network externalities and increased competition) and the variety reduction function (e.g. facilitating economies of scale and building a critical mass). Using inductive reasoning, the expected market effects of having competing committee standards are, for example,

- reduced market transparency;
- decreased overall interoperability, decreased network externalities and decreased ease of use;
- a fragmented market, possibly leading to submarket lock-in and - in case of insufficient competition per submarket - to vendor lock-in and monopolies (i.e., welfare losses, higher costs and less technology diffusion); and
- increased transaction costs (e.g., including the costs of converters and converting; barriers to exit/ switching costs).

Studies of standards wars confirm some of the above inferred effects, such as decreased interoperability in the case of communication between emergency services (Tetra versus Tetrapol) and document formats (ODF versus OOXML); and market fragmentation in the wars between DVD recordables (+ and -) and in mobile telecommunications (GSM versus CDMA). However, more elaborate research is recommended. Incompatibility and lack of (positive) network externalities largely determine the impact of such wars. In addition, uncertainty about their outcome strongly affects the market (e.g., it undermines competition, leads to a hold–up of investments, slows down innovation, and leads to market stagnation).

There are parallels between competing standards of different origin and competing standards versions (e.g. IPv4 and IPv6). Literature on standards dynamics illustrates the tension between, on the one hand, the pressure to develop state-of-the-art standards versions that incorporate new technical possibilities and, on the other, the pressure to maintain interoperability with the installed base of end-users. However, compatibility between standards versions and successors is often difficult to achieve without severe loss of functionality (e.g. SGML and XML).

In the past IT suppliers have introduced different means (e.g. converters and crosswalks) to re-create, retrospectively, compatibility between competing standards and standards versions. However, studies on the sustainability of documents and digital data (e.g. ODA/ODIF and DC/DCQ) show that such solutions have end-user implications for management, costs and performance. They increase the complexity of IT systems and make them more vulnerable. They heighten the costs of IT production and purchase, and often lead to performance degradation.

The field of IT is a dynamic one. Competing standards are therefore likely to undergo changes. This could have considerable implications for governments that want to support competing standards. To clarify what is at stake, the author of this report uses an equation that captures the cumulative effect of the number of standards and standards versions on interoperability (i.e., the number of converters or translations needed).

Summarising the research findings on the question *should governments choose between functionally equivalent committee standards in the context of public IT procurement,*

- the positive – informative, compatibility and variety reduction - effects of having one committee standard, and the disadvantages of having two or more;
- the impact of incompatibilities and loss of network externalities in standards wars;
- the reality of standards change in the field of IT; and
- the overall inadequacy of converters (in the broad sense) in re-creating compatibility

would make it difficult and costly to sustain government commitment for the support of two or more functionally equivalent standards.

### *Factors to be considered*

Regarding the second research question, *what factors should be taken into consideration,* the Dutch Standardisation Forum and the European CAMSS project have identified business need, market and standardisation criteria for assessing a standard's suitability for public procurement. These criteria are also relevant for choosing between competing standards. However, in respect to 'standardisation criteria', the author of this report refers to a study of a standards war on document formats to argue that having elaborate standards procedures in place need not reflect on the quality of the standard. The case illustrates that, where industry stakes are high, formal standards bodies have difficulty mitigating the 'balance of interests'.

Why do competing standards emerge in the first place? The author concludes that a main cause lies in a failing standardisation market. The supply-side of the market – i.e., both formal standards bodies and consortia - has a business incentive to draft overlapping standards while the demand-side - i.e. governments, companies and citizens - is not well-organised (inter)nationally. Its interests are not

well-represented in the primary standardisation process or by a retrospect standardisation approach (here: selection).

### *Recommendations*

Competition between and among de facto and committee standards need not constitute a problem for isolated submarkets. For government IT, however, where interoperability is crucial, the situation is different. Therefore, the report advises governments to select between functionally equivalent committee standards in IT procurement. The factors to be considered (business need, market, standardisation criteria) are detailed in, for example, the selection procedures of the Dutch Standardisation Forum and the European CAMSS project. Government selection procedures should include a paragraph on standards competition, the need to select and the underlying argumentation (i.e. the difficulty of sustaining support for competing, functionally equivalent standards in the dynamic field of IT). This in itself would be a clear message to 'the supply-side of the standardisation market' that the latter should be more selective in initiating overlapping standards. If shared by different European Member States, this approach might function as a means to correct 'perverse' business incentives of standard setting organisations.

However, to best serve the public interest in an interoperable, sustainable and affordable (i.e. vendor-independent) IT-infrastructure, governments should participate in key standardisation projects. This is likely to be more effective than retrospect selection.

Finally, it is recommended that the European Commission reviews the current tension between interoperability and competition in public tender law, that is, between the role of government as a an IT user and as a regulator of market competition. Means should be sought to reinforce the government's position as an IT user and consumer.

# 1. Introduction

This last decade the European Commission and several Member States have installed policy programs on standards (e.g. European Interoperability Framework, European_Commission_IDABC 2004; NOIV 2007) to improve the interoperability of their IT infrastructures, facilitate exchange between public authorities and ease the development and introduction of new eGovernment services for citizens and businesses. The term *open standards*[1] has been introduced to emphasize that these standards are to be non-proprietary and vendor-independent. They are to create a level playing field in the market, increase standard-based competition among IT vendors and help governments acquire a better grip on the quality and rising costs of IT projects. The development of European and national interoperability frameworks has coincided with efforts to better define commonalities and shared functions in the IT systems of different authorities (local, regional and national), and to identify cross-sector data (e.g. local government and cadastral data). Better harmonisation and integration is needed to reduce the growing complexity of government IT infrastructures.

### *Problem definition*

Targeted public IT procurement is viewed as a pivotal area for improving the interoperability of government IT infrastructures. Interoperability can be achieved by different means (Egyedi 2011). Unless other widely supported solutions exist, requiring vendors to comply to specific functional and (open) standards requirements is one of the more systematic and future-oriented means to achieve cross-governmental interoperability (CAMSS 2011). In this vein, a number of governments have defined supportive standard selection procedures.

While standards ease achieving interoperability, there is an ”unmitigated output of standards, especially competing standards” (Cargill and Bolin 2007, p.310) In this report the term *competing standards* refers to two or more functionally equivalent and/or largely overlapping standards. In the context of government IT procurement, several European Member States have been struggling with this phenomenon (e.g. Portugal and Denmark). In the case of competing standards, should Member States select standards for the purpose of public IT procurement? Or are there good reasons to support multiple standards?

There is no clarity about this issue. For example, European public tender law (Directive 98/34/EG) reflects a tension between European interoperability and competition policy. The law requires that, in order not to bias the market, public procurement officers must allow their requirements to be met by different technical means. That is, vendors must be asked to comply with a specified standard or meet the required functionality by other means. The latter cannot be a reason for rejection. This tension has been an issue with for example, the Tetra standard for cross-border radio communication between emergency services in Europe (Hommels, Cleophas et al. forthcoming) and

[1] E.g. the European Interoperability Framework’s (EIF) minimal requirements for an open standard, include the availability of a standard specification document for free or at a nominal charge, the availability of possible patents on a royalty-free basis, and no constraints on the re-use of the standard (European_Commission_IDABC, 2004, p.9).

in referencing to open standards (here: ODF) in Dutch public procurement (Notification 2008/140/NL).

An additional source of confusion is a discussion among scientists about whether competition between (open) standards is good for innovation (Blind 2008; Egyedi and Koppenhol 2010; West and Fomin 2011), about which more is said later on. Overall, little research has been done on the impact of competing open standards on interoperability, innovation, market development, the environment, etc. and factors influencing their impact such as royalties. Most scientific literature focuses on standards wars between *de facto standards*[2] such as HD-DVD and Blu Ray. Furthermore, scarce findings about the impact of standards wars are inconclusive. Some argue that standards competition hinders the development of markets (Shapiro and Varian, 1999); while others conclude that it promotes technological innovation (Blind, 2008).

### *Research questions and scope*

In this report a contribution is made towards synthesizing scientific literature and highlighting issues that are relevant for government IT from an interoperability perspective.

The questions addressed are:

> *In the context of government IT procurement, should governments choose between standards that have the same functionality? If so, what factors should be taken into consideration?*

The focus is, first of all, on government authorities in their role of IT users. Second, given their interest in interoperable and vendor-independent IT, the focus is on deriving insights about how to deal with competition between open[3] committee standards. *Committee standards* are documented specifications "established by consensus (…), that provide, 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" (adapted from ISO/IEC 2004, p. 8). The addition "and approved by a recognised body" is omitted from this definition to widen its applicability from standards of formal standards committees (e.g. International Organisation for Standardisation, ISO) to standards developed by fora and consortia (e.g. World Wide Web Consortium, W3C; Organisation for the Advancement of Structured Information Standards, OASIS and Ecma International) and professional organisations (e.g. Institute of Electrical and Electronics Engineers, IEEE).

Third, the focus is on compatibility standards, that is, on standards that effectuate "whatever technical connections between distinct production sub-systems are required in order for them to be utilised in conjunction within a larger integrated production system.'' (David and Bunn 1988, p.170). Compatibility can manifest itself in compatible complements (David and Bunn 1988, p.172), i.e., when subsystems A and C can be used together (e.g. plug and socket). It can also manifest itself in

[2] *De facto* standards are widely adopted - specifications or company standards that underlie – products or services. Because the latter have a sizeable market share, the underlying technical specifications become points of reference for other market players: the specifications are referred and built to by third parties.

[3] The royalty-free requirement of open standards, as defined in e.g. the initial EIF is loosened in this study in order not to exclude standards that, in practice, constitute part of the problem of having multiple standards.

compatible substitutes, i.e., when subsystems A (e.g. USB interface of a digital camera) and B (e.g. external hard disk) can each be used with a third component C (e.g. USB interface of a laptop) to form a productive system. In this report the terms compatibility and interoperability are used interchangeably.

Last, there are different types of interoperability: technical, semantic and organisational interoperability. Most of the scientific literature focuses on *technical interoperability*, that is, on interoperability that "covers the technical issues of linking computer systems and services. It includes key aspects such as open interfaces, interconnection services, data integration and middleware, data presentation and exchange, accessibility and security services." (European_Commission_IDABC 2004, p. 16) Correspondingly, this report will focus on technical standards. In the final discussion, however, it is recommended to explore whether the pursued line of reasoning might also be valid for semantic interoperability, i.e., standards that ensure "that the precise meaning of exchanged information is understandable by any other application that was not initially developed for this purpose" (European_Commission_IDABC 2004, p. 16) . The latter category of compatibility standards promises to become increasingly important for government procurement.

### *Aim*

This report aims to help those concerned with public IT procurement and procurement policy reflect on key issues relevant to the development of an interoperable and vendor-independent government IT infrastructure. The literature study and developed line of reasoning serve as contributions towards discussions on standards selection. The ultimate objective is to help public IT procurers, managers and policy developers make accountable decisions.

### *Research method*

In this report the author draws together and builds upon her earlier foremost qualitative studies (i.e. literature reviews, content analyses and case studies) and incidental quantitative work (Egyedi and Heijnen 2008). Key building blocks have been two in-depth case studies of competing standards (Egyedi and Koppenhol 2009; 2010; Hommels and Egyedi 2010); a preparatory study on the implications of competing standards (Egyedi 2010); case studies of standards change collected in the volume 'Standards Dynamics' edited by Egyedi & Blind (2008), among which a study on standards succession (Egyedi and Loeffen 2008); and a paper that addresses converters and other ways to re-create interoperability between multiple standards (Egyedi 2009). For details on the research methodology, the author refers to the respective studies.

Additional data has been gathered and complementary research has been done, including

- A synthesis of academic literature from foremost economics and innovation and technology management studies (section 3.1 and 3.2).
- A content analysis of policy documents on standards selection for public IT procurement public (section 2).
- Devising a formula on 'lack of interoperability' using insights from a case study on document formats (Appendix 1), and literature on standards wars and standards change (section 3.4.2).
- A discussion on expected micro-politics in standards selection policy (section 4.1), which extends insights from a case study (Egyedi & Hommels, under review).

- A market analysis of supply and demand in institutional standardisation (section 4.2) based on standardisation literature.

### *Structure of the report*

The next section further sets the scene for answering the research questions and introduces two initiatives on selecting standards for public IT procurement. Section 3 identifies different scientific perspectives that are relevant to take into account and synthesizes key findings about competing standards. Section 4 discusses factors to take into consideration when selecting standards. The report rounds off by re-addressing the two research questions and making recommendations.

## 2. Standards Selection for Public IT Procurement

European and Member State level initiatives have been taken to help select standards for public IT procurement. The questions whether or not to select between largely overlapping standards and, if so, on what basis fit within this context but have only incidentally been addressed by these initiatives. Two such initiatives are introduced below, i.e. the Common Assessment Method for Standards and Specifications (CAMSS) project at European level and the Dutch selection procedure of the Standardisation Forum (Forum_Standaardisatie 2011).

## 2.1 The European CAMSS project

The CAMSS project aims to provide guidance to Member States in choosing standards for government IT procurement. The documentation supports the systematic identification of relevant criteria. It makes the selection process more accountable but does not do the choosing. The CAMSS project is underway and planned to be finalised in 2012. At the current stage it provides

- a list of questions, most of which if answered affirmatively would favour the inclusion of the deliberated standard . That is, overall, the questions can be understood as selection criteria; and
- a process that supports the sharing of investigative findings between Member State governments and specifies how the underlying assessment of proposed standards should proceed. To avoid duplicate work in different Member States, a common library of such assessments ('Interoperability Statements') is ultimately aimed for.

The questions address

- business needs (i.e. functional performance, requirements, suitability and impact of choice, including the standard's stability and adaptability);
- standardisation criteria (quality of the standards body responsible for development and maintenance, in particular the appropriateness of procedures); and
- market criteria (support for the standard, its maturity and (re-)usability).

In CAMSS documents, competing standards are mentioned twice, i.e. under

- standardisation criteria the need for 'interoperability governance' between standards is mentioned as an area to be addressed by standard bodies; and
- market criteria the market share of (implementations of) competing standards is included.

## 2.2 The Dutch Selection Procedure

The aim of the Dutch selection procedure is similar to that of the CAMSS project, that is, to support interoperability of the Dutch public sector IT infrastructure with a procedure for selecting open standards for public procurement (Forum_Standaardisatie 2011). There are also differences with CAMSS. First, the Dutch procedure emphasizes the need to counter vendor lock-in and therefore requires *open* standards (in practice: as open as possible). Second, the procedure and corresponding selection criteria are used for *two* lists of open standards. One is called the comply-or-explain list and contains standards that - if relevant – must be referred to in tenders for public IT procurement (i.e. *mandatory*). The other list comprises *recommended* established open standards.

Four clusters of selection criteria are identified:

- Open standards process: standards development and maintenance is to be organised in an open, independent, accessible, transparent, careful and sustainable way;
- Added value: across government the interoperability gains should outweigh the costs and risks;
- Market support: providers and users should have enough experience with the standard; and
- Inclusion of the standard on one of the lists should stimulate standards adoption.

A few references are made to the problem of competing (open) standards and which one/whether to choose (Forum_Standaardisatie 2011). Notably,

- During the selection procedure a representative of the competing standard is invited to provide comments to the expert group that advises the Forum about including the standard on the comply-or-explain list (p.8) ;
- The standard should not conflict with and should have an added value vis a vis overlapping standards already included on the list; it should also offer added value in respect to competing standards (i.e., in respect to those not included on the list) (p.19);
- Related, regarding the comply-or-explain list, different versions of the same standard are dissuaded. The inclusion of multiple versions is undesirable and should only occur if the benefits outweigh the costs and e.g. downward compatibility is ensured, the market widely supports both versions, or conversion arrangements are in place (p.12).

Both the CAMSS project and the Dutch selection procedure do not address the question whether to select between or allow competing standards for public IT procurement, the problem discussed in the following sections.

## 3. Review of the Literature

In a paper called 'A welfare analysis of standards competition: The example of the ECMA OpenXML Standard and the ISO ODF Standard' Knut Blind (2008), a German economist, poses the question how competing standards should be evaluated theoretically in respect to their effect on innovation.[5] He identifies eight relevant parameters[6]. Together they determine whether - with a view to innovation - one should choose between standards or rather prolong the period of competition before making a choice. He concludes that, irrespective of the type of standard, competition fosters technology innovation. Blind's paper triggered a response from Egyedi and Koppenhol (2009, 2010). They object not so much to the arguments used, but rather to what they see as an incorrect underlying assumption. In developing his argument, Blind primarily analyses economic literature on and problems typical for de facto standards and then generalizes his findings to committee standards. For example, a recurrent problem addressed in economic literature is the risk that consumers prematurely get locked into a certain technology without really knowing its quality. According to Blind such uncertainty calls for a prolongation of standards competition until the technologies have taken shape and it has become clear which one is technically superior. Egyedi and Koppenhol have two objections to this view. Firstly, in most standards wars technical superiority, which is difficult to measure anyway, is not the defining factor for winning the war (Van_der_Kaa 2009). Which technology 'wins' is primarily attributable to the availability of products, the forming of alliances and successful marketing. Bearing in mind the war between Blue-Ray and HD-DVD in the market for High Density DVDs, prolonging the period of competition may even adversely influence the market. Market development stagnated, according to the media, because consumers feared being stuck with a 'losing' system and therefore postponed their purchases.

Secondly, Egyedi and Koppenhol object because, as they argue, both types of standards differ fundamentally. While committee standards and de facto standards have in common that they function as points of reference for the market, a committee standard is a negotiated agreement whereas a de facto standard is a product or service specification. Whereas de facto standards emerge from competition in the market, committee standards result from competition and negotiations within committees. The shared outcome, the negotiated specification, creates a level playing field for producers. Competition can then focus on how best to innovate based on the standard. That is, committee standards should be viewed as a platform for competition and prospective innovation rather than compete themselves (Egyedi and Koppenhol 2009, 2010). As such they resemble infrastructures (Swann, 2010) rather than products, and caution should be applied in generalizing findings on de facto standards to committee standards. (The metaphor of introducing competition between driving on the left-hand side and on the right-hand side of the road illustrates the difficulties introduced by competition between negotiated agreements.)

Different from the above discussion this report centres on the impact of competing standards on government IT interoperability rather than innovation. To address the question whether

[5] "How should multiple parallel existing standards, which exist in the same technological area, be fundamentally evaluated in terms of theoretical – static welfare, and most importantly with respect to their dynamic effect on innovation and competition?" (Blind 2008, p.1)

[6] The parameters are: "preference for network effects, local network effects, heterogeneity of the preferences, cost of the development and maintenance of standards, uncertainty regarding the technical quality, length of the life cycle, development potential, uncertainty regarding future user preferences." (Blind 2008, p.7)

governments should choose between competing committee standards, an economic framework is introduced that looks at the functions and market implications of committee standards, and at what happens if two or more such standards are in place (section 3.1). Next, the growing amount of literature on de facto standards wars in the area of consumer electronics and ICT is analysed on what it teaches us about competing (open) committee standards (section 3.2). Given the parallels between different competing standards and competing standards versions, the literature on 'standards dynamics' is reviewed on relevant insights (section 3.3). The viability of supporting multiple standards and the possibilities of recreating compatibility by other means (e.g. converters, gateways etc.) are discussed in section 3.4. The section closes by summarising the lessons learnt (section 3.5).

## 3.1 Economic framework

To start with, important concepts are introduced that will subsequently help explore the implications of supporting multiple committee standards.

### 3.1.1 Functions of standards

From an economic perspective, committee standards perform different functions. They provide information, foster compatibility and reduce variety (Blind 2004; Table 1, first column). Regarding their informative function, standards make life easier because we can refer to them and thus reduce informational transaction costs (Kindleberger 1983). Such costs entail, for example, the time and resources required to establish a common understanding between parties in the market. Standards reduce the costs of negotiations because "both parties to a deal mutually recognize what is being dealt in" (Kindleberger 1983, p. 395). They reduce the search costs of customers because there is less need to spend time and money evaluating products (Jones and Hudson 1996). In particular in markets where consumers cannot easily recognize the quality of a product, such as the IT market, consumers have an information disadvantage vis a vis producers. An information asymmetry exists (Akerlof 1970). If producers have much more information than consumers, market failure will occur (e.g. too little IT functionality for too high costs). Standards notably address market failure in two ways. First, standards make it easier for consumers to compare products. The information provided by standards increases market transparency (Reddy 1990). Standards thus help to correct the occurrence of 'adverse selection'. Adverse selection takes place if the supplier of an inferior product gains market share through price competition because the supplier of a high quality product has no means to signal this information to potential consumers. Standards that contain information about a product's quality will support suppliers in signalling this information and minimize the likelihood that consumer selection is based on the wrong assumptions. Moreover, because of increased market transparency, standards facilitate trade. They do so in particular in anonymous international markets, where parties to the transaction do not know each other.

Second, compatibility standards provide a platform or 'infrastructure' (Swann 2010) to compete and innovate upon. The desired economic effect of committee standards is to support 'full competition in the marketplace for suppliers of a technology and related products and services'(Ghosh 2005). The level playing field lowers the threshold for new producers, provides incentives for innovation, leads to a better price-performance ratio and leads to a larger variety of products for consumers. Moreover, standards facilitate the emergence of clusters of new economic activity. Examples are the cluster of paper processing equipment and office products (e.g. printers, copiers, fax machines,

binders) that has developed around the A-series of paper formats (ISO 216); and the vast amount of Internet services based on the TCP/IP protocol. Because e.g. interfaces and formats are standardised, consumers can switch more easily between providers and products and are less easily locked-in (Farrell and Saloner 1985).

The third economic function of committee standards is that of variety reduction. The principle aim of committee standards is to reduce needless and unhelpful variety by agreeing on a specification that can serve as a shared point of reference. An early definition of the Dutch standards body, which says as much (Van_den_Beld 1991), underscores that variety in itself is not of intrinsic value to consumers (e.g., few people will value using both the metric and imperial units of measurement). Moreover, from the producer's side, because of reduced variety, standards mitigate economies of scale (i.e., cheaper units) and help build the critical mass required for markets to take off. Again, by reducing needless and unhelpful variety, the market becomes more transparent (information function of standards) and runs more efficiently (compatibility function).

### 3.1.2 Market effects of multiple standards

What happens to the market if two or more largely overlapping standards are in place? The welfare gains from standards variety then need to be weighed against the sum of costs. Table 1 summarizes the effects for consumers and suppliers. The Table builds upon the economic functions of committee standardisation as discussed in the previous section (first column of Table 1), and their market effect (second column of Table 1, based on Blind 2004; Egyedi and Blind 2008; Egyedi and Muto 2011). Inductive inference is used to identify per economic function what the impact is of having multiple, functionally equivalent standards (third column of Table 1).

For consumers, here: government authorities and their interactions with citizens and companies, there would seem to be few benefits. Since the competing standards are functionally equivalent, having a choice would only be meaningful if the standards strongly differ in other respects (e.g., quality). More likely, two or more functionally equivalent standards will

- reduce market transparency;
- decrease overall interoperability, decrease network externalities (to be discussed in the next section) and decrease ease of use;
- fragment the market, possibly leading to submarket lock-in and – if there is a risk of insufficient competition per submarket - vendor lock-in and monopolies (i.e., welfare losses, higher costs and less technology diffusion); and
- increase transaction costs (e.g., extra costs of competing standards including costs of converters and converting; barrier to exit/ switching costs).

That is, reasoning from the economic functions of standards, the market and interoperability impact of multiple committee standards suggests that public authorities should try to avoid supporting two or more competing standards. As we shall see in the next section, empirical studies on standards wars partly confirm the inferred market effects.

| Functions of committee standards | Effect on the market | |
|---|---|---|
| | **One standard** | **Two or more standards** |
| Information | Increases market transparency<br>Reduces transaction costs (e.g. reduces information asymmetry)<br>Corrects adverse selection<br>Facilitates trade | Reduce market transparency<br>Increase transaction costs (e.g. costs of converters and converting)<br>Make comparison of product quality more difficult<br>Hinder trade by increasing e.g. informational transaction costs |
| Compatibility | Creates network externalities<br>Increases competition (i.e., increases number of producers, quality and choice of products, lowers prices, provides an incentive for innovation)<br>Decreases vendor lock-in (e.g. decreases costs of switching vendors and of maintenance) | Reduce interoperability<br>Involve switching costs<br>Reduce network externalities<br>Decrease competition (higher barrier to market entry for smaller players; higher prices)<br>Increase likelihood of standard-based lock-in (fragmented market)<br>Need for converters, etc. to recreate interoperability (extra complexity and risk of decreased functionality) |
| Variety reduction | Allows economies of scale<br>Facilitates building a critical mass | Less variety reduction, smaller markets, and therefore:<br>Reduced economies of scale<br>Reduced chances of building a critical mass |

**Table 1:** Main functions of compatibility standards and the market effects of having either one or more standards (based on Blind 2004; Egyedi and Blind 2008; Egyedi and Muto 2011)

## 3.2 Standards Wars

A growing number of economic, technology management and innovation studies of standards wars has emerged (Stango 2004; Van_der_Kaa 2009). Some are historical accounts and have become classic exemplars such as the Qwerty vs. Dvorak keyboard layout (David 1985), the competing video recording systems of Betamax, VHS and Video2000 (Shapiro and Varian 1999), the battle between Alternating Current and Direct Current (McNichol 2006), and Open Systems Interconnection (OSI) versus Internet (Hanseth, Monteiro et al. 1996). Of more recent date are the wars between proprietary platforms (West 2003); the war between HiperLAN versus IEEE 802.11 wireless LAN (Jakobs 2008); the standards war on DVD recordables (Dranove and Gandal 2003; Gauch 2008); the war between the Dutch e-purse systems of Chipknip and Chipper (de_Vries 2006); and between W-CDMA and CDMA 2000 in mobile telecommunications (Grindley, Salant et al. 1999). These battles

involve rival technologies. Some battles involve products (i.e., de facto standards) and take place in the market, while others concern negotiated agreements and take place in and between standards committees.

In such rival revolutions type of standards wars two factors determine the stakes and their dynamics (Shapiro and Varian 1999). First, the rival technologies are incompatible. This is a defining factor not only for de facto standards wars like Blu-Ray versus HD-DVD, but also in wars between committee standards. Some of the latter involve the –sometimes contested – fast tracking of consortium standards or industry specifications by formal standards bodies. Examples are the wars on 56K modems (Shapiro and Varian 1999), wireless communication (Lee and Oh 2006), DVD recordables (Gauch 2008), and document formats (Blind 2008; Chappert and Mione 2008).

A second and related defining factor in standards wars is the role of *network externalities* (Shapiro and Varian 1999). Externalities are the costs or benefits of a transaction incurred or received by members of society but not taken into account by parties to the transaction (Lipsey and Steiner 1979).[7] In the context of standards wars, 'positive network externalities' are particularly relevant, that is, the increased value of a network with every new connected network user (Farrell and Saloner 1985; Katz and Shapiro 1985). These can be *direct* (e.g. every new fax machine increases the reach of the network) or *indirect* network externalities (e.g. if everyone buys the same car brand the number of dealers and the availability of spare parts will be higher). Network externalities require compatibility. The absence thereof, as is the case with incompatible rival technologies, reduces the externalities of the networks involved. This can be illustrated with incompatible standards for pallet sizes. Multiple standards force traders to carry a stock of pallets of different sizes, which poses a particular problem for the developing countries where there is neither a rental market, nor an exchange market for pallets (Raballand and Aldaz-Carroll 2007).

While one might expect a single standard to result in areas where there are strong direct and indirect network effects (Weir 2007), this need not be the case. Similarly, standards wars need not necessarily end up in a 'winner-takes-all' situation(Singh and Dahlin 2009), which would have solved the problem of incompatibility and reduced positive network externalities . Under certain circumstances, Singh and Dahlin argue, there may be room for two standards and/or a niche standard. If there is no clear 'winner', incompatibility will lead to market fragmentation. In the consumer electronics market, for example, "[t]here's no denying that consumer electronics format wars are a nuisance. The rules of engagement are particularly cruel for the buying public, asking them to make an expensive bet on a technology that could be obsolete in a few years' time. They emerge with remarkable frequency: 78 rpm discs versus 45 rpm in the 1940s, 8-track versus cassette in the 70s, Betamax versus VHS in the 80s, digital audio tape versus the compact disc in the 90s. Not to mention, of course, the on-going QuickTime versus Windows Media versus RealMedia struggle" (Warner 2008)

If a 'winner' nonetheless emerges, this need not be due to its alleged technical superiority. For example, the 'winning' Qwerty keyboard was not most suited for speed typing, according to David

[7] Externalities disappear when they are included in the cost estimate and become internalized. Externalities can be negative, e.g. the polluting industry bringing down the value of houses in the area, or positive, e.g. a well-maintained park increasing the value of houses in the neighbourhood (Lipsey and Steiner 1979).

(1985). Nor was the VHS video recorder the most advanced system technologically, according to proponents of Philips' Video 2000. The weak causal link between 'superior quality' and 'winning a standards war' also throws a different light on a discussion among economists about minimizing the risk that consumers prematurely get locked into a technology of which the quality is not yet evident (Blind 2008). NB: Having said this, the underlying line of reasoning, that where products and services are concerned competition can spark innovation, is overall accepted. As such, competition between standards may constitute an incentive for competing standards committees to improve their standard. Ultimately, this can even lead to a race between new standards versions (e.g. DVD recordables; Gauch 2008).

The uncertain outcome of wars between rival revolutions is a key intermediate factor in determining their impact. Uncertainty undermines competition (Farrell and Saloner 1986). It leads to a hold–up of investments by third parties (Williamson 1979): producers will try to postpone investments for fear of investing in a 'losing' system and having to write off sunk costs (i.e., costs that are specific and irreversible and therefore cannot be retrieved). The same hesitations exist on the side of consumers. They will postpone their purchases. Accordingly, the market will stagnate.

For government procurers, certain aspects of the discussed standards wars are particularly relevant. First of all, the defining problems of incompatibility and lack of (positive) network externalities also apply to competing committee standards. They lead to fragmented markets, extra efforts to bridge these markets and user inconvenience on all levels. Furthermore, uncertainty about whether a 'winner' will emerge or multiple committee or de facto standards will remain can hold-up third party investments and consequently slow down innovation. Transposing this insight to public IT procurement, clarity about whether governments will select among competing standards and their criteria for selection are highly relevant for both investors and end-users.

## 3.3 Standard Versions: Competing over Time

Comparable to competing standards, different versions of the same standard could also be said to be 'functionally equivalent'. Rivalry can arise between them, as the IPv4 and IPv6 protocols illustrate (Vrancken, Kaart et al. 2008). Different versions can lead to interoperability problems equal to those between competing standards, as the literature on standards dynamics shows (Egyedi and Blind 2008). In this section, these problems as well as the way incompatibility is dealt with are examined more closely.

### 3.3.1 Standards change

Succession in standardisation refers to a situation in which a standard (the predecessor) is revised and succeeded by a new standard (the successor). It occurs among proprietary as well as non-proprietary committee standards. It implies change and renewal. Renewal comes in various shapes: new editions, revisions (new versions, technical corrigenda, amendments, annexes etc.) and new standards. The successor addresses the same functionality but represents a performance improvement in one or more aspects. Therefore, new entrants in the market (standards users) will usually implement the successor.

Standardizers will usually seek compatibility with a standard's predecessor to preserve the installed base - unless there are good reasons not to (e.g. too high functionality losses). The preferred way to

do so is to create a backward compatible successor. For example, WordPerfect 5.1 software, a de facto standard at the time, could handle WordPerfect 4.2 documents. The successor extends the possibilities of the predecessor. (NB: The reverse also occurs. Where companies only need a subset of the standard, they may want to specify a standards profile[8] to conform to, rather than comply with the more elaborate original standard.)

If the successor standard is compatible, compliant technologies should be able to work together with products that were able to interoperate with its predecessor. This is typically aimed for with a new edition or a minor revision of a standard. The innovations involved are incremental in nature, part of normal problem solving (Kuhn 1970) and proceed along a technological trajectory (Nelson and Winter 1977). The new standard exploits its predecessor's installed user base.

To identify and analyse different types of succession and their impact on the market, three dimensions are distinguished: (1) does the new technology represent a paradigm shift; (2) is the successor part of the same technological trajectory; and (3) is the successor compatible with its predecessor. They are listed in Table 2.

The Type I succession refers to a *grafting*[9] relation between successors. It is characterised by incremental improvements and trajectory-compliant developments, and maintains compatibility. In other words, grafting describes a specific type of heritage relationship: compatible succession.

The Type II successor represents an incremental shift. It is paradigm-compliant but incompatible with its predecessor (discontinuous standards development). For example, the Internet Protocol version 6 (IPv6) is not compatible with IPv4 (Vrancken, Kaart et al. 2008). To recreate compatibility a separate standard on "Transition Mechanisms for IPv6 Hosts and Routers" (IETF RFC 2893) has been developed. That is, IPv6 is a Type II successor, incompatible and discontinuous, but paradigm compliant.

The Type III successor represents a revolution. It introduces improvements that signify a radical paradigm shift (disruptive standards development) and is not backward compatible with its predecessor. In Telefax standardisation (CCITT, 1989-1992), for example, the succession of Group 3 for analogue networks by the Group 4 for digital networks illustrates a Type III succession (Schmidt and Werle 1998). In these situations, the rivalry that ensues between successors is no different from that which exists between unrelated standards with equivalent functionality.

[8] "Profiles (...) define conforming subsets or combinations of base standards (...) to provide specific functions. [They] identify the use of particular options available in the base standards (...)" (ISO/IEC JTC 1 N 5154, 1998.01.05)

[9] Drawing an analogy with the process of grafting in horticulture, where a scion (added, improved functionalities of a new standard) is grafted onto a stock (prior standards functionalities), scion and stock need to be closely related if the desired plant part is to survive (Encyclopaedia Britannica). With regard to standardisation, the term *grafting* refers to "the process of developing a standard (successor) based on another standard (predecessor) with the intention to improve the latter's functionality and/or usefulness in other respects while preserving compatibility with its predecessor's context of use." (Egyedi and Loeffen 2008, p. 84)

| Successor categories<br><br>Dimensions | Type I: Graft | Type II: Shift | Type III: Revolution |
|---|---|---|---|
| Technology Paradigm Change | incremental | incremental | radical |
| Standards Trajectory | continuous | discontinuous | disruptive |
| Compatibility Outcome | compatible | incompatible | incompatible |

**Table 2:** Taxonomy of successor standards (Egyedi and Loeffen 2008).

The characteristics that define the dynamics of wars between competing standards, i.e. incompatible technologies and lack of network externalities, also apply to Type II and Type III successions.

To put the possibility of creating downward compatibility into perspective, the XML standard developed by World Wide Web Consortium (W3C) was explicitly intended to be compatible with its predecessor, i.e., the 1988 SGML standard developed by an ISO/IEC JTC1 committee (Bosak 1996). That is, it was positioned as a Type I successor. However, despite the high value set on maintaining compatibility between the two standards, as their efforts illustrate, the W3C committee could not satisfactorily resolve the tension between the required new functionalities for XML (e.g. run on the Internet) and vested interests in the SGML standard (Egyedi and Loeffen 2008).

The SGML-XML case illustrates, on the one hand, the efforts those involved are prepared to make to maintain access to a standard's installed base and address vested interests; and, on the other hand, that compatibility – even between successors – can be difficult to achieve.

### 3.3.2 Dealing with the impact of standards change

A Type I succession usually has little impact on the market. For example, the users of the Aachen Wireless LAN had few problems with the transition from IEEE 802.11b to IEEE 802.11g (Jakobs, 2008). However, revisions and extensions can create severe difficulties. A study of the IT infrastructure of a Dutch ministry showed it to be in a constant flux of change largely because of forced upgrades of the de facto standard (vendor lock-in), the interoperability implications this had for other software, and the three year cycle needed to roll out these changes –just in time to roll out the new upgrade ministry-wide (Egyedi 2002).

The case studies of standards change discussed in the edited volume 'The Dynamics of Standards' (Egyedi and Blind 2008) point out several reasons for standards change and, correspondingly, identify different ways to address the incompatibilities that arise (Table 3). There are ad hoc and systematic ways to deal with the adverse impact of standards dynamics, and solutions that try to prevent problems from occurring (*ex ante)* and those that try to deal with them *ex post*. Most relevant for this report on competing standards is the category of solutions that recreate compatibility *ex post* and *ad hoc* such as the creation of crosswalks between a standard and its successor. Sometimes this seems possible (e.g. from DC to DCQ; Van der Meer 2008). But more often the results of such efforts are ambiguous (Egyedi and Loeffen 2008).

| Type of Solutions | Ad hoc | Systematic |
|---|---|---|
| **Ex ante** | - | Quality standards process<br>Flexible, 'future-proof' standard design, modular approach, 'adaptability standards' (Krechmer 2006) |
| **Ex post** | Re-creating compatibility:<br>Crosswalks, converters, plug-ins, bridges, multi-protocol stacks, etc. | Downward compatibility |

**Table 3**: Solution domains for incompatibility between standards versions.

To give an example, Van der Meer (2008) has studied the issue of sustainability (i.e. longevity) and ownership of documents and digital data in the context of using (successive versions of) proprietary software over the years. The problem is that consumers trust proprietary software vendors to keep old data and documents accessible by new software versions. Regarding the sustainability of digital data Van der Meer identifies a number of partial and temporary solutions, i.e.: data refreshment, migration and conversion, and the emulation of earlier data handling devices. Emulation is required if users have no strategy to archive and update the data handling devices. Such was the case, for example, with tools that could handle ODA/ODIF (Van der Meer 2008). That is, in principle such ex post measures may partly and temporarily solve the adverse effects of standards change. But they are usually costly and often inadequate.

## 3.4 Converters unproblematic?

There are different means to re-create interoperability between competing standards (e.g., Farrell and Saloner 1992), e.g. converters, plug-ins, bridges, multi-protocol stacks, gateways and routers. Some ease coexistence. For example, in ICT and consumer electronics competing standards are sometimes implemented in single devices (*multiprotocol implementations*, Gauch 2008); take, for example, equipment that can handle different DVD recordable formats. While it involves extra costs, producers and users of one standard then still have access to the externalities of the competing standard. Such solutions reduce the consumer's fear that the market will tip towards the competing standard leaving them with an obsolete technology. However, these solutions sustain market fragmentation. Since they allow consumers to benefit from the externalities of both markets, there is no urgent need to integrate standards and markets (e.g. DVD recordables; Gauch, 2008). A similar phenomenon is at stake with the dual stack implementation of IPv4 and IPv6 (Vrancken et al. 2008). Although aimed to ease migration from IPv4 to IPv6, the dual stack allows co-existence and lessens the need to migrate.

Other solutions go beyond co-existence and re-create compatibility. The manner in which this is done can have important implications: "Converters can be one-way or two-way with very different strategic implications." (Shapiro and Varian 1999, p.286) Shapiro and Varian (p.282) advise vendors "Just don't build a two-way bridge to another region where you face an even stronger rival".

An example of the complexity involved in re-creating compatibility between two committee standards is discussed in Appendix 1. It addresses the committee standards war between the document formats OOXML and ODF, which raised unusually high interest among citizens (e.g. demonstrations in the streets of Oslo and protest songs on YouTube).The study illustrates that converters increase system complexity and thereby overall system vulnerability; heighten the costs of production and purchase; and often lead to performance degradation (Shapiro and Varian 1999), as conversions between the document formats show (Langer 2008).

## 3.5 Variables that capture lack of interoperability

Selection committees for IT procurement not only face the problem of different competing standards but also that each of these standards is likely to develop versions. That is, where $S_{i,j}$ refers to standard i version j, selection committees are faced with different competing standards $S_{i=1..n}$ and different versions of these standards $S_{j=1..n.}$. The more competing standards and standards versions the more converters (i.e. translations, mappings, routers etc.) are needed (i.e., from one standard to the other and vice versa) to bridge the resulting incompatibility. That is, the degree of incompatibility *X* can be operationalized by the number of converters needed. To give an example, in the case of two standards, one with two versions $S_{1,1}$ $S_{1,2}$ and the other with three versions $S_{2,1}$ $S_{2,2}$ $S_{2,3}$, twenty converters are needed. See Table 4.

| Standard $S_{i,j}$ | $S_{1,1}$ | $S_{1,2}$ | $S_{2,1}$ | $S_{2,2}$ | $S_{2,3}$ |
|---|---|---|---|---|---|
| $S_{1,1}$ | - | $S_{1,2}$ x $S_{1,1}$ | $S_{2,1}$ x $S_{1,1}$ | $S_{2,2}$ x $S_{1,1}$ | $S_{2,3}$ x $S_{1,1}$ |
| $S_{1,2}$ | $S_{1,1}$ x $S_{1,2}$ | - | $S_{2,1}$ x $S_{1,2}$ | $S_{2,2}$ x $S_{1,2}$ | $S_{2,3}$ x $S_{1,2}$ |
| $S_{2,1}$ | $S_{1,1}$ x $S_{2,1}$ | $S_{1,2}$ x $S_{2,1}$ | - | $S_{2,2}$ x $S_{2,1}$ | $S_{2,3}$ x $S_{2,1}$ |
| $S_{2,2}$ | $S_{1,1}$ x $S_{2,2}$ | $S_{1,2}$ x $S_{2,2}$ | $S_{2,1}$ x $S_{2,2}$ | - | $S_{2,3}$ x $S_{2,2}$ |
| $S_{2,3}$ | $S_{1,1}$ x $S_{2,3}$ | $S_{1,2}$ x $S_{2,3}$ | $S_{2,1}$ x $S_{2,3}$ | $S_{2,2}$ x $S_{2,3}$ | - |

**Table 4**: Number of converters needed to bridge the incompatibility between two competing standards $S_{1,1..2}$ and $S_{2,1..3}$ with two and three versions respectively. $S_{i,j}$ refers to standard i version j.

The following equation summarizes the problem of interoperability posed by competing standards. Here the variables that define incompatibility $X$, i.e., the number of possible converters needed to achieve interoperability, are

$$X= n(S_{i,j})^2 - n(S_{i,j}) = n(S_{i,j})[\, n(S_{i,j})-1]$$

where $n(S_{i,j})$ is the total number of different standards i with version j. $X = 0$ stands for optimal interoperability, i.e., no converters needed. Applied to the example of two competing standards with two and three versions at time *t1*, respectively, the equation becomes

$$X= 5\,(5-1) = 20$$

That is, to secure two-way interoperability between different combinations of five standard versions at time *t1* twenty possible combinations must be taken into account if no selection is made.[10]

The equation illustrates that in a static world (i.e. short term view) selecting two or more standards might be an option if their added value is high – and if their implementability (see below) is not a complicating factor. But in the long run different versions are likely to develop that acerbate the interoperability problem and, correspondingly, increase transaction costs. That is, in the field of IT the metaphor of the universal plug, which suggests that overcoming incompatibilities between multiple standards is technically feasible, does not readily apply because the field is too dynamic. Following this reasoning through, selecting two or more functionally equivalent standards for IT procurement would seem difficult to sustain.

In sum, the problematic side of converter solutions in the broad sense as well as the implications of the lack of interoperability formula warn against trivializing lack of interoperability between two standards and too easy reliance on technically re-creating compatibility (downward/upward as well as converters). The scale of IT use involved in government IT-procurement, and the non-transparency of IT products and services make long-term government support for two or more largely overlapping standards too costly.

For the sake of clarity, in the previous only two sources of incompatibility were taken into account, i.e. competition between different standards and successive standards versions. A third source of incompatibility must be mentioned for the sake of completeness, i.e., different implementations of the same standard (Egyedi 2008). The phenomenon that two products that both claim to be standard-compliant can be incompatible is often puzzling to consumers and can be highly problematic. For example, different implementations of the Z39.50 standard can lead to different query results. If a query result is later needed to account for an important decision and cannot be reproduced, it may have legal repercussions (Van der Meer 2008). The cause of incompatibility may lie in the way the standard process has been conducted (e.g. compromises), in the way the specification has been drafted (e.g. ambiguities, complexity and lack of quality of a standard), or in the way the standard has been implemented (e.g. embrace- and-extend strategies included). To check whether implementations are standard-compliant and interoperable, standard conformance and interoperability tests are conducted. Kirchhoff speaks of the 'validation' of implementations (Kirchhoff 2011). Validation is an indirect means to examine the quality of a standard specification.[11]

[10] Whereas one might question whether all possible combinations between standards and standard versions will actually arise in practice – is it likely that communication will foremost take place between those using (different versions of) the same standard? –the research question is whether government IT infrastructure should aim to support multiple (sub)markets.

[11] For example, validating implementations of the (JTC1) OOXML standard proves to be highly difficult because of the specification's lack of quality and volume (Bjorn Kirchhoff, in answer to a question about the absence of OOXML validation in his presentation, SIIT2011 conference, Berlin)

# 4. Factors to be considered for Meta-Standardisation

*What factors should be taken into consideration in choosing between standards that offer the same functionality?*

There is no significant difference between assessing a standard's eligibility for public IT procurement and selecting between two (or more) competing standards for the same purpose. In this respect the criteria mentioned in the selection procedure of the Dutch Standardisation Forum, which is used here as a running example, and the European CAMSS project are also useful to help choose between competing standards. For example, i, under equal circumstances preferably the more mature standard will be chosen for inclusion on the list (market criterion).

The Dutch Standardisation Forum and CAMSS both mention three questions as being important for selecting a standard, i.e.,

1. Does the standard under scrutiny meet government IT-needs?
2. Does the source of the standard, i.e. the standard setting organisation, foster confidence in the standards and maintenance process?
3. Does the market support the standard?

The Standardisation Forum further specifies them in a checklist of 33 questions that includes 'Does the standard setting organisation have a procedure in place for stakeholders to file a complaint about the workings of a standards committee?' (Standardisation Forum, 1.3.3; translated from Dutch) and 'Do multiple providers support the standard?' (Standardisation Forum, 3.1.1; translated). The current CAMSS document contains 89 questions. They also function as a checklist and help experts to systematically examine issues relevant to the selection process. In practice, in particular with the (more detailed) CAMSS list, not all questions will be equally relevant for each candidate standard. Moreover, they are not always easy to answer (e.g. 'Is the standard's functional application area well-defined?', Standardisation Forum, 2.1.1, translated). Expert discussion is needed to answer them (e.g. an expert review is one of the steps taken in the Dutch selection procedure). While some questions, notably in the CAMSS document, could more explicitly refer to the possible need to choose between competing committee standards, the existing selection criteria are a valuable starting point for selecting among competing standards. The task of weighing multiple criteria (business needs, market and standardisation criteria) remains a difficult one, as is weighing the short term (e.g. sunk cost) and longer term (e.g. transaction cost) considerations.

Two caveats must be noted regarding selection procedures for competing standards. First, there is a likelihood that micro-politics will invade discussions about the suitability of government selection procedures (section 4.1). Second, current market failure requires critical reflection on the 'standardisation criteria' (section 4.2).

## 4.1 Micro-politics in the selection procedure

Exceptions aside, government representatives hardly participate in international IT standards committees as end-users. By selecting standards for government IT-procurement, governments engage in second tier standardisation. They 'standardise' by retrospectively selecting standards

instead of participating and influencing primary standards processes. This could be termed *meta-standardisation*.

In the case of competing standards, the stakes are usually high (see section 3.2). It is therefore likely that, if given the chance, companies will try to influence the organisation and process of meta-standardisation. Micro-political strategies are likely to be pursued such as (a) casting doubt on the quality of the competitor's standard or standards process, (b) creating confusion, for example, by using terms differently, and/or (c) uttering implicit or explicit legal threats, for example, about the legitimacy of the selection process (Egyedi & Hommels, under review).

In respect to possible legal threats, as noted, European Member States that want to use a certain standard in public procurement must include a statement in their call for tenders that also allows for a functionally equivalent specification.[12] Although the government- consumer often does not want another solution, this inclusion is meant to safeguard competition. It testifies to the fact that, first, within the European Commission 'standards selection in support of public procurement' is subject to the rival policy frames of competition and interoperability. The two policy frames largely coincide with supply-side interests (industry) and demand-side interests (users) of the market, respectively. In the context of public procurement, the government's role is that of a large IT-user and consumer responsible for developing and maintaining a ('seamless') IT infrastructure. Interoperability policy is the primary framework for achieving this.

Second, the inclusion of an 'or equivalent functionality' clause for standards testifies to the confusion among policy makers who hold that, in a public procurement context, committee standards (negotiated agreements) can be treated as de facto standards (the specifications of products with a dominant market share). See also the introduction to section 3. Where no distinction is made between committee and de facto standards, the problem of competing standards for interoperable government IT goes unrecognised.

In sum, in the context of selecting between competing standards the debate among experts is likely to intensify. The danger exists that the micro-politics of standards wars will enter the selection procedure and that competition policy arguments will be used to side-track public procurers from working towards an interoperable and vendor-independent IT infrastructure. That is, to ensure that the interest of government as an IT user remains the central focus of standards selection, distinguishing between (a) de facto and committee standards (i.e., in most cases) and (b) the policy aims of interoperability and innovation is important.

## 4.2 Standardisation as a failing market

The selection procedures of the Dutch Standardisation Forum and the CAMSS project include 'standardisation criteria' that emphasize the importance of the source of the candidate standard. The standard setting organisation should have in place a well-organised process for developing standards and standards maintenance. For example, the Dutch criteria include the need for an open standards process (e.g. accessible for and answerable to the interests of all stakeholders), accessible standards, their royalty-free availability, the independent status of the Standard Setting Organisation (SSO) and

[12] See e.g. the policy documents Notification 2008/140/NL; and "Onderwerp: Richtlijn 98/34/EG - beantwoording opmerkingen (art. 8, lid 2) van de Commissie en van Zweden".

well-considered maintenance procedures. Their reasoning is that if an SSO is well-reputed, scrutiny can be relaxed.

Typically, international formal standards bodies like the ISO, IEC and ITU and their European and national counterparts would fall within this category. Their procedures are well-reputed. Less self-evident is whether the technology-dedicated, IT-oriented standards fora and consortia that have emerged since the mid-1990s have the necessary procedures in place (Hawkins 1999; Cargill and Bolin 2007). In response to the rise of consortia and the salient standards which some of them have set (e.g. TCP/IP and HTML), the formal standards bodies have installed procedures to fast-track externally developed specifications. Until recently, fast-tracking was an important option for some standards consortia because formal recognition of their standards tended to ease government use.

Recently the European Commission has - also formally – acknowledged (informal) SSOs as an important source of public procurement standards (European_Commission 2011). This inclusive policy is not without risks. Naturally, industry stakeholders shop for the forum with the most favourable conditions (Jakobs 2007). "When a constituted standardization organization blocks activities, or when it fails to meet necessary expectations, it is the work of a moment to create another consortia, alliance, technical committee, or similar standardization activity that is 'more in tune with the expectations of the market', (…)."(Cargill and Bolin 2007, p. 308) Companies that can afford it start their own consortium. Founding a consortium has become a business in itself[13].

On the surface, a much more diverse and dynamic market of standard setting organisations would seem to have emerged. But underlying it is an unexpected amount of homogeneity in procedures (institutional homogeneity; Bunduchi 2008), intra-committee dynamics, and commercial orientation. Particularly relevant for public procurement is, first, that where large industry players are the driving force in standardisation, formal participatory procedures seem to make little difference (Egyedi 2003). The formal standards bodies' aim to include all relevant ICT stakeholders (e.g. industry, users, governments, SMEs, NGOs), both at the level of the national members and internationally, is usually not realised (Jakobs 2005).[14] Moreover, the OOXML fast track process in ISO/IEC JTC1 (see Appendix I) illustrates that multinational IT companies take part in and determine standards negotiations in national mirror committees across the world. That is, JTC1's nationally oriented standards procedures and voting system has difficulty to withstand the pressure of globally oriented ICT players. The OOXML case indicates that, in effect, the formal JTC1 system can be exploited in a similar way as a consortium can. If this assessment is correct, it further justifies the European Commission's move to treat fora and consortia on a par with formal standards bodies (European_Commission 2011). But it also qualifies the way standardisation criteria in the CAMSS and

[13] Lecture by Deepak Kamlani, 'Standards and Consortia-The evolving landscape', Standards Edge Conference, Georgetown University, March 2007.

[14] This is does not mean that there are no counter examples. Two standards processes in which inclusiveness play and have played a key role are, respectively, (a) the CEN CENELEC ETSI Joint Working group on eAccessibility.Therein associations such as ANEC (European consumers standards organisation), the European Disability Forum and national disability organizations like ONCE for Spain are represented, and some EU countries (e.g. ministry for health and social affairs) as well as the US mission to the EU have representatives; and (b) the ISO 26000 effort on Social Responsibility, in which new procedures for multi-stakeholder participation were explored.

the Standardisation Forum's procedures should be interpreted in the light of public IT procurement (e.g., even a well-reputed SSO should remain under scrutiny).

Second, there is no real 'standardisation market'[15]. The demand-side of the market is hardly organised. As a result there are few restraints on the supply-side, the SSOs, for developing - competing - standards. The business models of standard setting organisations – both formal organisations and consortia –largely hinge on initiating new work item proposals (e.g. membership fees; their primary sponsors are industry). They thus have incentives to develop overlapping standards.

Only in areas where driving industry forces have a clear stake themselves and in the few areas where governments, multi-nationals and other users are well-organised is there a chance that competing standards can be avoided.

In sum, currently IT standardisation is showing signs of market failure, i.e., of a market in which industry players are too influential and the formal standardisation system too dependent (it has difficulty upholding the 'paradigm of standardisation'; Cargill and Bolin 2007) , and the demand-side of the market is too weak to correct incentives for developing competing standards – to the detriment of interoperability.

## 5. Conclusion and Recommendations

Public IT procurement policy is needed that supports the development of a seamless (i.e. interoperable), cost-effective (i.e. vendor-independent) and sustainable government IT infrastructure. In this context,

> *should governments choose between standards that have the same functionality? If so, what factors should be taken into consideration?*

Selecting two or more largely overlapping, functionally equivalent standards for government IT procurement is inadvisable for several reasons. Many of the benefits of standardisation get lost with multiple standards. Competing standards will reduce market transparency; decrease overall interoperability, decrease network externalities; decrease ease of use; fragment the market, possibly leading to submarket lock-in; if there is a risk of insufficient competition per submarket, to vendor lock-in and monopolies (i.e., welfare losses, higher costs and less technology diffusion); and increase transaction costs (e.g., extra costs of competing standards including costs of converters and converting; barrier to exit/ switching costs). See Table 1.

The problem of incompatibility between competing committee standards is acerbated by the likelihood that competing standards will undergo changes over time. That is, the incompatibility between competing standards as well as competing versions must then be bridged – in addition to the problem of standard-compliant but incompatible implementations. Standards change should therefore also be taken into the deliberation of whether to select only one or to allow more functionally equivalent standards. The developed formula for lack of interoperability underlines the limits of using converters and other ad hoc and ex post measures to overcome incompatibilities. They

[15] I sincerely thank Arjan Widlak for the idea of re-framing standardisation as a market.

involve extra costs, increase system complexity and lead to performance degradation. Moreover, converters and e.g. multiple implementations are likely to sustain competition, prolong lock-in, and thus reinforce long term market fragmentation. While they might represent a partial or temporary solution in a static context and with simple technologies, in the dynamic and complex (as defined by diversity and large scale) field of government IT infrastructure such solutions are less viable.

That is, the potential scale of the problem of lack of interoperability in government IT, the height of transaction costs (financially , functionality and inconvenience-wise), and its possible impact on communication in and between government entities and with citizens and businesses leave little room for *not* selecting between competing standards.

Regarding the selection criteria, there is little difference between assessing a standard's suitability for inclusion on a list for public IT procurement and selecting one out of more competing standards. The same factors are relevant and should be taken into consideration. The questions listed in the selection procedures of the Dutch Standardisation Forum and the European CAMSS project provide useful guidance for such a selection process. However, if competing standards are indeed functionally equivalent, the criteria for meeting 'business needs' will be less relevant. Moreover, the 'standardisation criteria' for including standards on the public procurement list need to be treated with caution. At present, the nationally-oriented international and European standards procedures and voting systems are not suited to mitigate and withstand the strong pressure of international ICT players.

Where competing standards are concerned, the battle ground has shifted from standards committees to public procurement policy and standard selection procedures (i.e., meta-standardisation). Advocates of competing standards are likely to exert exceeding pressure on and use micro-political strategies commonly used in standards wars to influence selection policies and procedures.

Finally, there is a 'standardisation market' failure. While the supply-side of standards, the consortia and formal standards bodies, have incentives to proceed with developing overlapping and competing standards, the demand-side of the market (including large IT users such as governments and companies) is hardly organised and imposes no restraints. This means that the problem is likely to increase unless users (here: governments) clearly indicate that they will not support the implementation of multiple competing standards.

## 5.1 Policy Recommendations

First of all, based on the previous research governments are advised to take 'selection between functionally equivalent committee standards' as the starting point of related policy on IT procurement. The factors to consider for choosing between competing standards (business need, market, standardisation) are detailed in selection procedures such as those of the Dutch Standardisation Forum and the European CAMSS project.

More specifically, these selection procedures should include a paragraph on standards competition, the need to select and the underlying argumentation (i.e., the difficulty of sustained support for competing, functionally equivalent standards in the dynamic field of IT). This in itself would be a clear message from government IT users that the supply-side of the standardisation market should

try to avoid developing overlapping standards – at the risk of being excluded from the market of public IT procurement. In this respect, the European move to include the 'selection between competing standards' in the CAMSS project would strengthen the demand-side of the standardisation market. In particular CAMSS' aim to share investigative findings between European Member State governments and arrive at a common library of 'Interoperability Statements' strongly signals to standard setting organisations the need for improved (standards) supply-side coordination. A successful CAMSS project promises to help correct 'perverse' incentives for developing competing standards and therefore deserves strong support of the European Member-States.

However, to best serve the public interest in an interoperable, sustainable and affordable (i.e. vendor-independent) IT-infrastructure, the author recommends targeted ex ante government participation in standardisation. This is likely to be more effective than ex post selection (meta-standardisation). To this end, governments need trusted in-house IT experts to represent them.

To close off, it is recommended that the European Commission reviews the tension in current public tender law between interoperability and competition, that is, between the role of government as a an IT user and as a regulator of market competition. Means should be sought to reinforce the government's position as an IT consumer and purchaser and simultaneously reduce the bureaucracy of the procurement process.

## 5.2 Research Recommendations

Given the scope of this report and the time limits, certain issues have not been addressed that might be relevant for selecting among competing standards while others require more elaborate research .

- The market effects of competing committee standards (Table 1, third column), which were inferred inductively and partly confirmed empirically , need to be qualified further by additional research.

- Of interest is (a) whether the answer to the research question 'Select or not?' might differ across technologies and types of innovation such as architectural, platform, incremental and radical innovations (Egyedi and Sherif 2010); and (b) whether the conclusions for technical standards can be generalised to semantic standards (Folmer and Verhoosel 2011). This requires additional study.

- In their article, Singh and Dahlin (2009) discuss competing standards as potential local optima in a standards convergence trajectory. The idea of looking at standardisation as a two-phased step is an interesting one – although to my knowledge still foremost theoretical. Further research on its applicability and past occurrence is recommended.

- In standards wars, sometimes the structure of a market changes so much over time that the war dissolves. An example is the war between Tetra and Tetrapol, which ultimately ended by a merger of companies (Hommels and Egyedi 2010). This confirms that market structure (e.g. number of standard implementers in the CAMSS and Dutch procedures) is indeed a crucial selection criterion and warrants more elaborate study.

- An open eye should be kept for the usefulness of - erstwhile proprietary - product specifications. These may change status and become committee standards (e.g. PDF/ A) or

change ownership status (acquire a public license, e.g. GPL as a defensive mechanism). Little systematic insight exists about such shifts in status and their impact on the market.

- A follow-up report is recommended in which the line of reasoning introduced in this report is applied to a series of case studies of competing standards.

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## Appendix I: Standards War between ODF and OOXML

On request, a case study on competing standards in the field of document formats has been included for illustrative purposes. It is based on Egyedi and Koppenhol (2009, 2010).

In 2008 the Joint Technical Committee 1 of ISO/IEC that focuses on IT standardisation, JTC1 in short, accepted a second standard for document formats (Office Open XML, ISO/IEC 29500). This OOXML standard was based on specifications from Microsoft. It was accepted despite JTC1's publication of a very similar standard for document formats two years earlier: the Open Document Format (ODF, ISO/IEC 26300).

### *Rival Technologies*

The OOXML technology addresses the same problem and does not substantially differ from the ODF technology. More in detail, the ODF standards effort aims to store in XML[16] the digital documents made with word processor, spread sheet, or presentation software. The advantage of doing so is that this makes the documents independent of the software used to create them. For example, if software A and software B both use the same document format Y to write and read electronic documents, it becomes much easier for users to switch to the other software provider and for users of different software programmes to exchange documents. ODF explicitly supports supplier independence[17]. Moreover, an important side-effect of encoding documents conformant to an open, public standard is that it allows one to retrieve their content irrespective of possible future changes to the software –proprietary or otherwise. If access to 'old' document content depends on whether or not a commercial software provider upholds backward compatibility, this provider in practice 'owns' the data. A standards-based vendor-neutral IT-environment helps to secure the future accessibility of digital content (e.g. property documents and cultural heritage included). This is referred to as *digital sustainability*. Applying XML in software products thus increases the digital sustainability of electronic documents.

Supplier-independence of consumers is especially important in the case of *civil* ICT standards (Updegrove 2008), that is, for standards that affect information exchange between government and citizens (e.g. e-government services). In such situations the government will not want to bias the market by prescribing certain software.

Microsoft's argument to initiate a second very similar XML-based standard in JTC1 was that the legacy of existing Microsoft Office documents had not sufficiently been taken into account by ODF. OOXML was '[to be] fully compatible with the existing corpus of Microsoft Office documents' (ECMA-376 Part 1, Introduction, p. X). (I will not go into the (de)merits of this argument or what ensued[18],

[16] '[XML] markup encodes a description of the document's storage layout and logical structure.' W3C (2006). Extensible Markup Language (XML) 1.0. 4th Edition, W3C Recommendation.

[17] http://www.oasis-open.org/committees/office/charter.php

[18] For those interested in the OOXML standards process in JTC1 I refer to Egyedi & Koppenhol (2010). Of interest is also the blog of Alex Brown, who chaired the decisive international JTC1 meeting in 2008. He is

for it has no direct bearing on the principle implications of having competing committee standards. However, whereas according to certain economic theory competition with the existing ODF standard could be assumed to give an extra quality impulse to those working on OOXML, such an effect was not observable[19].) Eventually, the OOXML standard was approved as ISO/IEC 29500 in November 2008.[20]

### *Implications of Competing Committee Standards*

The principle of document formats is not easy to understand for a layperson. Having two standards in this area makes it worse. Figure 1 illustrates the problem in a simplified way. If there were only one standard Y and the two hypothetical software suppliers A and B would adopt it, the documents that comply with document format Y would be readable and processable irrespective of the software supplier. However, if document format Z were also standardised, each software supplier would need to include a plug-in to access (read) and write documents that are differently formatted or install a document converter. As noted earlier, solutions such as converters and plug-ins come at a cost (see section 3.4).

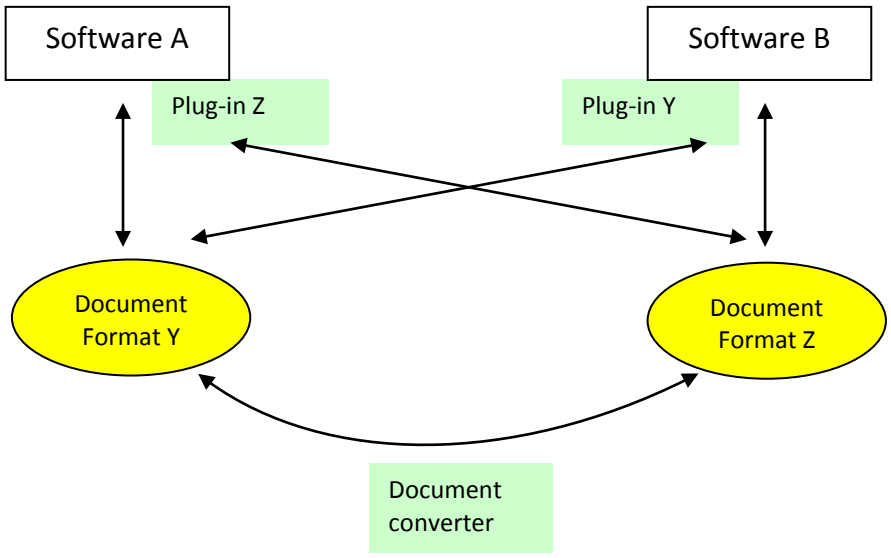


**Figure 1:** The interoperability implications of having two standards on document formats (Y and Z) in the simplified case of having only two software suppliers.

Two largely overlapping standards undo the full advantages of standardisation. The implications discussed earlier arguably also apply in this case. That is, having two points of reference is confusing and expensive. It decreases interoperability and raises transaction costs (e.g., inefficiency of document handling). In the period of competition the arrival of a second standard (here: OOXML) supported by a dominant player, is likely to lead to uncertainty among other software developers, possibly a higher barrier to enter document format-related market niches, and a hold up of

disappointed that by 2010 Microsoft has not itself yet implemented the OOXML standard it contributed to JTC1 despite promises to that effect (http://www.adjb.net/post/Microsoft-Fails-the-Standards-Test.aspx).

[19] More than a thousand serious comments on the OOXML standard had to be dealt with during a key JTC1 meeting. (participant observation of JTC1 committee meetings by Aad Koppenhol)

[20] Meanwhile Microsoft has stated its willingness to actively support the ODF standard (http://www.microsoft.com/presspass/press/2008/dec08/12-16implementationnotespr.mspx).

investments in ODF. The duplicate efforts in standardisation demand extra time and money, resources that cannot be dedicated to software development and innovation (e.g. e-government services). Additional resources are side-tracked to overcome incompatibility (plug-ins) and develop converters. Not least, the advent of OOXML is likely to prolong vendor lock-in (i.e., high costs and higher barrier to exit) and to lessen the sense of urgency needed to address the issue of digital sustainability.

| **Standards** | **ODF** | **OOXML** |
|---|---|---|
| Originally submitted by | Sun Microsystems[21] | Microsoft |
| Standards consortium | OASIS | Ecma International |
| XML-based | Yes | Yes |
| Aim of supplier independence | Yes | No |
| ISO/IEC standard | ISO/IEC 26300 | ISO/IEC 29500 |
| Year | 2006 | 2008 |
| ISO/IEC standard corresponds to | OpenDocument v1.0 Specification<br>(OASIS May 2005) | ECMA-376 2nd edition (Ecma, Dec. 2008) |
| Accelerated ISO/IEC JTC1 procedure | Publicly Available Specification (PAS) | Fast Track |
| Access to accelerated procedure | Recurrent requirement for OASIS to be approved as PAS submitter | One-time application by Ecma for A-liaison status |
| Ballot period | 6 months | 5 months |

**Table 5:** Comparing ODF and OOXML (Source: Egyedi & Koppenhol, 2009, 2010)

Where governments take JTC1 to be a trusted source of public standards, they may feel forced to support both standards. Apart from being inefficient, a twofold implementation increases the costs of e-government. That is, citizens must ultimately bear the costs of lack of industry and SSO coordination – e.g., costs of inefficiency, higher costs of IT use, and higher taxes for government IT projects.

[21] http://lists.oasis-open.org/archives/office/200212/msg00003.html

### *Failure of coordinative governance in standardisation*

Committee standardisation is an alternative coordinative mode of market governance. Market players participate on a voluntary basis to develop standards within a set of rules. These rules vary (slightly) across standard setting organisations.

The ISO and IEC have an international reputation for conducting a fair process, striving to involve all relevant stakeholders and promoting consensus decisions. Having a formal ISO/ IEC status usually implies that the standard is widely supported and stable. Also externally developed specifications like ODF and OOXML can acquire a formal ISO/IEC status. To achieve this, they need not undergo the normal, lengthier committee process in full. Two very similar short cuts exist to accelerate the JTC1 process, i.e., the Fast-track procedure and the Publicly Available Specification (PAS)-procedure. See Table 5. These procedures have been installed to heighten the visibility of already well-accepted specifications which, because of their maturity, are not expected to undergo (m)any changes. In the case of ODF and OOXML, the benefit of fast tracking for companies is not only a means of marketing their specification but also a means to more easily acquire access to the considerable market of public procurement[22] (Egyedi 2001).

In the case of OOXML standardisation, JTC1 did not live up to the reputation of its parent organisations ISO and IEC. First, the OOXML specification submitted for fast tracking was not mature. To have nevertheless proceeded, has made JTC1 vulnerable to accusations of serving single industry interests and rubberstamping (i.e., too easy ratification of externally developed specifications). NB: In the past also other standards bodies like the ITU and standards consortia like W3C (Rada 2000, p.22) have been accused of 'rubberstamping' (Besen and Farrell 1991).

Second and most relevant here: ending up with two very similar rival committee standards casts doubt on JTC1's effectiveness in coordinating the IT market and providing a real alternative to market processes.

[22] According to estimations, public procurement covers 16 - 30% of the IT market in Europe.