THE POWER TO STANDARDIZE

Standards development organizations and the strategic preferences of companies

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Occam's razor has its limits; I share a propensity for complexity.

Though the medieval philosopher William of Occam admonished us not to increase, beyond what is necessary, the complexity required to explain phenomena; this principle has only limited applicability as a guide for living a full life.

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List of abbreviations

API	Application Programming Interface
CSS	Cascading Style Sheet
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IG	Interest Group
RFC	Request For Comment
SDO	Standards Development Organization
TC	Technical Committee
URL	Uniform Resource Locator
WG	Working Group
XML	eXtensible Markup Language

Frequently mentioned standards organizations

CCITT	Comité Consultatif International Télégraphique et Téléphonique (now ITU-T)
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
ISO	International Standardization Organization
ITU	International Telecommunications Union
JTC1	Joint ISO/IEC Technical Committee
W3C	World Wide Web Consortium

Note: an overview of all standards development organizations in the realm of web technology can be found in appendix I.

1. Introduction

Where it was traditionally only an area of technical specialists, compatibility standards have since moved to the realm of strategic management. Compatible products can reap the benefits of *network effects* or *positive network externalities*. The larger the network of compatible products, the larger the benefit is for consumers and producers to be part of that network. In telecommunications, network effects are clearly visible. Email and telephone are prominent examples. Technologies can become compatible (or standardized) by several different processes, Schmidt & Werle (1997) analytically distinguish three: by governments, by the market, or by committees. This thesis will focus on committees, although we do not ignore market (*de facto*) standardization.

Committees can be explicitly institutionalized or more informal in nature, as long as its mission is to cooperatively develop standards. In general, decisions are made by way of consensus. Standard developing organizations (SDOs) are an example of committee-based standardization.

This thesis focuses on standardization of web technologies. These are roughly described as communication technologies that rely on the TCP/IP protocol and/or the HTTP protocol for network transport. Although there is a blurred line between web technology and other communication protocols, technologies that utilize the web as a platform of communication are the main focus. In this field, it is increasingly common for firms to join one or more SDOs in order to develop standard technologies and sponsor adoption of standards (Axelrod et al., 1995). In 1990, Andrew Macpherson counted about eighty international telecommunication standards organizations. With the rise of the internet as a commercial platform, the number of SDOs has increased accordingly. The multitude of SDOs and its plethora of members indicate the growing strategic significance of compatible web standards.

Interconnectedness is paramount for the internet to function, and compatible technologies form the basis of it. Besides the goal of interconnectivity and compatibility, standardization can be viewed as having multiple functions:

amplification of the sophistication of technologies[1], coordination of the development of technologies (Farrell & Saloner, 1988; Schmidt & Werle, 1997), and reduction of transaction costs (Reddy, 1990; Voelzkow, 1995). Additionally, it offers companies a level playing field for the high-stakes strategic standards game, where rewards *can* be very high. The business environment in which companies operate that sell products that are subject to network effects are so-called *network markets*. These are typified by its winner-takes-all (Shapiro & Varian, 1998) or winner-takes-most (Liebowitz, 2002) nature, based on the economic effects of network externalities.

Presently, the strategic relevance of standards is elevated because network markets are progressively more driven by the demand side (Shapiro & Varian, 1998). People increasingly whish to participate in networks that allow them to share databases, have access to large selections of compatible software, exchange documents, combine products made by different vendors, or simply communicate directly (Besen & Farrell, 1994). The business community progressively stresses the importance of standards. Ray Lane, former CEO of Oracle, states:

> *[Customers] want standards-based software that doesn't require the labor expenditure of the past. Software CEOs have two choices: They can try to impose their proprietary methods on the market or they can adopt a new service-based approach to providing and maintaining software.* (Southwick, 2004)

At the launch of a new web security SDO, Stratton Sclavos (2004), CEO of VeriSign, noted that one of three imperatives for the internet security industry is

> *Open and interoperable standards for strong authentication of everything.*

And added:

> *You will see more standards. This is about creating standards that drive adoption so that we all benefit from a lower cost infrastructure for security.*

[1] It is very common for technologies to be enhanced quickly by way of stratification and modularization. The TCP/IP protocol for example has seven layers, which are modules that are built on top of each other; all modules have room for improvement while staying compatible with the other layers.

Many more company statements can be found concerning the importance of open standards in the area of web-related products and services. These facts combined vouch for statement that open standards development is a *hot topic* nowadays.

The multitude of SDOs in the field of web standardization indicates numerous standardization processes. Consequently, firms have to make resource allocation decisions concerning SDOs. They have to decide whether to become a member of an SDO or not, and, if they are a member, what amount of resources (time, money, people) to spend on an SDO. A variety of factors influence the value proposition of membership of an SDO. The eventual goal is profit maximization by creating a large installed base of users to reap benefits of network effects (David & Greenstein, 1990). However, the profit incentive is a bad measure when making resource allocation decisions for SDOs. According to Axelrod et al. (1995), a firm cannot know a priori:

- whether a standard will become successful
- how profitable the standard will be
- what proportion of any profits the company will garner

Therefore, Axelrod et al. (1995) use a utility maximization function. A firm's preferences for alliances serve as an approximation to a profit maximization strategy. For complex alliance composition problems, it is virtually impossible to determine complete pay-off functions as game theory traditionally requires. Instead the predicted alliance configurations are simple Nash equilibria based on the assumptions of preferences of firms (Axelrod et al., 1995). This thesis will follow this line of reasoning and will therefore not develop game theoretic models. The focus will be on the firm's preferences for SDOs, and factors that influence it.

Characteristics of SDOs are partly shaped by their behavior vis-à-vis other SDOs. Today, most of the SDOs in the field of web technology have liaison relationships. These prevalent ties indicate that many SDOs have overlapping efforts and/or interests. The network of connected organizations makes a pure economic analysis quite intricate. Therefore, we will additionally take a transcending view of the connected organizations in the market. We consider them as actors in a social-like network. It lets us to define the concept of *network characteristics*. These are

distinctive traits that an SDO displays as it interacts with other organizations in the network. Characteristics like power and prestige are examples. We look at *network characteristics* in conjunction with the model of *sequential adoption*. Genschel (1997) describes in this model how standardization is a process *within* the SDO, as well as *between* SDOs.

The significance of coordination and collaboration between SDOs is the focus of this thesis. Especially network characteristics will influence the level of success in dealings with other SDOs. We investigate what traits of SDOs are preferred by companies that are making resource allocation decisions with regard to SDOs. Hence, the subject matter of this thesis can be summarized in the following central question: ***which network characteristics of SDOs do companies prefer?***

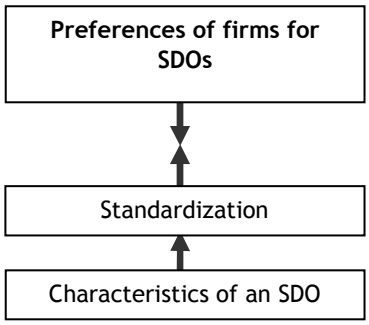


Figure 1 – SDO characteristics, standardization, and preferences of firms

The characteristics of an SDO – including network characteristics – shape the standardization process. In this respect, standardization is a visible manifestation of the characteristics of an SDO. How this standardization process matches the strategic preferences of firms is the main question here. This issue is quite broad, hence our focus on interactions between SDOs as a part of the overall standardization process.

For a thorough understanding of the question at hand, first standardization literature and social network analyses are reviewed. Besides an economic overview of standards and network markets, the process of standardization is discussed. The few empirical studies of standardization and the great number of 'modeling exercises [which] have run well ahead of the solidly established fact base' have almost exclusively had an economic or econometric foundation (David & Greenstein, 1990; Schmidt & Werle, 1997). Game theoretic settings are commonly used to explain standardization in monopolistic or oligopolistic constellations. Hence additionally, literature on social networks is reviewed to shed light on the dynamics in networks of connected actors.

Secondly, the practical part will be formed by a research done at the World Wide Web Consortium (W3C), a standardization organization for web technologies.

Research performed in November/December 2002 assessed the value proposition of the W3C membership of the international members. In addition, we present an analysis of 48 SDOs in the area of web technologies and its connections. This network is analyzed with methods from social network theory. The practical research must be seen as an addition and practical elaboration of the theoretical part.

This thesis is divided into five sub-questions, which lead to an informed and structured discussion of the topic and lets us answers the main question and the end.

1. How can the business environment be described? *An introduction to standards, network markets, and standardization.*
2. What are the different tactics a firm can pursue to push its *own* technology in the market? *An elaboration of de facto standardization.*
3. What are the dynamics in networks of firms and coalitions, and how do they influence the preferences of firms for SDOs? *A discussion of cooperation strategies in standardization, and a review of social network analysis.*
4. Who are the players in web standardization, and how do they interact?
5. Case study at the W3C: How do members of the W3C assess the value of W3C's mission, methods, products and services?

The organization of this thesis goes from general to specific and from theoretical to practical, hence first laying a base in terms of terminology and understanding. From there, we build to more specific cases.

2. Standards and standardization

2.1 Introduction

The economic value of many products in the economy is influenced by its aggregate consumption in the market place. Usually, the value increases as the amount of products sold rises. As said before, this is called *positive network externalities*, or *network effects*. The term *externality* is used because external factors can influence product valuation. Besides total number of products in the market place, the amount of related or complementary products in the economy is also an influential factor. Related products can have strong or weak ties to the product, and can be directly or indirectly compatible with the product.

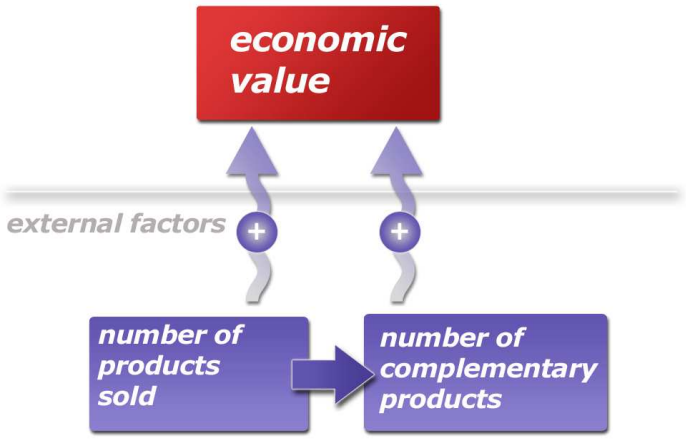


Figure 2 – The influence of network externalities on the economic value of a product

For example, the valuation of a washing machine – besides its actual features and capabilities – is also influenced by the number of washing machines sold of that brand and of that type. This influences the availability of spare parts, suitable detergents, and knowledgeable repairmen (Economides & Skrzypacz, 2003). Another example is email, the existence of more people with email addresses leads to higher valuation of an individual email account.

Nearly every good is in some way connected to other goods with which it has a relation; it is in a (virtual or physical) network, and is influenced by network effects[2].

[2] For an elaborated discussion of network effects, see Katz and Shapiro (1985).

The strength of the network effects varies, from weak (the washing machine) to strong (email).

Many businesses in the high technology sector operate in an environment where network externalities exist. What this means for the business environment will be discussed in this chapter. Before we begin to analyze the literature on standardization, a primer on standards and network markets is given. Hereafter, we will follow the framework of Chiesa & Toletti (1998) and its three dimensions of standardization. A standardization strategy is here intended as the set of decisions concerning tactics, timing and forms of co-operation (Chiesa, Manzini, & Toletti, 2000). Chiesa & Toletti (1998) argue that companies consider these systematically distinguished dimensions when they deem standardization necessary. The overall standardization strategy consists of elements of all three dimensions. Additionally, all these dimensions have an influence on each other. However, this is not considered here.

Figure 3 – The standardization strategy (Chiesa & Toletti, 1998)

The first two factors will be discussed in this chapter; the dimension of cooperation is discussed in the next chapter combined with an overview of social network theory.

2.2 Standards

The term *standard* is understood here as 'a set of technical specifications adhered to by a producer, either tacitly or as a result of formal agreement' (David & Greenstein, 1990). The process of standardization is the pursuit of this conformity, with the objective of increasing the efficiency of economic activity. However, standardization can and does occur without formal promulgation as a 'standard' (Tassey, 2000). The term standard is used ambiguously, and is defined different by different parties[3]. Hence, its meaning depends on the context in which it is used.

Standards can be organized according to various characteristics. David (1987) bases his three-layered taxonomy on an economic perspective. Baskin, Krechmer, & Sherif (1998) add a fourth layer, and the consolidated model can be seen below. These layers represent basic standards (reference standards) to more sophisticated standards (etiquette standards).

Figure 4 – Four-layered taxonomy of technical standards (Baskin et al., 1998; David, 1987)

Web standards are mostly compatibility standards; they define the interface with which to communicate. There are exceptions, such as character encoding[4], which is more a basic reference standard. Compatibility implies that there are multiple nodes in the network that must act together in some way; being compatible. This means that there are agreements between different parties within the network to use certain standards for certain tasks. In networks, changes in one part of the network can lead to

[3] The World Wide Web Consortium for example calls its approved web technologies not *standards*, but *recommendations*. Companies however play more loosely with the term *standard*; it acts more as a marketing tool as it tends to increase trust for consumers.

[4] Character encoding is the way natural language characters are represented in bits (ones and zeroes). As the web is truly world wide, there has to be a way to represent all international 'alphabets' in bits, from the Cyrillic to the Thai.

changes in other parts, creating dynamics that are specific for so-called network markets.

2.3 Network markets

Network markets are defined as markets where users want to buy products compatible with those bought by others (Besen & Farrell, 1994). The users of these compatible products will form a virtual or physical network, which is characterized by network externalities. Although this concept is not new to the economy, the information age has seen its vast prevalence[5]. Shapiro et al. (1998) note that while the old economy was driven by economies of scale, the 'new' information economy is driven by economies of networks. The economics of networks are mostly *not* characterized by the supply side, as is the case with economies of scale, but by the demand side. In network markets it simply pays to be part of a large network. Companies that attempt to create a large market for their information goods will be subject to the notion of increasing returns. Increasing returns denote that if something is ahead, it will benefit from that and get further ahead. The initial gain acts as a positive feedback for additional gains, making the positive feedback even stronger, and the gains larger. This also holds for the opposite side, positive feedback makes sure that products that are on the decrease will decrease even more. Positive feedback is the key concept in network markets. Arthur (1990) argues that in network markets stabilizing forces do not appear to operate as they do in industries with decreasing returns. Subsequently, there is no way of knowing what equilibrium will form. Sometimes small influences (either in reality or in perception (Besen & Farrell, 1994)) can have large outcomes because of decisions that prove to be path dependent[6]. While much of the economy is subject to decreasing returns, predominantly knowledge based industries are typified by increasing returns. In Arthur's (1990) view, the analysis of industries with increasing returns should be seen as a dynamic process with random events, and with natural positive feedbacks or non-linearities.

[5] For a historical background on the notion of information as an economic good, see the historical note at the end of this thesis.

[6] Initial actions, perhaps insignificant ones, do put us on a path that cannot be left without some cost (Liebowitz & Margolis, 1995).

Arthur (1996) identifies three underlying mechanisms of increasing returns in high-tech industries. First, network effects, are discussed above. Second, up front costs are high. Many products are heavy on know-how and light on resources. This leads to high initial costs, and subsequent unit costs that drop as sales increase. Thirdly, customer groove-in is an influential factor. Customers can be locked in, which is a situation where consumers are seemingly unable to switch to other products because it may be too costly – in a monetary and non-monetary sense. Losing compatibility may be not preferable either. Besen et al. (1994) add that history matters in this sense. Because consumers may prefer compatibility, they may defer from buying better products that arrive later. Liebowitz (2002) rightly points out that network effects play a key role in lock-in effects.

While the idea exists that it is better to be part of large network, it is actually the future size of the network that is of influence (Economides, 1996). Users try to estimate how large the network *will* be. They do this based on the installed base and the fact whether the product is winning or losing. Take for example the usage of word processors. In the early days of desktop computing WordPerfect was adopted by many users. Because of the network effects and subsequent positive feedback, WordPerfect became the de facto standard in word processing quickly. In the late 1990s however, Microsoft Word won market share. Little by little WordPerfect began to loose its user base and consumers saw it; they also saw MS Word winning. This eventually resulted in MS Word being the de facto standard nowadays. Success begets more success, which is the notion of positive feedback and can be seen from this example. Besen et al. (1994) characterize network markets as *tippy*, because the coexistence of incompatible products may be unstable. Hence, positive feedback leads to a market with (temporary) monopolies, as it leads to extreme outcomes: the losers loose as the winners win.

Concluding, the literature on network markets and positive feedback sees a highly dynamic market with (small) forces that can lead to extreme outcomes. It perceives standardization as promulgation of a dominant design, which can be hard to predict in advance. Because of the volatile network market, firms apply tactics that would increase their chance of success in the market place.

2.4 Tactics in standardization

One of the three dimensions of a standardization strategy as identified by Chiesa & Toletti (1998) is *tactics*. The term tactics is referred to as the different ways a firm can pursue to press the market to adopt its own technology as a standard (de facto standardization). These tactics describe situations where companies *do not* participate in committees to develop and standardize technologies. Although some of these tactics can be referred to as strategies, its focus is more short term than long term. Companies can selectively use some of these tactics dependent on its product, competencies, *etc* to 'assemble' its overall standardization strategy. While this thesis mainly focuses on firms that (are considering to) participate in an SDO, we cannot ignore the fact that many companies are developing technologies without any interference of an SDO. Or, as Schmidt et al. (1997) say it: 'No committee in the world can prevent market standards from evolving or simply replace them with its own products. And nobody can force a firm to get involved in committee work or to devote its strategic potential exclusively to collective standardization'. Hence, this literature analysis functions as a backdrop of current practices seen in the market today. Moreover, many companies apply hybrid strategies of committee and market standardization. Therefore, an understanding of de facto standard setting in the market is relevant.

From the literature, five tactics seem to be most common (Arthur, 1996; Axelrod et al., 1995; Besen, 1992; Besen & Farrell, 1994; David & Greenstein, 1990; David & Steinmueller, 1994; Farrell & Gallini, 1988; Grindley & Toker, 1993; Katz & Shapiro, 1994; Langlois & Robertson, 1992; Schmidt & Werle, 1997; Shapiro & Varian, 1998):

1. second sourcing
2. building an early lead
3. influencing forecasts of future sells
4. attracting the suppliers of complements
5. price commitments

Second sourcing – This tactic is used by companies letting competitors into the market by licensing a technology at low royalties or by using an *open architecture*

(Katz & Shapiro, 1994). These so-called RAND (reasonable and non-discriminatory) conditions can be seen in many products. For example, the *x86 instruction set*, a technology for microprocessor architecture, is licensed by Intel to its competitors. Licensing fees are paid to Intel, and because of its endemic adoption became a standard. Second sourcing is also a way of gaining trust of the users (Farrell & Gallini, 1988).

Building an early lead – Because network effects dictate that users are more willing to join a large network, building a large user base quickly is a strategy that can be profitable for companies. It increases the likelihood of becoming the standard. Especially in markets where sales or the amount of user are highly visible, this tactic is effective. Shapiro & Varian (1998) argue that the best way to secure a leadership position is through an early presence in the market, combined with a willingness to cut prices and margins in the short run. This strategy reaps the full benefits of network effects and consumer lock-in. Being first however, is not at all essential notes Liebowitz (2002), he calls it 'a truly pernicious bit of faux wisdom'. He sees two kinds of lock-in, weak and strong, where in the case of the former, first-movers do not automatically win; weak lock-in is quite easily overcome, as self-compatibility seems pivotal. Moreover, he does not see any evidence of 'first-mover wins' in the case of strong lock-in; products are commonly supplanted by superior equivalents.

Influencing forecasts of future sells – It is not the actual size of the network that is key to network effects; it is the *future* size of a network. Firms can try to influence future sales of its product. For example, MS-DOS was not the epiphany of technical superiority, but the fact that IBM supported it yielded enough trust to expect great profits. Technology that is *expected* to be the winner can really become the standard; it is a typical situation where there are self-fulfilling forecasts (Chiesa et al., 2000). Product preannouncements are another way to psychologically influence the consumer. By communicating that innovating products will be launched, a firm can discourage users to buy from the competitor (Farrell & Saloner, 1986).

Attracting suppliers of complements – Network markets exist of networks of compatible products. Complementary goods play an important role as they can leverage the adoption of a certain technology. This is the reason, for example, that

IBM and Microsoft encourage independent developers to write software for their operating systems (Besen & Farrell, 1994). Arthur (1996) has a slightly different approach. He argues that technological products exist within logical groupings of products that support and enhance them; they exist in mini-ecologies. A strategy that uses the notion of ecologies is linking and leveraging. This means transferring a user base built up upon one node of the ecology to neighboring nodes or products.

Arthur (1996) sees technological ecologies as the basic units for strategy in the knowledge-based world, players compete by not locking in a product on their own but by building *webs* – loose alliances of companies organized around a mini ecology – that amplify positive feedbacks to the base technology.

Price commitments – A public commitment to low prices over the long term is another way to convince prospective buyers that they will get large benefits from joining a particular network (Besen & Farrell, 1994). Commitment can be explicitly stated in long-term contracts or more implicit through public communications.

2.5 Timing in standardization

Categorizing timing in standardization basically comes down to classifying standards as *ex-post* or *ex-ante* (Chiesa et al., 2000). If the technology was standardized before the introduction to the market it is called *ex-ante*, in the other case it is called *ex-post*. The decision to standardize ex-ante is closely related to the decision to collaborate with other firms (the other dimension of standardization strategy). It is virtually impossible for firms to succeed in ex-ante standardization without an agreement with potential competitors. Ex-post standardization on the other hand happens when a firm is successful at imposing its technology on the marketplace unilaterally, creating a de facto standard.

Baskin et al. (1998) build on the aforementioned notion, and use the terms *anticipatory standards* and *responsive standards*. They add a third type of standard as well, the *participatory standard*. The three types are distinguished by the timing of the standardization effort. Subsequently, this influences their characteristics accordingly. The timing is positioned according to a product cycle as can be seen from the figure below.

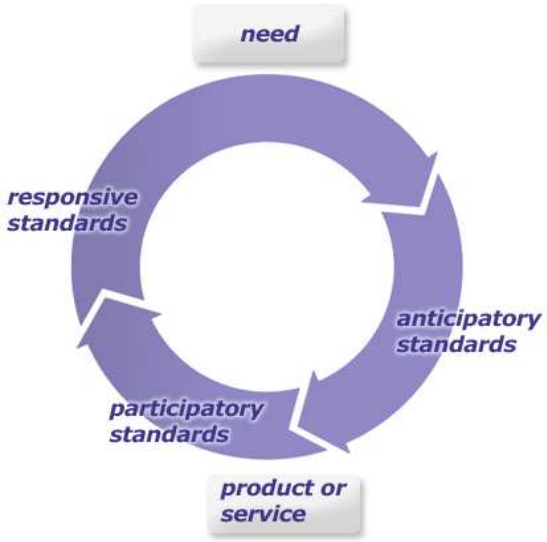
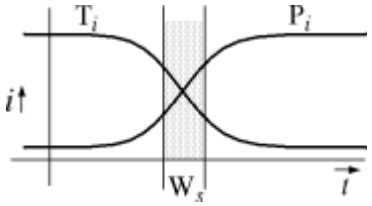


Figure 5 – Standardization position in the product cycle (Baskin et al., 1998)

Understanding a product or service starts with the notion of a need, this can lead to development of technology and subsequent standards, which can lead to the actual product. This can in turn lead to responsive standards and a subsequent (new) need.
Anticipatory standards are comparable to ex-ante standards. They are created before widespread acceptance of the device or service. Noteworthy to say, is that anticipatory standards can be developed within SDOs, just like participatory standards. Baskin et al. (1998) note that participatory standards are developed, tested, and used in an interactive environment. Standards are not agreed on before a working prototype has been constructed. As the development proceeds and new knowledge is created, standard proposals can be changed. Hence standardization proceeds in lock-step with implementations that test the specifications before adopting them. These are developed in standards development organizations. Most of the SDOs assure quality by implementation or prototype experience.

Responsive standards – equivalent to ex-post standards – are a way for companies to get their technology 'recognized' as a standard after introduction in the market place. Firms might want to do this in official SDOs to codify the reality that it is widely used, or to allow its reference in future work. Overall, 'responsive standards offer a systematic way of distilling scientific information and available data into useful technical constructs. They expedite the consolidation of knowledge and provide avenues for sharing technical know-how.' (Baskin et al., 1998 p. 11)

Because the boundaries between the three kinds of standards seem vague, a discussion of the underlying mechanisms may clarify concepts. In his internet essay, Gosling (1990) analyses phase relationships in standardization[7]. He quotes Toshi Doi of Sony who describes the standardization process in terms of the level of *technical* and *political* interest in time. As time passes, technical interest declines as the technology becomes understood. Similarly, generally fueled by economic pressures, the political interest in a technology increases as can be seen in the diagram below.

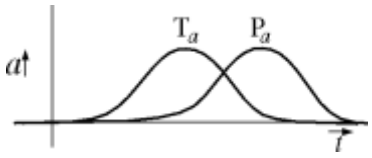


t = time
i = interest
T_i = technical interest
P_i = political interest

Figure 6 – Technical and political interest in standardization (Toshi Doi)

For a standard to be usefully formed, the technology needs to be understood: technological interest needs to be waning (Gosling, 1990). However, if the political interest becomes too big, the different parties have too much at stake in their own vested interest to be flexible enough to accommodate the unified view that a standard requires. Therefore, in this model there is a so-called window of standardization (W_s) where the technology is understood, but the political situation has not become too hotly contested for constructive negotiating.

Gosling (1990) explores this model even further by transforming the open ended technical and political *interest* in the diagram into bell-shaped curves of technical and political *activity*. The resulting graph shows two phases of activity that proceed in different intensity. It is assumed that technical activity precedes political activity. The resulting graph is shown below.

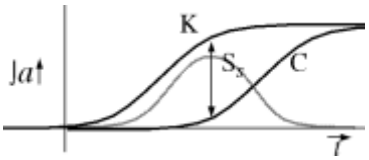


a = activity
T_a = technical activity
P_a = political activity

[7] This essay is not published anywhere besides on his personal website. Moreover, he quotes Toshi Doi, but fails to give the source. His essay is nevertheless included because it gives some insights that are nowhere else to be found in the literature. However, the validity of these insights may be questioned. Further academic analysis of this subject would be worth pursuing.

Figure 7 – Technical and political activity in standardization (Gosling, 1990)

As these activities proceed, they produce results. The *result* curves are the integrals of the *activity* curves. The diagram is shown below.



K = knowledge
C = calcification
S_s = sensibility of standardization

Figure 8 – Knowledge, calcification, and sensibility of standardization (Gosling, 1990)

The resulting integrals show knowledge (K) and calcification (C). Calcification is the result of political activity. The term reveals some personal sarcasm from Gosling, who is biased against too much political interference in technological development. The basic notion is that interference from managers, in their role of corporate *politicians*, can have a lethargic effect on technical development. When the focus shifts from technical to commercial aspects, inflexibility is introduced. When calcification is subtracted from knowledge (K-C) the *sensibility of standardization* (S_s) is formed. Gosling argues that the optimum time for standardizing a technology is when S_s is at its maximum, which will be in a region where knowledge is high, but calcification has not yet set in. This is an elaboration of the aforementioned *window of standardization*.

If the models from Baskin et al. (1998) and Gosling (1990) are combined, one can analyze whether anticipatory, participatory, and responsive standards have their distinctive place on the S_s curve. Obviously, it depends on the specific circumstances of the standardization effort. But the underlying interest and resulting activities from different groups (technical and political) seem to be influences on the standardization process.

2.6 Conclusion of chapter 2

This chapter gave an overview of standards, network markets and two of the three dimensions of a standardization strategy: tactics and timing. It analyzed the literature on these subjects, and revealed gaps and contrasting views.

It showed that most high technology products in the economy are linked to one another through compatibility standards. Together with users, they form networks that show network effects. This is the main characteristic of network markets and is the cause of increasing returns. The resulting network markets are tippy as they can spawn (temporary) monopolies. In this unstable environment, companies have to apply tactics and consider timing issues when standardization is sensible. Five tactics where identified from the literature that companies can pursue to press the market to adopt its own technology as a standard. Additionally, timing issues were considered. Ex-post and ex-ante standardization were discussed and combined with a model that explored its underlying forces.

This chapter saw the high stakes and the high volatility of network markets. A fundamental question for firms facing horizontal competition in a network market therefore is whether competition to become the standard (competition for the market) will be more or less profitable than the competition within the market. The latter being a situation where standardization is done by agreement, creating a (seemingly) less volatile market. The next chapter will discuss cooperation.

3. Dynamics in networks of firms and coalitions

3.1 Introduction

The choice to collaborate with other firms is closely tied to a choice for compatibility. Chiesa & Toletti (1998) see choices in collaboration as the third dimension of a standardization strategy. This chapter will explore the dynamics present in networks of companies that are faced with rational decision making in a strategic environment. Game theoretic models are typically used in the existing literature to predict what coalitions will form in a given market. However, an inherent problem with these highly stylized models is its simplification. Because companies cannot exactly foresee the consequences of their actions, the outcomes of the complex interplay of sometimes antagonistic parties are hard to predict. Ray & Vohra (1999) say that before a firm enters a coalition, its plan should consist of a set of conditional statements that describe how the division of a coalition's worth occurs in every contingency. 'The notion of a contingency here is ambiguous: it could be as minimal as the simple realization of the coalition's worth, but, in principle, it could include information such as the process leading up to that worth, the coalition structure formed, the order of coalition formation, and so on. (p. 293)'.

3.2 Cooperation in standardization

Chiesa et al. (2000) distinguish two main typologies of cooperation: *developing* alliances and *sponsoring* alliances. The latter is situation where two or more companies join in order to agree on the sponsoring of a *pre-existing* technology. The focus of this thesis however will be on developing alliances, though not all literature makes this sharp division – some alliances will develop *and* sponsor technology[8]. Moreover, much literature on standards alliances focuses on the dynamics of formation, rather than the existing situation with a wealth of SDOs. Nevertheless, it

[8] In reality this division is also not sharp. Standardization organizations can rubber-stamp existing technologies (with or without minor adjustments) and claim the technology was developed *in-house*. Other SDOs will emphasize collaborative development, although no one can ignore the fact that (groups of) companies will try to introduce more or less developed technology to the standardization process.

gives valuable insights into the preferences of firms that are considering to join an alliance, or making resource allocation decisions when already a member of one or more SDOs.

The developing alliance falls roughly in the category of what Axelrod et al. (1995) call the *explicit* alliance. The prerequisites for the formation of such an alliance are the existence of a rapidly evolving technology, no dominant firm (Katz & Shapiro, 1985), or competing technologies. Besen et al. (1994) add that a need for compatibility is paramount, and formation of coalitions will be encouraged if a standards battle will likely dissipate potential profits. An explicit alliance allows the members to have input and control over the developing standard, it reduces R&D costs by spreading it over multiple companies, and it combines the variety of specialties of the members (David & Greenstein, 1990). Be it cooperation that lasts one episode, or committees that are more indefinite in nature, Farrell and Saloner (1988) see such careful and explicit cooperation as a natural response for the need for coordination. This is needed because the market sometimes fails to achieve standardization.

The strength of network effects has a pivotal role in the formation of coalitions (Economides & Skrzypacz, 2003). In markets with strong network effects, full compatibility prevails. The creation of, what Van Wegberg (2003) calls, a *grand coalition* is seen. As the network effects get smaller, more coalitions will form with unequal sizes. Axelrod et al. (1995) argue that these predicted alliance configurations are simple Nash equilibria, i.e., an alliance constellation in which no firm has an incentive to change to another alliance. Bloch (1995) also concludes that the alliances formed in an equilibrium are unequal in size and inefficient[9]. In the case of an industry-wide (*grand*) coalition standardization tends to be slower than a situation with a multitude of competing coalitions (van Wegberg, 2003). Though, competition between standards coalitions can dissipate some benefits of having a standard (Bloch, 1995; van Wegberg, 2003).

[9] Both Bloch (1995) and Economides et al. (2003) model a two stage game where in the first stage companies can choose affiliation with a coalition, and fight for the market in the second stage. In this setting, firms can exclude (potential) competitors from the alliance.

When it comes to preferences of firms for types of alliances Axelrod et al. (1995) and Economides (2003) have two basic assumptions: a firm favors joining a big alliance over a small one, and, the utility of joining an alliance reduces as rivals are present in the alliance, especially close rivals[10]. Firstly, a larger alliance has the benefit of larger network effects; the platforms with the most firms will be more valued by customers. The second assumption is based on the notion that competition from firms with the same standard is fiercer than competition across standards, because products based on the same standard will be less differentiated[11]. In other words, competitive advantage[12] will be less as rivalry between competitors is more intense, because of an increased threat of substitute products (Porter, 1986; 2001).

Thus, companies have to make trade-offs when making decisions about joining a standards coalition. Additionally, when they are member of an SDO, resource allocation decisions have to be made. Factors that will be of influence on these decisions are:

- size of a coalition
- presence of competitors
- standardization process

The standardization process will be shaped by three main factors: speed, efficiency, and intellectual property policy. The latter is an ever more important issue. How intellectual property rights affect standardization is described by Lemley (2002), Bekkers, Verspagen, & Smits (2002), Lea & Hall (2004), and Egyedi (2001) among others. This issue involves an interplay of companies and intellectual property laws

[10] Axelrod et al. (1995) divide companies as close or distant rivals. Companies compete more directly with members from their strategic group within the industry (close rivals) than companies outside it (Fiegenbaum, Hart, & Schendel, 1996; Caves & Porter, 1977).

[11] The literature does not take into account whether the technology is a significant or less significant part of the end product. For example, products with a standardized electrical plug can easily be differentiated.

[12] The idea of competitive advantage marks a departure from traditional economic thinking, which was focused on comparative advantage. Whereas comparative advantage is inherited (availability of basic factors of production, like cheap labor or energy, or natural resources), competitive advantage is created.

(in an international context) in the light of collaborative open standardization. Its complications are interesting, but not the focus of this thesis.

The abovementioned factors are summarized in this figure. Note that the standardization process, presence of competitors, and the size of an SDO almost certainly affect each other in various ways. We will however, not investigate these influences.

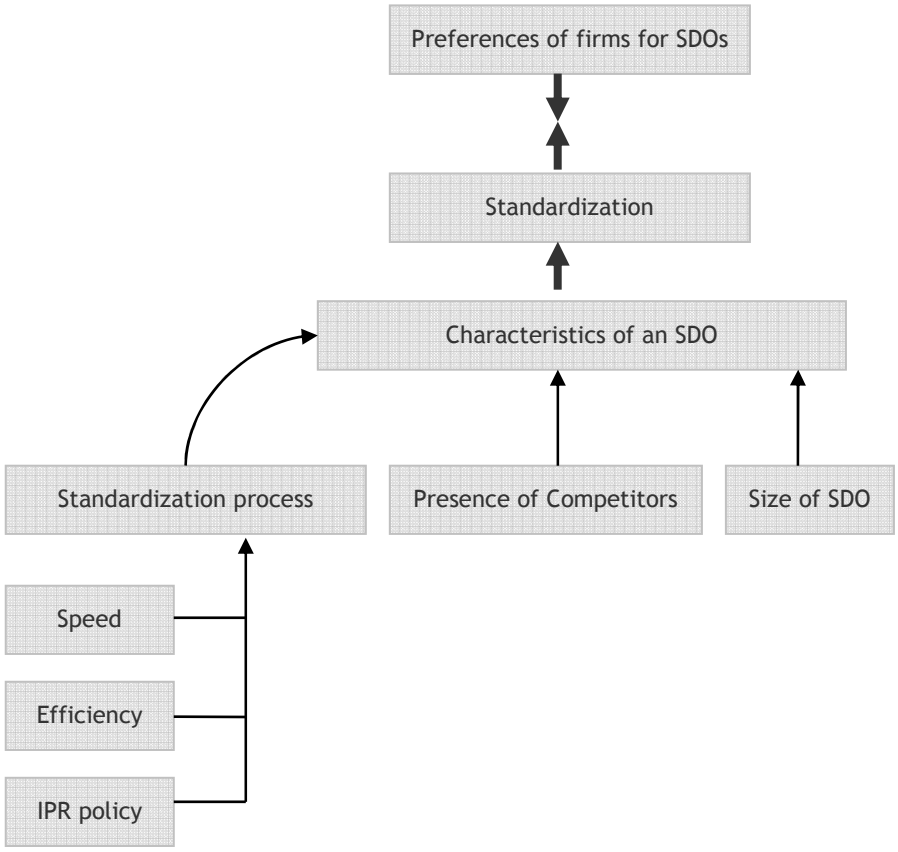


Figure 9 – influences on the characteristics of an SDO

3.3 Fragmentation of the standardization landscape

In the world of web technologies and its strong network effects, leading scholars foresee that coalitions to be industry-wide (Besen, 1993; Besen & Farrell, 1991; David, 1993; Economides & Skrzypacz, 2003). The co-existence of more than one standard-setting organization is assumed to be unstable and inefficient. This is, however, in contrast to reality. Macpherson (1990) counts about 50 standards organizations for international telecommunication. Recently, with the blurring lines

between telecommunication and computer technology its number has increased[13]. Genschel (1997) investigates this discrepancy between this so-called *natural monopoly hypothesis* and the organizational fragmentation of the real world.

In his paper the history of standardization in telecommunication is reviewed as a backdrop for explaining the current (stable) situation of a fragmented organization of standardization. From the 1970s on, standardization in telecommunication was beginning to fragment. The CCITT, a sub-unit of the International Telecommunications Unit (ITU), had up to then monopolized standardization. However, as telecommunications and computer technology were beginning to converge and the politics of de-regulation and liberalization took root in the US and UK, the position of the CCITT was undermined (Cowhey, 1990). In addition, the power of the national PTTs eroded as the telecommunications industry became more transnational (Genschel, 1997). Network operators started to form global alliances and compete in foreign markets (Bernard, 1994). At the same time, the variety of telecommunication services exploded (mobile communication, computer communication, paging, multimedia, *etc*) and transmission technologies multiplied (satellite transmission, optical cables, mobile communications, etc.)(Rutkowski, 1994). This had its effect on standardization; the CCITT lost its monopoly as other standards bodies entered the arena, especially in the field of computer communication where the lines of demarcation became blurred (Genschel, 1997). The process was accelerated throughout the 1980s and 1990s, resulting in a relatively complex situation of a multitude of standards organizations.

The underlying reasons for firms to abandon the centralized structure of one standards organization are spatial proximity, blocked reforms, and competition for market share (Genschel, 1997). First, the rush for standards, while being a worldwide trend, was primarily seen as a local problem. Interaction between industry players tended to group locally and players that were spatially close interacted more strongly. Therefore, when problems of technical coordination occurred, firms would prefer a regional SDO to a worldwide organization. Regional SDO would have the advantage of being quicker, more flexible, and more responsive to local needs.

[13] As an indication of the present situation, the next chapter shows 48 SDOs in the realm of web technology of which many are formed after 1990.

A second reason was the failure of the large standards bodies[14] to adapt to the new technical, political, and economic environment. Many companies criticized structure and procedures of these SDOs and were frustrated by excessive delays. Reforms were not imminent, because *veto-players*, i.e., actors whose concurrence is necessary for a policy decision, blocked reforms (Genschel, 1997). Hence firms set up their own organizations.

The third reason for groups of companies to arrange its own standardization was the possibility of excluding competitors. In the centralized setting before 1970, nobody had to fear from standards, they just served to facilitate international connections. Standard setting resembled a conflict-free *game of pure coordination* (Schmidt & Werle, 1997) as can be seen in the figure below.

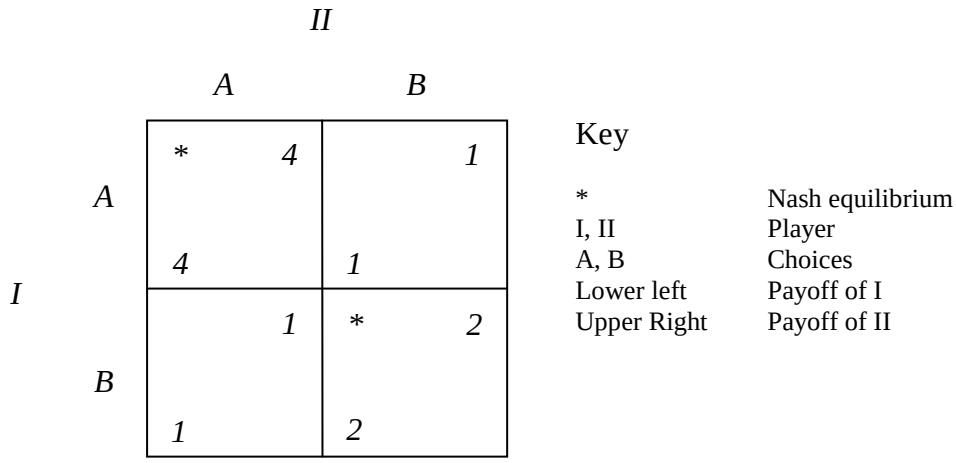


Figure 10 – Pure coordination (Genschel, 1997)

Parties prefer coordination to no coordination, and alternative options are equally valued. In this situation two market players (I & II) have the choice for two competing technologies (A & B). These choices render a payoff that depends on their choice. In this classic game theoretic setting, players do not know what option the other player will choose. Both players in this case will opt for strategy 'AA' as it gives them both the highest payoff. They both value one technology above the other, creating a predictable equilibrium. This equilibrium also has the highest combined payoff. However, if technologies are valued differently by different players, a less predictable situation emerges. This is what historically happened with changes in deregulation

[14] Such as the CCITT, the International Standardization Organization (ISO), and the International Electrotechnical Committee (IEC).

and internationalization resulting in a situation where the effects of standards became more ambiguous (Genschel, 1997). Higher dependence on standards and the possibility of a standards war let to a more competitive environment where standards gained strategic significance. The pure coordination game had therefore been altered to a *battle of the sexes game*. In this game, each firm prefers compatibility over rivalry, but they argue which technology should be the standard (Besen & Farrell, 1994). Individual interests are in partial conflict; individual rationality and collective rationality do not perfectly coincide (Schmidt & Werle, 1997; Swann, 1994). The resulting situation can be seen in the figure below.

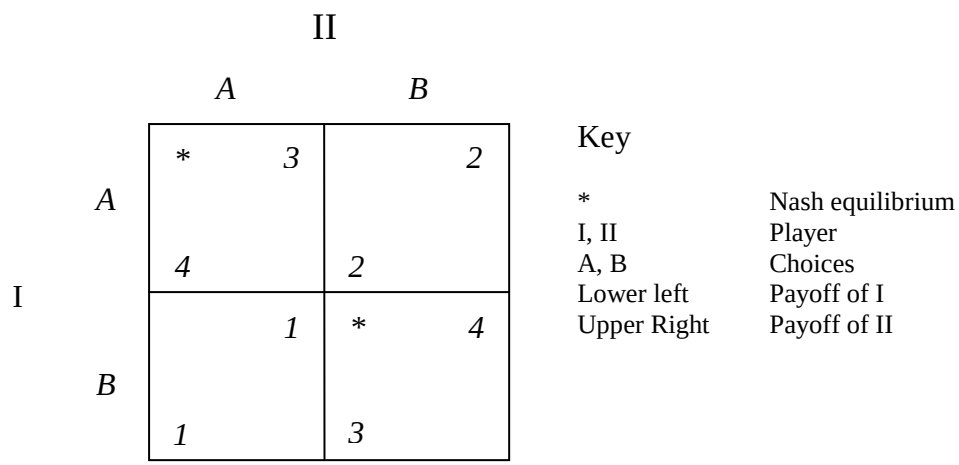


Figure 11 – Battle of the sexes (Genschel, 1997)

The new situation introduces coordination problems as actors have conflicting views. Either strategy 'AA' or 'BB' will prevail. Because of the increased strategic role of standards, firms can fight for market share by allying with like-minded actors to reduce bargaining problems and increase the chances in favor of their plans and priorities (Genschel, 1997).

3.4 Strategic options in a fragmented structure

The fragmentation maintained stable because 'the fragmented structure provides strategic options which would be lost if standardization was monopolized again. More specifically, the fragmented structure opens the possibility to strategically exploit *institutional bias*' (Genschel, 1997 p. 611). The term institutional bias notes the difference in composition and technical orientation of a particular organization. It is

an important feature because many SDOs do not have boundaries that are clearly defined; *jurisdictions* overlap as well as membership. Standards organizations never do exactly the same job with exactly the same people. The reason is that most players are highly specialized technically and locally (Porter, 1990; Schmidt & Werle, 1997), and participate only in those SDOs whose work is of immediate concern. Thus, companies have to allocate people and strategic potential to those standards organizations where they can be successful. The responsiveness to specific ideas and concepts will vary among SDOs as they differ in their institutional bias (Genschel, 1997; Riker, 1980). Where some ideas can fail in one SDO, it can be successful in another.

Hence, we move away from game theoretic dealings with competitors to pragmatic preferences of the individual firm[15]. When a firm is seeking a place to lay down or develop a technology, it will encounter players with different agendas and preferences. Firms may want to stick to certain ideas, while they can let go of others. However, because of the fragmentation, concessions have to be less severe. Companies can stick to a proposal even after it may have been dismissed by one standards organization. The supply of organizations with like-minded actors is not limited to one. Hence firms can permit to say 'no' to an SDO. The fragmentation and institutional bias thus provides a multitude of points of access to the standards process which allow actors to remain obstinate (Genschel, 1997).

How does standardization play out, given the fact that companies can *shop around* for SDOs until they find one that, when joining, will be most efficient in reaching their goal? Negotiation is always an inherent part of standardization, but in a fragmented structure, it tends to be more compartmentalized. Different sub-groups will develop standards independently in different SDOs. Rather than in a monopoly standards organization, where conflicts would be more likely to be intense and deal making difficult and time-consuming (Farrell & Saloner, 1988; Genschel, 1997; Heckathorn & Maser, 1987; van Wegberg, 2003), making agreements in multiple (smaller) SDOs is deemed to be easier. However, agreement *within* an SDO is only half the problem in a fragmented structure, the other half must come from agreement *between* SDOs. However, Genschel (1997) argues that inter-SDO coordination attempts have proven

[15] One might say these are exactly the same things.

to be unsuccessful because of two reasons. First, disruptive disagreements that had been avoided by partitioning into different SDOs resurfaced in inter-organizational negotiations. Second, negotiations proved to be simply not needed. 'Inter-organizational coordination come about by unilateral adaptation, without any bargaining.'(p. 615). As Genschel sees a first mover advantage in a game theoretical setting (a first mover significantly reduces the options for the others), in the noisy environment of telecommunications a first move can easily fail to start a bandwagon, this is concurred by Liebowitz (2002). Nevertheless, the eventual adoption of a standard will be decided when one of the SDOs *gives in* and follows the model of the other: sequential adoption.

This model of adoption resembles the two-stage game by Economides & Skrzypacz (2003) and Bloch (1995). However, Economides & Skrzypacz conclude that in markets where network effect are strong (as in telecommunications and web technology) a industry wide coalition will form, and Bloch argues that, while he notes that multiple coalitions will form, they will be inefficient. This is contested by Genschel (1997 p. 616) which concludes that 'fragmented standard-setting does surprisingly well', because the advantage of the fragmented structure is that it combines two modes of achieving agreement; it is a mixture of bargaining and sequential adoption. Farrell & Saloner (1988) conclude similarly, they see a hybrid form of both communication and unilateral preemptive actions as the most efficient, and an improvement of the *pure* committee system.

Who will win in the sequential adoption model depends on several factors. Although the competition is left to the market eventually, coordination is an important intermediate step (Genschel, 1997). The risk of failure decreases as the power of impending first movers (i.e. the importance of their decisions for others) declines. This power can be increased if multiple SDOs join forces. There is a trade-off for smaller players; here, it is a matter of strategic wit to keep negotiations small enough to prevent conflict and extended bargaining, but large enough to assure that any decision will be accepted by non participants (Besen, 1993). Thus, Genschel (1997) concludes there are three steps in the process that make up the standardization process – although the second step is elaborated vaguely:

1. Agreement on a standard within an SDO.

2. Optional coordination between SDOs if the SDO is deemed not powerful enough.
3. A push of the standard in the market timely.

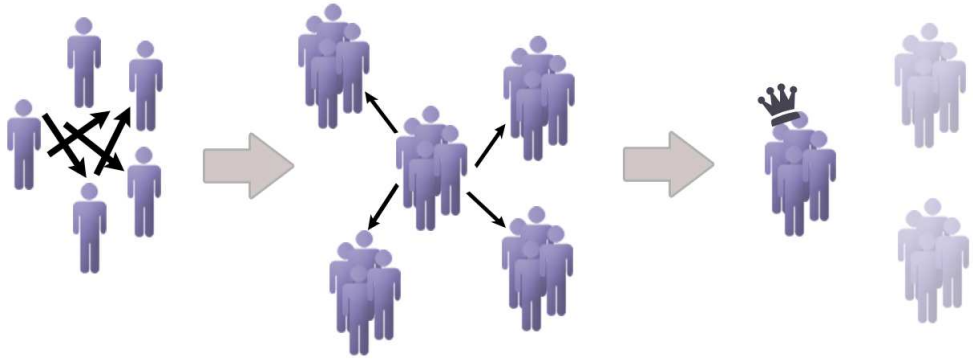


Figure 12 – Three-step standardization process (Genschel, 1997)

The second step includes the term 'power'. However, how is the power of an SDO defined? What will it take for an SDO to have the power in coordination rounds with other SDOs once a standard is set within the SDO? Up to now, we have discussed literature that focused on the economic side of standardization. It is common in the IS/IT domain to explain management phenomena with a technical-economic rationality (Kumar, Van Dissel, & Bielli, 1998). The widely used game theoretic settings however assume purely rational actors that are seeking economic benefits from the business transactions undertaken (Fomin & Keil, 2000). Social transactions between actors are mostly ignored still. However, social network analysis can give insights in networks of actors. These actors can be individual persons, or groups of persons (in the form of organizations). The *web* of connected actors can reveal information flows, power differentials and influence.

3.5 Social network analysis

For a long time it was argued that a simple Schumpeterian[16] understanding of market forces, where a superior technology will be chosen by the market, lacks an understanding of the influence of the socio-institutional environment on innovation

[16] In network markets subject to technological progress, competition may take the form of a succession of 'temporary monopolists' who displace each other through innovation. Such competition is often called Schumpeterian rivalry, named after the 20th century economist Joseph Schumpeter (Farrell & Katz, 2001).

(Chow, 1999; Pinch, 1988). Technology is not an artifact with predetermined features and impact on the market (Lyytinen & Damsgaard, 1998; Pinch, 1988). Neither the market, nor the development of technology are closed systems; both are subject to the influence of socio-institutional forces (Chow, 1999).

This analysis (as well as other economic analyses of standardization) can be placed in the broader context of *governance theory* (Schneider & Kenis, 1996). Governance theory is a very broad label covering research in sociology, political science, and economics on the way institutional arrangements (governance systems) structure and regulate 'the interplay between the *local rationalities* of actors and the *global rationality* of the system composed by them'(Genschel, 1997; Grandori, 1995). Several generic governance forms have been identified, such as markets and hierarchies (Williamson, 1991), clans and networks (Ouchi, 1980; Powell, 1990), and communities and bargaining systems (Scharpf, 1988; Streeck & Schmitter, 1985). It turns out that almost never standardization can be explained by *one* governance type; rather the real world shows an interplay of at least two. We turn our attention to the governing role of networks as we explore its influence on standardization.

In the sequential adoption model of Genschel (1997), SDOs are faced with a mixture of competition and collaboration with other SDOs once a standard is set internally. Official connections – and thus collaboration – between SDOs can take three different forms:

- reciprocate membership
- memorandum of understanding
- official liaison relationship

The common denominator in these relationships is the exchange of information between the entities. This can be in the form of ideas, technological know-how, or (architectural) vision. Collaborating and competing SDOs combine the complexity of exchanges with the non-existence of a formal hierarchy. Powell (1990) sees this situation as a distinct form of organizational design. Moreover, as economic life is embedded in social structure (Granovetter, 1985), formal and social the ties between SDOs tend to coincide. Formal connections between SDOs simply indicate that there is a (potential) exchange of information between individuals of different groups.

Hence, we draw upon social network literature for analyzing behavior of an SDO in its network. We apply rules that are traditionally intended to explain interactions between individuals, on interactions between *groups* of individuals. The justification for this comes from the nature of the organization of connected SDOs (Powell, 1990):

- There is a lack of hierarchy between them.
- There are no market transactions.
- The means of communication between actors are relational (rather than *routines in hierarchical systems* and *prices* in market systems).
- The climate is open-ended and focused on mutual benefits.

In this structure, the characteristics of the parts are shaped by the interaction that takes place among them. Be it on micro (between individuals) or macro (between groups) level, social ties influence behavior and interests.

Although Granovetter (1985) clearly differentiates between economic and social schemes of economic behavior, its implications are indeterminate because of the imbalance of relatively specific economic theories and the broad statements about how social ties shape economic and collective action (Uzzi, 1997). Because of the broadness of socio-economics, we will only focus on power and influence.

We hypothesize that the number and nature of connections between SDOs affect its ability to be successful in pushing *its* standard in the market – step 3 of Genschel (1997). Theories of social networks can help us understand how connections to other standards organizations influence the power of an individual organization.

The more powerful the actor is in the network, the higher the chance on success for *its* technology. *Power* is a multifaceted construct that can include size for example; bigger organizations are more powerful than smaller ones. Power can also be extracted from the position of an actor in a network. Though, while size is an inherent property of an actor, relations between actors are not; they are the property of a system of actors (Scott, 2000). The notion of power within a network is closely related to *centrality*, both in organizations and in more informal networks (Degenne & Forsé, 1999). We extend this notion to the network of SDOs and assume that centrally positioned actors (SDOs in this case) enjoy a position of privilege over those relegated

to the periphery. There are multiple ways of measuring centrality, Freeman (1979) distinguishes three: degree centrality, closeness centrality, and betweenness centrality.

Degree centrality is the simplest and most intuitive measure of centrality. It quantifies the number of connections to others as a measure of centrality. Central actors simply have more connections to other actors than peripheral individuals do. Although the measure can be done absolutely, it is more sensible to have a relative measure (c_{NDi}). This is calculated by dividing the absolute centrality (c_{ADi}) by the number of total possible connections ($n - 1$, if n is the total number of nodes):

$$c_{NDi} = \frac{c_{ADi}}{n - 1}$$

Note that C_{NDi} is measured in percentages, where 0 means a totally isolated individual and 1 (100%) a fully connected actor. Degree centrality however stresses the local viewpoint[17] and measures transaction activity (or capacity) for each member of a given network, but disregards its capacity to control them (Degenne & Forsé, 1999). The following measures take this into account.

Closeness centrality looks beyond immediate contacts, as to see how *close* the actor is vis-à-vis all other actors; it is a global measure. The *path length* to other actors is cardinal. It is the number of *hops* one has to take to arrive at another actor; if there is an immediate connection, path length is 1, and if – in social terms – one connects to a friend of a friend path length is 2. Sabidussi (1966) defines closeness centrality (c) as the sum of its geodesic[18] distances (d) to all points on a graph:

$$c_i = \sum_j d_{ij} \quad \textit{(where i and j are connecting actors)}$$

[17] In a network, actors can be central in their own *neighborhood* (the sum of its direct connections), but not central if the whole network is considered. This is the difference between local and global centrality.

[18] The shortest path length between two nodes on a graph.

As an actor's closeness to others increases, so does its access to information (Leavitt, 1951), power (Coleman, 1973), prestige (Burt, 1982), influence (Bavelas, 1950; Friedkin, 1991), and social status (Katz, 1953).

Betweenness centrality takes a slightly different approach. Freeman (1979) notes that some weakly connected actors may still be indispensable to certain transactions. The greater an individual's actual or potential *intermediary value* to all actors in the network, the greater his control over communication flow and independence of others to communicate (Degenne & Forsé, 1999). Again, this measure is scaled relatively; true intermediates score closer to 1 as outliers score 0.

The abovementioned measures of centrality are based on raw scores of degree and distance. Bonacich (1972; 1987) takes this into account and argues that the centrality of a particular point cannot be assessed in isolation from the centrality of all the other actors to which it is connected. A player that is connected to other central players sees its centrality amplified. However, Bonacich also introduces an arbitrary parameter in the form of β. This factor can be chosen by the researcher to set path distances that are to be used in the calculation of centrality[19]. It gives the model flexibility and randomness at the same time. Additionally, the value of β also depends on the type of relations the actors share. The value of β must bear a link to transitivity[20] with which it should be positively correlated.

Bonacich (1987) states that this measure indicates an actor's power. 'Indeed, a central actor connected to other central actors can certainly de considered powerful' (Degenne & Forsé, 1999 p. 139). Weber (1922) sees power as the *probability* an order will be executed. However, Cook et al. (1983) have opposed the idea that power and centrality are necessary synonyms. They argue that connections with uninfluential actors can prove to be invaluable in certain negotiations, and relations with too powerful players can sometimes prove to be a handicap because they have too many

[19] β defines which actors should be included in calculating centrality; it is an attenuation factor that sets a demarcation, and hence defines focus of the formula.

[20] In an informal network, where A's power over B does not give A any power over C, transitivity is weak. It is a measure how power transfers from node to node. Hierarchy increases transitivity; in the military for example, a general's authority extends beyond staff officers down to the rifleman who actually executes the order (Degenne & Forsé, 1999).

relational options. ‘If we hypothesize that every actor wants to dominate any coalition he builds, we must allow he will only succeed to the extent that he avoids overly powerful partners’(Degenne & Forsé, 1999 p. 140). This is what Genschel (1997) and Besen (1993) also conclude in an economic sense. There can be too many connections that increase the stakes, so that coordination efforts end in a bargaining game subject to potential deadlock and delay. Gosling (1990) would see it as an increase of political interest which leads to *calcification*. Overall however, just as there is no doubt that power and centrality go hand in hand, it is most clear that the bond is most ambiguous (Degenne & Forsé, 1999).

In the case of the fragmented standardization landscape, how does centrality or power play out? Power is not a characteristic of one actor; it needs a relationship to exist. It depends on centrality and transitivity, though the traits of the specific network are also influential. Knoke (1990) conjugates domination and influence to yield four different types of power behavior:

		Influence	
		Absent	*Present*
Domination	*Present*	Coercion	Authority
	Absent	Power Broking	Persuasion

Figure 13 – Power behavior in different settings (Knoke, 1990)

In the case of the plethora of SDOs related to web technology, there is no clear domination of one or more SDOs present. However, influence is present. Hence the power behavior will be more in the form of persuasion than anything else.

Keohane & Nye Jr. (1998) look at it slightly different as they distinguish two types of behavioral power: hard power and soft power. Hard power is the ability to get others to do what they otherwise would not do through threats or rewards. Soft power, on the other hand, is the ability to get desired outcomes because others want what you want. It is the ability to achieve goals through attraction rather than coercion. Soft power will be used more than hard power in the case of SDOs, as a lack of authority prevents SDOs to make use of solid force.

3.6 Coordination power

Firms make resource allocation decisions toward SDOs dependent on several factors. We assume that one major factor would be the assessment whether the SDO of which they *are*, or *will be* a member, will ultimately produce a standard that is successful in the market, hence reaping all the benefits of their investment. It is understood that corporate decision makers routinely rely on *reputation* of an organization in making important judgments (Dowling, 1986). Thus, a relatively subjective measure – reputation for example – can have a large influence on decisions. In this light, we introduce the latent construct of *coordination power*. It is defined as the chance that a technology will be successfully accepted by the market place once it has been developed in an SDO. That is, it will *win* in the sequential adoption model of Genschel (1997). Coordination power is defines as a characteristic of an SDO. It can come into play before, during, or after the process of standardization in an SDO. We hypothesize that:

> ***H1: Firms find it important that standards development organizations have high coordination power.***

This coordination power will be treated as a multidimensional construct along the lines of the *Fortune* scale of Fombrun & Shanley (1990). We consider coordination power to consist of the following elements:

1. **Centrality** – As noted before, centrality is positively correlated with power. Highly connected and centrally positioned SDOs will have higher coordination power.
2. **Willingness to coordinate** – If a standardization organization has a high willingness to coordinate, it will increase its focus and resources directed towards cooperation. This will be beneficial to coordination power.
3. **Quality of 'products' (technical specifications)** – Information is the 'currency' with which exchanges take place. Products that are of high quality will increase persuasion over and attraction (soft power) of other SDOs, hence increasing coordination power.

4. **Reliability/predictability** – If the management of an SDO is considered reliable, and thus predictable, its attraction to other SDOs will be enhanced. Coherency will be advantageous for its coordination power.
5. **Proactiveness in the standards community** – A proactive role of an SDO will enhance coordination power. As opposed to being passive, leadership will be beneficial for an SDO to reach its goal effectively.

Both *quality of products*, and *reliability/predictability* are also part of the multifaceted concept of *reputation* as measured by Dollinger, Golden, & Saxton (1997) and Saxton (1997)[21]. They show that partner reputation has a positive effect on alliance outcomes. Thus, reputation is a concept that is *close* to our construct. It was stated already that actors in a network with high closeness centrality often have more power (Coleman, 1973) and prestige (Burt, 1982). However, terms like power and reputation are consolidated constructs, subjectively present in the human psyche. They consist of a vast multitude of different measures. Many measures for reputation will also be present for power, hence they will show overlap, and will correlate positively. The four measures of the model above are a pragmatic attempt to measure a latent concept. Nevertheless terms like prestige, reputation, and coordination power may sometimes seem interchangeable.

With the introduction of coordination power, we have in total defined four factors that define the characteristics of an SDO, which in turn influence the standardization process (both *within* and *between* SDOs) which can more or less match the preferences of companies. The figure below consolidates this information.

[21] In total, they distinguish three dimensions that make up *reputation*. The third is financial performance. We do not take into account the financial side of SDO relations here.

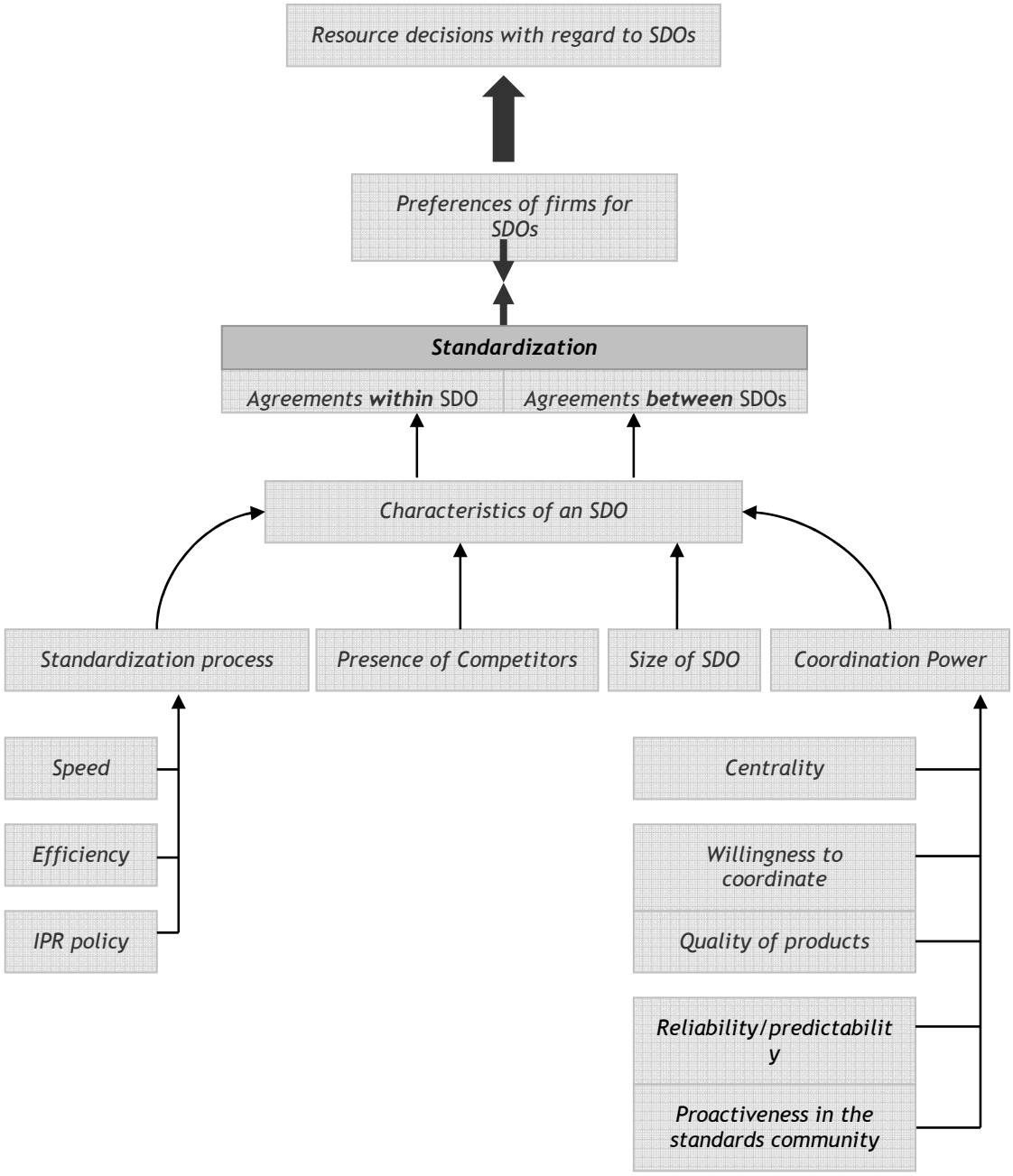


Figure 14 – The shaping of the standardization process, and it influence on resource decisions.

To test the hypothesis presented above (H1), a research done at the World Wide Web Consortium will give some insights into the preferences of SDO members. The next chapter will discuss this research as well as give an overview of the SDOs in the area of web technology.

3.7 Conclusion of chapter 3

This chapter saw how companies interact to form coalitions, and how these coalitions act in standard setting. There are conflicting views on the creation of standards coalitions. While many scholars argue that the existence of a monopoly standard setting is a stable equilibrium, reality shows us a fragmented environment. This fragmented environment is seen by others as stable and rather efficient. Genschel (1997) provides us with a model of intra-organizational bargaining followed by sequential adoption. Though, an important intermediate step is the assessment of an SDO whether it will be successful in sequential adoption. The important factor of power is elaborated. The analyses of social networks provide a theory of power and persuasion in networks of actors. More central players tend to be more powerful. In the network of SDOs the manifestation of power will tend to be in the form of persuasion and soft power.

Next, the concept of coordination power was introduced. We hypothesize that (prospective) corporate members prefer SDOs with high coordination power. This concept is assumed to consist of several underlying characteristics including centrality, willingness to coordinate, quality of products, reliability/predictability, and proactiveness in the standards community.

4. Standards organizations in web technology

4.1 Introduction

This chapter will start with a brief overview of the SDOs in the area of web technology in terms of scope and organizational characteristics. Following Schmidt & Werle (1997), and ignoring the specific peculiarities of individual organizations, the SDOs discussed here share the following characteristics:

- Participation is voluntary and not remunerated.
- Participation is, within certain membership rules, open to those who are 'substantially interested' (the organization may have a membership fee).
- The work is committee-based, cooperative, and consensus oriented.
- Organization and working procedures are impartial, unsponsored, and politically independent (*due process*).
- The work is based on technological knowledge and follows the principle of parsimony of standard options.
- Standards are international, nonmandatory *public goods*; they are nonproprietary or at least nondiscriminatory.

The primer on SDOs is followed by the results of two researches to support our hypothesis that companies – perhaps implicitly – find it important that SDOs have high coordination power. The first research was done at the World Wide Web Consortium. It will reveal that the tested four of five measures of coordination power are deemed important by its members. Moreover, the allocation of employees to the W3C correlates positively with the measure for coordination power. The second research investigates the actual links between SDOs. It shows that links are very prevalent between SDOs, and that more centrally players have more members.

Thus, the model presented in the last chapter (showed in figure 14) is analyzed by a double test. In assessing the components of coordination power we use results from the W3C research to test whether willingness to coordinate, quality of products, reliability/predictability, and proactiveness in the standards community are deemed important by W3C members. Their opinions are linked with the number of employees in working groups and interest groups of the W3C to show the correlation between

opinions and allocation decisions. The remaining component *centrality* is measured by analyzing the relationships that exist between SDOs today. With the methods described earlier, centrality is measured. We present the relation between centrality and number of members of an SDO. The two tests combined measure the five components of coordination power.

4.2 The Standardization landscape

There has been a significant increase of standards development organizations in the twentieth century. Especially its latter half saw the number of SDOs rise quickly. What follows is a brief and selective *tour d'horizon* through the universe of SDOs to reveal the most important organizations.

National standards bodies (NSBs), such as ANSI in the United States, BSI in the UK, or AFNOR in France, have mostly been created in the beginning of the twentieth century by businesses, national governments, or both. Their common goal was to ensure products, processes, measures, or technologies were standardized in order to make the economy more efficient. Founded in 1904, the International Electrotechnical Commission (IEC) was set up to harmonize and standardize technology in almost all spheres of electrotechnology in an international scope. Its constitutive basis is representation of NSBs where each of the participating countries has one vote. The NSBs are explicitly required to be as representative as possible of all the interests of the country concerned (Macpherson, 1990; Schmidt & Werle, 1997). In 1947, representatives from 25 national standards bodies formed the International Organization for Standardization (ISO). Its setup is broader than the IEC, as its objective is to "facilitate international exchange of goods, services, and know-how" (ISO Annual report, 2003). The ISO and IEC have always have a close working relationship, and they are perceived as "twins" (Schmidt & Werle, 1997). This manifested itself in 1987 when the two organizations created the Joint ISO/IEC Technical Committee (JTC1). Its central task is to coordinate the definitions of basic and generic information technology standards. Equivalent to other standardization bodies, JTC1 exists of subcommittees (17) and numerous working groups (60). Formally, ISO and IEC are nongovernmental and non-treaty organizations.

In this regard they differ from the International Telecommunication Union (ITU), which is an intergovernmental United Nations treaty organization. The ITU is

responsible for promoting and developing telecommunication technology on an international scale. Its standardization branch, the CCITT was created “to study technical, operating, and tariff questions and to issue recommendations on them with a view to standardizing telecommunications on a worldwide basis” (Constitution, Art. 13 II, in ITU 1990 p. 16). With the reorganization of the ITU in 1993, the CCITT was converted into the ITU-T. Whereas representation of countries in ISO is done by NSBs, the ITU-T traditionally had representation from the national PTTs or the dominant private operating companies. Schmidt & Werle (1997) are of the opinion that this indicates a more political character of the top level of the ITU-T as part of an intergovernmental organization, as contrast to the ISO as an “ordinary” international organization. ISO/IEC/JTC1 and ITU-T were the dominant players in telecommunication for a long time, and remain dominant in selected areas. However “the historic division of labor among the CCITT [ITU-T], the ISO, and the IEC has been eroded because a clear separation of technical domains has proven to be unfeasible as information processing and telecommunications rely to a considerable extent on the same basic technologies. A gray area has evolved, triggering jurisdictional conflicts” (Schmidt & Werle, 1997 p. 50).

As a complement to the well-established top-level standardizations organizations, multiple regional standards organizations were set up with similar structure. The main organizations, representing the three economic blocs of the modern world, are the European Telecommunications Standards Institute (ETSI), in the US the Standards Committee for Telecommunications (ANSI T1), and the Japanese Telecommunications Technology Committee (TTC). Some observers found these organization serious competitors for the ITU-T (Hawkins, 1992). Yet none of them was created with the express purpose of competing with the ITU-T (Mazda, 1992).

Up to now, the organizations discussed all have national representation as the basis for its organization. This assumes national unity, and creates driving forces that are *political* of nature. Partly, the business community was discontented with this practice. It created its own standards organizations throughout the years. The relatively old European Computer Manufacturers Association (ECMA) was set up in 1961. As its name implies, members traditionally were computer manufacturers engaged in Europe. Later, its membership policy became less strict. Another noteworthy organization is the Institute of Electrical and Electronics Engineers

(IEEE) of which its core membership is in North America. It is a transnational society with about 300,000 individual members in more than 130 countries (www.ieee.org). "The gathering, organizing, and disseminating of technical information is seen as pertinent to the IEEE's scientific, educational and (above all) professional objectives" (Schmidt & Werle, 1997 p. 53). Moreover, some of its technical committees (TC) also developed telecommunications-related standards. Prominent examples come from TC 802, which has developed standards for wireless computer communication.

SDOs that explicitly deal with the internet and its technology include the Internet Society (ISOC), which was founded in 1992. This non-governmental organization has as objective "to facilitate and support the technical evolution of the internet as a research and educational infrastructure and to stimulate the involvement of the scientific community, industry, government, and others in the evolution of the Internet" (Articles of Incorporation of the Internet Society 3.A). The central unit of standardization under the auspices of the ISOC is the Internet Engineering Task Force (IETF). The IETF is a loosely self-organized group of people which contributes to the engineering and evolution of internet technologies (RFC3160[22]). It is an open, all-volunteer organization, with no formal membership or membership requirements. The IETF is overseen by the Internet Architecture Board (IAB), which is in turn responsible to the ISOC. It is organized into a large number of working groups, each dealing with a specific topic. Currently, this informal-looking group is responsible for many important internet standards, or RFCs. Instead of RFCs, the World Wide Web Consortium (W3C) calls its 'approved' technologies *recommendations*. This consortium of international members develops interoperable technologies (specifications, guidelines, software, and tools) for the World Wide Web. Membership of the W3C is restricted to companies, research institutions, advocacy groups, or other consortia; private individuals cannot become a member. W3C is responsible for many technologies that make the web work, such as HTML, CSS, HTTP (with the IETF), and the *lingua franca* of web communication nowadays: XML.

[22] RFC is an abbreviation for Request for Comment; a document published by the IETF. Every standard is also an RFC. RFC 3160 can be found on http://www.ietf.org/rfc/rfc3160.txt (Aug 2004).

This selection of SDOs revealed overlapping scopes of the organizations as well as differences in interest. Schmidt & Werle (1997) distinguish three constitutive coordination interests that have shaped international standardization: a country based political (control) interest, an organizational or business-based commercial (profit) interest, and an individual or professional knowledge (consolidation) interest. Elements of each of these interests are present in every SDO, however they differ in intensity. Moreover, they argue that the interests are complementary rather than substitutive. This argumentation serves as a replacement of the traditional categorization of SDOs as *intergovernmental*, *treaty-organization*, or conventional labels like *consortium*, *forum*, or *task force*. It recognizes that every SDO is different in its set-up and membership.

4.3 Research at W3C

The main goal for the research at W3C was to get a picture of the value proposition of the international (corporate) members. What do the members find important in W3C? Why are they investing in W3C, and which elements do they value most? With this goal in mind, the members were surveyed in November 2002.

4.3.1 Background of the W3C

The W3C was created in October 1994 by Tim Berners-Lee. It is organized as a member consortium. The W3C exists of a team of technical specialists (about 70) and 358 international members[23]. Members mainly include providers or users of ICT, but also advocacy groups and research institutions. W3C has two classes of membership: affiliate members, and full members. In short, large companies must become a full member (annual fee: US$ 57,500), and small companies, government agencies, or non-profit organizations are eligible for affiliate membership (annual fee: US$ 5,750).The rights and privileges of the classes are the same.

The goal of the W3C is to lead the web to its ‘full potential’ by developing interoperable web technologies (w3.org). An elaboration of the structure of W3C, its communication flows, and an outline of the recommendation track (the formalized standardization process) is given in appendix III.

[23] As measured in September 2004.

The W3C develops its technologies in working groups (WG) in a five-step standardization process. The process includes certain clearly defined objectives to ensure the quality of the technology. Every WG consists of one or more people from the team, and representatives from the member organizations. Every WG can have one or more persons from a member organization; however, every member organization has only one vote. This is to ensure that the process is fair and democratic.

The approach of the research in 2002 was to assess the value of W3C's mission, methods, products, and services to each member organization. In different cases, the vision of the team does not perfectly coincide with the commercial interests of member companies. Even the member organizations have mostly (slightly) different interests. Joseph Reagle (1998) puts it like this: "*the W3C's work is focused on specifications and consensus development between sometimes antagonistic parties, in a contentious domain*." This survey was intended to offer the team a structural tool for *listening* to the members on a variety of topics.

4.3.2 Methodology

All representatives of W3C member organizations were asked to fill in the web-based questionnaire. They were specifically asked to answer the questions on behalf of the organization they worked for. The survey was filled in by 89 respondents, which was about 20% of the total membership in 2002. The questions that are used for this thesis are a part of the whole questionnaire (which is reprinted in appendix IV).

The questionnaire queried the members about their opinions about W3C's mission, methods, products, and services. The main focus was on how *important* these issues were for the responding members. Importance was measured with a 4-option Likert scale with the options *not important*, *somewhat important*, *important* and *very important*. Calculations are done by assigning each option with a number: not important = 1, somewhat important = 2, important = 3, and very important = 4. This allows for calculations on the data, most straightforward is the calculation of the mean. The higher the mean is, the higher the perceived importance.

Four of the five dimensions of coordination power are measured by this survey. Centrality is presented in the next paragraph. Each dimension is measured by several questions. Because each dimension is again a concept in itself, the questions are meant to assess that concept. Questions can be indirect measures, but, when added up, constitute to a good representation of that particular concept. Each set of questions is assessed for internal validity by Cronbach's alpha. Moreover, the whole set of questions is tested for internal validity (or reliability) to ensure it measures the underlying concept of coordination power. The four dimensions are assembled as follows:

Product quality (9 items)

The importance of[24]*:*

- Interoperability and quality assurance *(5-7)*
- Implementation experience *(5-6)*
- Recommendation track process *(5-8)*
- Technical specifications *(2-1)*
- Charter development *(5-1)*
- Member review *(5-4)*
- Working group process *(5-2)*
- Cross working group review *(5-3)*
- Promotion of best practices *(8-3)*

Reliability/predictability (8 items)

The importance of:

- Interoperability *(3-5)*
- Evolvability *(3-6)*
- Coherent vision and architecture *(3-1)*
- Vendor neutrality *(3-9)*
- Universal access *(3-2)*
- Usability *(8-5)*
- W3C's support of maintaining and improving existing recommendations *(7-4)*
- Guidelines *(2-2)*

Willingness to coordinate (1 item)

The importance of:

- Coordination with other Standards Bodies *(1-11)*

[24] The numbers in brackets correspond to the specific question and sub item in the questionnaire, which can be found in appendix IV. Introductions to questions can provide better context for specific questions.

Proactiveness in the standards community (2 items)

The importance of:

- W3C's leadership in development of cutting-edge technologies *(7-3)*
- W3C's leadership within the standards community *(7-2)*

The measure for resource allocation comes from two questions that let the respondents specify the number of employees from their company in working groups (WGs) and interest groups (IGs). Within the W3C, the goal of a WG is typically to produce deliverables, while the principal goal of an IG is to bring together people who wish to evaluate potential web technologies and policies. Participation in either of these groups means a considerable investment in time for an employee. It can be considered as a significant gauge for resource allocation. The total amount of people from a particular company in WGs and IGs is defined as a measure.

4.3.3 Limitations

There are three main limitations to this research. First, the original purpose of the survey does not coincide perfectly with the objectives in this thesis. The investigation into the value proposition of W3C members yielded enough measures for product quality and reliability/predictability, but only two questions were appropriate for measuring proactiveness in the standards community. Only one question tested for willingness to coordinate. If the questionnaire was set up for measuring coordination power, different questions would have been formulated. Although internal validity is ensured for all the dimensions, proof for the model could have been better with a specialized questionnaire.

Second, the measure for the amount of people in WGs and IGs could be based on estimates. Because some large companies have lots of employees working in WGs and IGs, the responding representative may have made an educated guess instead of precisely checking the amount of employees. Although there is no concrete evidence for this, it would not be impossible. A more precise and objective measure could be done by reviewing the W3C’s database; however, this was not possible at the time of this writing.

Thirdly, the respondents were explicitly asked to answer questions on behalf of their company. However, as representatives come from different positions in the hierarchy of their company, bias could be introduced. For some companies, standardization is more important than others. This affects the background of the

representatives which affects the way the respondent can adequately answer questions on behalf of their company. Some may have mixed personal opinions with company views.

4.3.4 Respondent population

The 89 respondents seem to be a fair cross-section of the total membership. The percentage of full and affiliate responding members is 39%, and 61% respectively. As of the time of the survey, the actual ratio of full to affiliate members was 23% and 77% respectively. Thus, the full members are overrepresented in this survey by 16%. Furthermore, the respondents represent a variety of different industries and sizes[25]. Unfortunately, no data was available in terms of size and industry-type for the whole population at the time of the survey. Thus, only the *full-to-affiliate-member-ratio* gives conclusive statistics about how the 89 respondents are representative for the whole W3C membership. How the results of the survey are representative for the corporate membership of all SDOs in web technology is unclear. However, most of the large corporations that responded to the W3C questionnaire are also member of many other SDOs. It would be not surprising if their views and opinions were consistent throughout all the SDOs that they are member of.

4.3.5 Results

The results show that the four dimensions of coordination power are deemed important to very important by the respondents. Detailed statistics are shown below.

dimension	mean	Cronbach's alpha	questions	n	variance
Product quality	3.41	0.72	9	73	0.035
Reliability/predictability	3.38	0.70	8	78	0.058
Proactiveness in the standards community	3.33	0.75	2	86	0.078
Willingness to coordinate	3.61	-	1	83	-
Total: four dimensions of coordination power	**3.40**	**0.81**	**20**	**67**	**0.045**

Table 1 – Statistical breakdown of the dimensions of coordination power

[25] Appendix V has holds a detailed breakdown of these statistics.

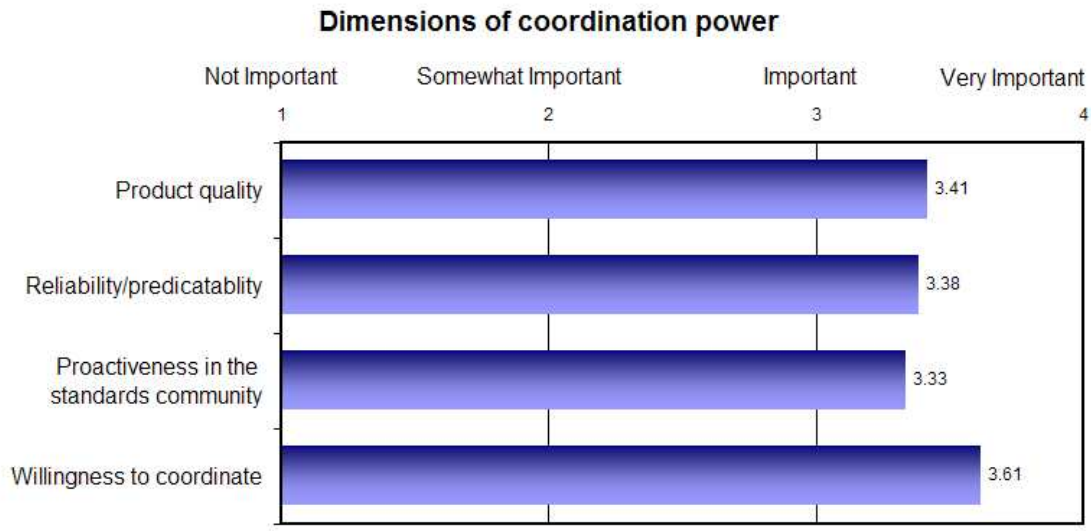


Figure 15 – The averages (importance) of the four dimensions of coordination power

The results show that there is good evidence that the four dimensions measure a single concept. Although Cronbach's alpha does not have a generally agreed cut-off, usually 0.7 and above is acceptable (Nunnally, 1978). Moreover, the alpha of 0.81 supports the internal validity of the overall model: the 20 questions measure a single construct. For assessing a correlation between the opinions of companies and their resource allocation decisions, we use a regression analysis. The results are shown below.

model	B	std. error	standardized beta	t	significance
Constant	-44.82	20.62		-2.17	0.03
Coordination power	15.45	6.08	0.30	2.54	0.01
Dependent Variable: **Employees in WGs and IGs**					
$R^2 = 0.09$		Adjusted $R^2 = 0.08$		Significance F-test = 0.01	

Table 2 – Regression model with independent variable 'coordination power', and dependent variable 'employees in WGs and IGs'

The factor of coordination power has a significant influence. For an increase of one point in the 4-point scale of coordination power, a company is expected to have about 15 people more in WGs and IGs. However, this is an average. The factor of coordination power only explains 9% of the variance of manning of WGs and IGs. This can be seen by the low R^2 and the high standard error of the *constant* in the regression model. An additional regression analysis that takes the relative amount of

people in WGs and IGs (employees in WGs/IGs divided by employees in the company) yields similar results.

model	B	std. error	standardized beta	t	significance
Constant	-0.65	0.34		-1.88	0.06
Coordination power	0.21	0.10	0.26	2.11	0.04
Dependent Variable: **Relative amount of employees in WGs and IGs**					
$R^2 = 0.07$		Adjusted $R^2 = 0.05$		Significance F-test = 0.04	

Table 3 – Regression model with independent variable 'coordination power', and dependent variable 'employees in WGs and IGs relative to the total amount of employees in a company'

Again, the factor coordination power has a significant influence, but the R^2 is equally low. On average, there is support for the statement that companies that find coordination power more important are also willing to invest more resources (people in WGs/IGs) in the W3C. However, resource allocation is only very modestly explained by the importance W3C members give to the four dimensions of coordination power. Although the tested dimensions are only part of the overall model to explain resource allocation decisions, the factor of influence is very slim.

4.4 Links between SDOs

The fourth dimension of coordination power is centrality. The test for this dimension comes from a research of the actual links between 48 SDOs in the realm of web technology. We test whether closeness centrality correlates with the actual number of members. The decision to become a member of an SDO is a visible result of a resource allocation decision. A positive correlation would indicate support for our hypothesis.

4.4.1 Methodology

The information of links between SDOs was gathered from the web sites of the SDOs. In an extensive search three types of relationships were noted: a reciprocate membership, a memorandum of understanding, or an official liaison relationship. The search was done by first identifying the liaisons of a particular SDO (in this case W3C), and subsequently identifying its liaisons, and so forth. This is called the *snowballing technique*. In this process, SDOs that do not deal with web-technology

were also encountered, and were subsequently omitted in the results. The main criterion to include a specific SDO was how applicable their standards are on the web. In total 48 SDOs were identified that shared links between each other. The resulting network is a subset of the whole standardization landscape. However, the number of links *within* the network exceeds the number of links to SDOs *outside* the network of web-related SDOs.

With software for social network analysis (UCINET) closeness centrality was measured. Bonacich power would yield a more refined measure, however a proper value for β could not scientifically be defined. Research into transitivity in SDO relations would be necessary for this. Closeness centrality is a global measure, and is assumed to bear a link to power. We correlate this to the number of members of an SDO. This statistic was taken from the websites of the SDOs. Because some SDOs have various membership classes, our criterion was that a member should have voting rights. This ensures that we only include organizations that have to make noteworthy resource allocation decisions[26]. Moreover, for some SDOs (such as the IETF or IEEE) membership information was not available. This resulted in a sample of 38 SDOs.

4.4.2 Limitations

There are three main limitations to this research. First, the type of matrix used to map the connections between the SDOs is a square case-by-case matrix, or adjacency matrix. This matrix has as characteristic that it is symmetrical through its diagonal axis, the reason is that the network is treated as 'undirected'. This means that the relation of A with B is the same as the relation from B with A. In the case of the SDO relationships, this is a simplification. Some SDOs are members of other SDOs, and thus is their relation stronger one way than it is the other way. A directed and valued matrix would be more accurate (Scott, 2000), it would include the direction of a relationship and a of valuation of the individual connection, creating a picture that would better describe the reality. However, the strength of the ties was not available from the SDO websites.

Second, some websites of SDOs are very clear in stating its formal relations with other SDOs, others are not. Luckily, a relation involves two parties, and when

[26] Some SDOs offer memberships that only require a small membership fee but no voting rights. Hence, active involvement in the standardization process is not possible.

one website states it has a relation with another SDO; one does not need the other SDO to indicate it. However, this introduces a limitation, namely the accuracy of the stated relations: the information on the websites is treated as true and up-to-date. Despite the fact that the search for formal relations was thorough, there could be relations in the analysis that are based on false or outdated information.

Third, because the definition of web technology is not strict, the decision to include or not include SDOs is not an objective process. This subjectivity introduces a limitation. For example, should the ICC, a consortium that standardizes (digital) color codes, be included? It is included in the study, because a significant amount of their work includes the web. Therefore, a case-by-case evaluation must lead to a decision. The main criterion was how applicable their standards are on the web. However, the cut-off threshold was not quantifiable.

Lastly, what may be considered as a limitation is the snowballing sampling technique. Scott (2000) argues it is, by its very nature, likely to be organized around the connections of the particular individuals who formed its starting point. Although this is valid for some types of networks, it seems not to introduce a bias in this study. This is because the resulting network is a dense network with many connections. If this is combined with the thorough search that was done in discovering links, it is not probable that the result would be different if another starting point was chosen.

4.4.3 Results

The results show a highly connected group of SDOs, as can be seen in figure 16. The prevalence of links between SDOs is very common. The 48 SDOs shared 201 links between each other, which is an average of 4.2 relations per SDO. 25 SDOs have up to five relationships with other SDOs, 23 have more than 5 relations. W3C has the maximum of 27 liaisons in the area of web technology. The overall density is 54.1%, where 100% is a situation where every organization is linked to each other. The geodesic paths between the SDOs are also short; on average an SDO can connect to any other SDO in 2.1 steps. Another characteristic of the network is the absence of real subsets of linked organizations (cliques). However, a core/periphery classification can be made. There is a highly connected core of 16 SDOs (density: 70.8%), and 32 less connected SDOs. Appendix VI provides details of this classification.

Even though the density is quite high for this network, centrality differentials are visible. The results indicate that the number of (voting) members correlates positively with closeness centrality. Regression shows the following results.

model	B	std. error	standardized beta	t	significance
Constant	-405.91	146.72		-2.77	0.01
Closeness centrality	12.84	3.07	0.57	4.55	0.00
Dependent Variable: **Members**					
$R^2 = 0.33$	Adjusted $R^2 = 0.31$		Significance F-test = 0.00		

Table 4 – Regression model with independent variable 'closeness centrality', and dependent variable 'number of members'

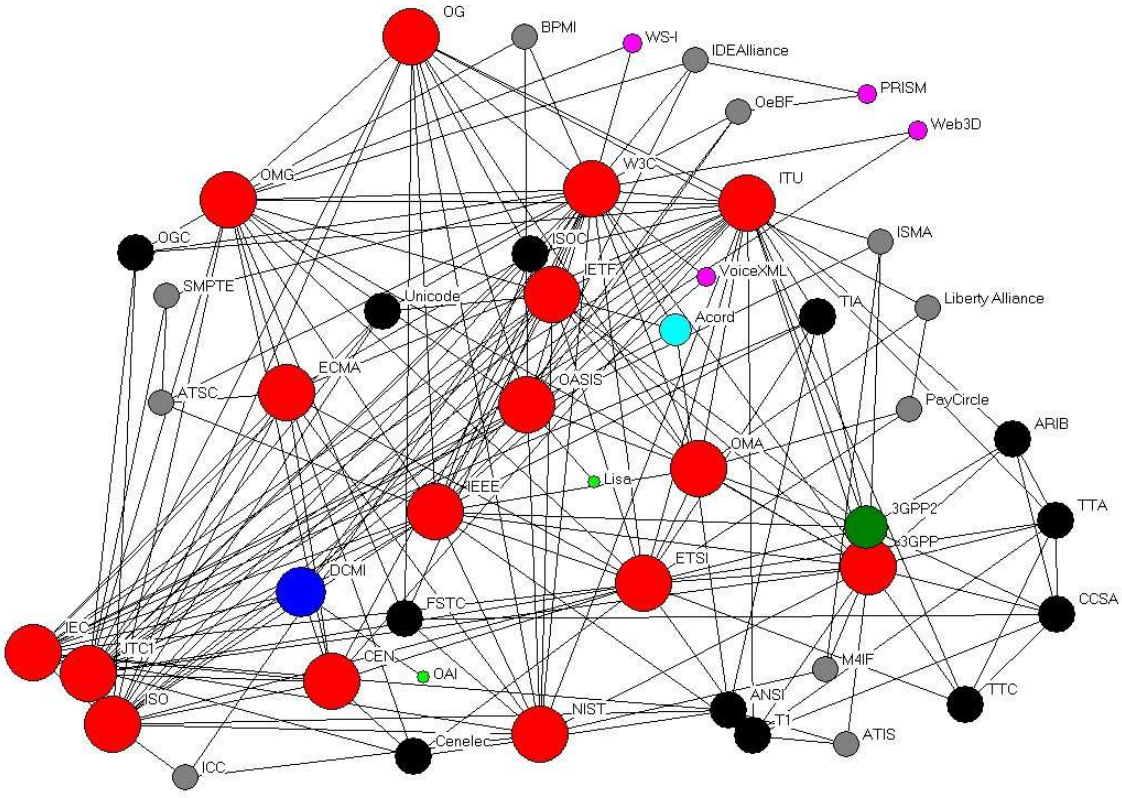


Figure 16 – Connected SDOs in the realm of web technology

The results are significant in both the independent variable as the constant on the 99% confidence level. Although there is a significant positive link between number of connections and members, the proportion of variation in the response that is explained by the regression model (R^2) is a modest 33%. Still, this is in line with our model. The

hypothesis was that centrality is only a part of the overall pool of variables that would explain SDO membership. Regression of the number of links (*absolute degree centrality*) and the number of members demonstrates similar results. It shows that on average for every liaison an SDO adds, 17 new members can be expected (significance = 0.00 / R^2 = 37%).

The hypothesized notion that companies rather allocate resources to SDOs with high centrality is assumed in this regression. This study however is not conclusive of the *direction* of the correlation. SDOs with more members will have more financial resources; these can be spent to engage in connections with other SDOs. Then, more members will be the reason for more connections. Assuming that SDO members have certain influence on the policy of the SDO, one would not expect liaisons to be formed if it would not be deemed important. The sheer number of connections indicates that links are found important, maybe even necessary. Nonetheless, is could be evenly plausible that an SDO with many connections will be more attractive for companies. Centrally placed SDOs will be a better organization to become a member of, because it increases the chances of success of a certain technology.

Yet, the most plausible solution would be a mixture of the two influences. Not *solely* do more connections lead to more members, or *solely* the other way around, a combination of the two could explain part of the membership and connections of an SDO. It can be seen a reinforcing loop: more connections lead to more members lead to more connections. It would simply be not probable that *only one* of these forces would be at work. However, which influence is stronger cannot be determined by this research.

4.5 Conclusion of chapter 4

There are many standard developing organizations that produce technologies in the field of communication technology. However, web technology is a vague concept as communication technologies converge. Some SDOs clearly develop only web technologies, such as the W3C, IETF and OASIS. Others, such as ISO and IEEE, are broader in scope. The characteristics of an SDO can be described by its constitutive coordination interests; underlying forces of political, commercial, and professional nature can explain the many differences in the multitude of SDOs.

From a research at the W3C we conclude that four dimensions of coordination power (quality of products, reliability/predictability, proactiveness in the standards community, and willingness to coordinate) have a significant influence on the resource allocation of responding W3C members, however, only 9% of the variance in WG/IG manning is explained by the tested dimensions.

The fourth dimension of coordination power was tested with a study of the links between SDOs. Reciprocate memberships, memoranda of understanding, and official liaison relationships were counted of 48 SDOs in the realm of web technology. This was correlated with the number of members of SDOs. The results show that there is a significant positive link between the closeness centrality and number of members. However, the direction of the causality is open to interpretation; the regression analysis does not prove if one phenomenon causes another or the other way around. As the influences are not mutually exclusive, it would be probable that both forces exist. However, further research would be worth pursuing.

5. Conclusion

This thesis focused on corporate resource allocation decisions with respect to standardization. We investigated which factors influence these allocation decisions. Because standardization as a whole is a complex issue, we focused on the interactions between SDOs and its effect on overall standardization. Because dealings between SDOs are a significant part of standardization, the question arises what characteristics an SDO should posses to be successful in the network of SDOs. Hence, the central question of this thesis is: ***Which network characteristics of SDOs do companies prefer?***

In answering this question we first review the sub-questions stated in the introduction. The first two sub-questions were about a description of the business environment and the tactics in *de facto* standardization. Most products in the high technology sector have standardized components or interfaces. This results in network effects being very common. This is the main characteristic of network markets and is the cause of increasing returns. The environment is deemed unstable because of these phenomena. De facto standardization can be pursued by companies, as the rewards can be very high. Five tactics were identified that companies can pursue to press the market to adopt its own technology as a standard. Additionally, timing issues were discussed. The underlying technical and political views on standardization explained when standardization is most sensible. Concluding, the business environment (*network markets*) can be described as unstable and dynamic. Market standardization can be very profitable, but risky.

The third sub-question is *what are the dynamics in networks of firms and coalitions, and how do they influence the preferences of firms for SDOs?* The interactions of firms and the formation of coalitions are described abundantly in the literature. When it comes to standardization, the strength of the network effects, as well as speed and efficiency are cardinal factors in formation of coalitions. While many scholars theoretically describe a natural monopoly hypothesis, the reality shows an abundance of SDOs in web standardization. We use the standardization model of intra-organizational bargaining followed by sequential adoption to provide us with a framework. This framework is used to distinguish the preferences of companies with respect to SDOs. We assume that resource allocation is shaped by preferences for

SDOs. These preferences match more or less the way standardization is organized at an SDO, both within and between SDOs. This is affected by the characteristics of the SDO, which is shaped by several factors: the standardization process (speed, efficiency and IPR policy), presence of competitors, and size. An additional factor is introduced which focuses how SDOs deal with the process of sequential adoption. This factor measures the probability that an SDO will be successful in pushing its standards in the market. The probability increases if the SDO has greater influence or attraction (soft power) vis-à-vis other SDOs. We have called this factor *coordination power*, which exists of five dimensions: centrality, willingness to coordinate, quality of products, reliability/predictability, and proactiveness in the standards community. If an SDO has high coordination power, other SDOs will follow (or use) its standards; they will not rival the technology. Our hypothesis is that companies prefer SDOs with high coordination power. It would increase the chance that the standards that they invest in (by being a member of an SDO) would eventually become widespread in the market place.

To test our hypothesis, two studies were described. One study assessed the opinions of W3C members on a variety of topics (answering sub-question five). We tested coordination power as a latent multidimensional construct. Four of five dimensions were tested by this research. The results show that the four dimensions are deemed important to very important: a mean of 3.4 on a scale from 1 to 4. Furthermore, the results were subjected to a regression analysis to test whether the importance of coordination power correlates with actual resource allocation at the W3C. There was a (statistical) significant correlation found. Companies that found coordination power more important also have more employees in WGs and IGs. However, only a small part of the variation (9%) in the manning of WGs and IGs could be explained by the importance given to the four dimensions. On the other hand, in the overall model, the four dimensions of coordination power are also a part of the array of influences.

After an elaboration of the most important SDOs in the field of telecommunications and web technology, a study of the connections between 48 SDOs was presented. This answers the fourth sub-question. The remaining dimension *centrality* was measured and correlated with the amount of members of the SDOs. The results show that there is a significant positive link between the closeness centrality and number of members. However, which factor influences which – the

direction of the causality – is not answered. As the influences are not mutually exclusive, it would be probable that both exist.

Coming back to the central question, there is slim evidence that companies prefer the network characteristic of coordination power. Although the mean of four dimensions of coordination power is high, actions speak louder than words – or opinions in this case. Companies that are already a member of an SDO tend to allocate more resources to the SDO as they find coordination power more important, although proof is not very solid. However, evidence points in the direction that not only standardization within the SDO is found important, but also the power play between SDOs. The correlation between centrality and number of SDO members also proves that – regardless of the direction of the causality – liaisons with other SDO are deemed important. It does however not tell us whether SDOs with high centrality have a greater attraction to prospective members.

The researched coordination power is only a part of the overall attractiveness of an SDO. The remaining factors were not elaborated here, but further research would be worth pursuing.

The complete picture of resource allocation is left mostly in the dark by us unfortunately. We could only provide a small flashlight and it turned out to shine on a part of the picture that is no very clear. We are still guessing what the picture exactly looks like.

5.1 Discussion

Although our findings are not immovable, it touches upon many interesting subjects. It would be interesting to question companies *in detail* about the process of allocating resources towards standardization (the considerations, the steps involved). It will depend on the nature of the company and its strategy how allocation is decided upon. Some companies have a limited focus, and will consider only a small subset of the SDOs in membership decisions. Larger companies will strategically employ personnel in different SDOs in different intensity. For instance, IBM is a member of almost all 48 SDO that were discussed. The amount of resources that go to specific SDOs would be interesting information for further research.

Dynamism is another subject untouched. SDO membership is not only influenced by the number of liaisons. The W3C has lost members in the past year because of the worsened economic situation. More information on the dynamics of SDO membership would be valuable. A longitudinal study could provide more insights into the movements of memberships. The study presented here is a snapshot measurement.

The influences SDOs have on each other would be another interesting area for deeper investigation. We presented a model of behavioral power; however, how this manifests itself in reality still remains a question. Schmidt & Werle (1997 p. 60) concur as they argue:

> *One crucial weakness of economic approaches to explaining the evolution and functioning of committee standardization is their tendency to neglect power. They do not regard prevailing resource and power differentials between countries or between organizations or individuals, as crucial variables affected the phenomena under consideration.*

Lastly, what the literature lacked until a short time ago was the connection of standardization as commoditizing and corporate strategy. Because of standardization, technologies become commodities, and thus poor building blocks for a competitive strategy. In a Harvard Business Review article Nicholas Carr (2003) explains that only a small amount of companies use IT in a truly (sustainable) competitive fashion. Most companies buy standardized products, with standardized processes built in. These investments are certainly not foolish, but the idea that it gives the company a strategic advantage is flawed according to Carr (p. 42):

> *It is a reasonable assumption, even an intuitive one. But it is mistaken. What makes a resource truly strategic – what gives it the capacity to be the basis for a sustained competitive advantage – is not ubiquity but scarcity.*

With this remark let us go back to the first sentence of this thesis and wonder what the true strategic significance of standardization is. •

6. Appendix I: An overview of SDOs

Standard development organizations in the field of web technology.

Abbreviated Name	Name + URL	Synopsis †
3GPP	3rd Generation Partnership Project 3gpp.org	The scope of 3GPP is to produce globally applicable Technical Specifications and Technical Reports for a 3rd Generation Mobile System based on evolved GSM core networks and the radio access technologies that they support.
3GPP2	3rd Generation Partnership Project 2 3gpp2.org	3GPP2 is a collaborative third generation (3G) telecommunications specifications-setting project comprising North American and Asian interests developing global specifications for ANSI/TIA/EIA-41 Cellular Radio telecommunication Intersystem Operations network evolution to 3G.
Acord	Association for Cooperative Operations Research and Development acord.org	ACORD is a global, nonprofit insurance association whose mission is to facilitate the development and use of standards for the insurance, reinsurance and related financial services industries
ANSI	American National Standards Institute ansi.org	The ANSI is a private, non-profit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system. The Institute's mission is to enhance both the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity.
ARIB	Association of Radio Industries and Businesses arib.or.jp	ARIB's goal is to advance rapidly the use of radio technology for the benefit of society. This is done by integrating knowledge and experience in various fields of radio use such as broadcasting and telecommunications, research and development in radio technology, and serving as a standards development organization for radio technology.
ATIS	Alliance for Telecommunications Industry Solutions atis.org	ATIS is a US based body that is committed to rapidly developing and promoting technical and operations standards for the communications and related information technologies industry worldwide using a pragmatic, flexible and open approach.
ATSC	Advanced Television Systems Committee atsc.org	The Advanced Television Systems Committee, Inc., is an international, non-profit organization developing voluntary standards for digital television.
BPMI	Business Process Management Initiative bpmi.org	BPMI is a non-profit corporation that empowers companies of all sizes, across all industries, to develop and operate business processes that span multiple applications and business partners, behind the firewall and over the Internet. The Initiative's mission is to promote and develop the use of Business Process Management (BPM) through the establishment of standards for process design, deployment, execution, maintenance, and optimization.

CCSA	China Communications Standards Association ccsa.org.cn	To carry out research and survey activities on communications standardization systems; To promote the implementation of communications standards through carrying out related activities, such as promulgation of communications standards, consultation, service and training.
CEN	European Committee for Standardization cenorm.org	CEN is contributing to the objectives of the European Union and European Economic Area with voluntary technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes, and public procurement.
Cenelec	European Committee for Electrotechnical Standardization cenelec.org	CENELEC's mission is to prepare voluntary electrotechnical standards that help develop the Single European Market/European Economic Area for electrical and electronic goods and services removing barriers to trade, creating new markets and cutting compliance costs.
DCMI	Dublin Core Metadata Initiative dublincore.org	The DCMI is an open forum engaged in the development of interoperable online metadata standards that support a broad range of purposes and business models. DCMI's activities include consensus-driven working groups, global conferences and workshops, standards liaison, and educational efforts to promote widespread acceptance of metadata standards and practices.
ECMA	European Computer Manufacturers Association ecma-international.org	Ecma International facilitates the timely creation of a wide range of global Information and Communications Technology (ICT) and Consumer Electronics (CE) standards
ETSI	European Telecommunications Standards Institute etsi.org	The mission of ETSI is to develop globally applicable deliverables meeting the needs of the telecommunications and adjacent electronic communications community, whilst supporting EU and EFTA regulation and initiatives. Ecma is driven by industry to meet the needs of industry, generating a healthy competitive landscape based on differentiation of products and services,
FSTC	Financial Services Technology Consortium fstc.org	The FSTC is a consortium of leading North American-based financial institutions, technology vendors, independent research organizations, and government agencies. It sponsors collaborative technology development-pilots, proofs-of-concept, tests, and demonstrations-supported by member financial institutions and technology companies. Its aim is to bring forward interoperable, open-standard technologies that provide critical infrastructures for the financial services industry.
ICC	International Color Consortium color.org	The ICC was formed for creating, promoting and encouraging the standardization and evolution of an open, vendor-neutral, cross-platform color management system architecture and components.
IDEAllianc e	International Digital Enterprise Alliance idealliance.org	The goal of IDEAlliance is to enable publishers and other information-driven enterprises to strategize, innovate, standardize and implement information technology solutions in an open and cooperative cross-industry environment.

IEC	International Electrotechnical Commission iec.ch	The IEC is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardization and as references when drafting international tenders and contracts.
IEEE	Institute of Electrical and Electronics Engineers ieee.org	The IEEE is committed to the advancement of the theory and practice of electrical, electronics, communications and computer engineering, as well as computer science, the allied branches of engineering and the related arts and sciences and technologies and their application.
IETF	Internet Engineering Task Force ietf.org	The IETF is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual.
ISMA	Internet Streaming Media Alliance isma.tv	The ISMA is a non-profit corporation formed to create specifications that define an interoperable implementation for streaming rich media – video, audio and data – over Internet Protocol (IP) networks.
ISO	International Organization for Standardization iso.org	ISO is the world's largest developer of standards. Its principal activity is the development of technical standards. ISO is a network of the national standards institutes of 146 countries, on the basis of one member per country. ISO is a non-governmental organization: its members are not delegations of national governments.
ISOC	Internet Society isoc.org	ISOC's mission is to assure the open development, evolution and use of the Internet for the benefit of all people throughout the world. It is a professional membership society that provides leadership in addressing issues that confront the future of the Internet, and is the organization home for the groups responsible for Internet infrastructure standards, including the Internet Engineering Task Force (IETF) and the Internet Architecture Board (IAB).
ITU	International Telecommunication Union itu.int	The ITU is an international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services.
JTC1	Joint ISO/IEC Technical Committee jtc1.org	Develop, maintain, promote and facilitate IT standards required by global markets meeting business and user requirements concerning design, development, performance, security, portability, and interoperability of IT systems and tools. Its standards development is conducted with full attention to a strong business-like approach
Liberty Alliance	Liberty Alliance Project projectliberty.org	The Liberty Alliance develops the technology, knowledge and certifications to build identity into the foundation of mobile and web-based communications and transactions
Lisa	Localization Industry Standards Association lisa.org	LISA is a non-profit organization for the GILT (Globalization, Internationalization, Localization, and Translation) business community. Members include manufacturers, services providers, and industry professionals representing corporations with an international business focus. LISA has developed language-technology standards and best practice guidelines for enterprise globalization.

M4IF	MPEG Industry Forum mpegif.org	The MPEG Industry Forum is a not-for-profit organization with the goal to further the adoption of MPEG Standards, by establishing them as well accepted and widely used standards among creators of content, developers, manufacturers, providers of services, and end users.
NIST	National Institute of Standards and Technology nist.gov	NIST is a non-regulatory federal agency within the U.S. Commerce Department's Technology Administration. NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life.
OAI	Open Archives Initiative openarchives.org	The Open Archives Initiative develops and promotes interoperability standards that aim to facilitate the efficient dissemination of content. The Open Archives Initiative has its roots in an effort to enhance access to e-print archives as a means of increasing the availability of scholarly communication.
OASIS	Organization for the Advancement of Structured Information Standards oasis-open.org	OASIS is a not-for-profit, global consortium that drives the development, convergence and adoption of e-business standards.
OeBF	Open eBook Forum oebf.org	The Open eBook Forum is an international trade and standards organization for the electronic publishing industries.
OG	Open Group opengroup.org	The Open Group is an international vendor and technology-neutral consortium that is committed to delivering greater business efficiency by bringing together buyers and suppliers of information technology to lower the time, cost and risk associated with integrating new technology across the enterprise.
OMA	Open Mobile Alliance openmobilealliance.org	The mission of the Open Mobile Alliance is to facilitate global user adoption of mobile data services by specifying market driven mobile service enablers that ensure service interoperability across devices, geographies, service providers, operators, and networks, while allowing businesses to compete through innovation and differentiation.
OMG	Object Management Group omg.org	The OMG is an open membership, not-for-profit consortium that produces and maintains computer industry specifications for interoperable enterprise applications.
OGC	Open Geospatial Consortium opengeospatial.org	The OGC is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services. Through a member-driven consensus programs, OGC works with government, private industry, and academia to create open and extensible software application programming interfaces for geographic information systems (GIS) and other mainstream technologies.
PayCircle	paycircle.org	PayCircle is a vendor-independent non-profit organization. Its main focus is to accelerate the use of payment technology and develop or adopt open payment APIs (uniform Application Programming Interfaces) based on XML, SOAP, Java and other Internet languages.

PRISM	Publishing Requirements for Industry Standard Metadata prismstandard.org	The PRISM specification defines an XML metadata vocabulary for managing, aggregating, post-processing, multi-purposing and aggregating magazine, news, catalog, book, and mainstream journal content.
SMPTE	Society of Motion Picture and Television Engineers Smpte.org	SMPTE develops standards in the motion picture industry. It has a long history of service to the motion imaging community through standards activity, education, promotion of engineering and scientific activity, dissemination of information and communications in these fields, and networking and career development through its membership and sectional organizational structure
T1	Standards Committee for Telecommunications t1.org	Committee T1 develops technical standards and reports regarding interconnection and interoperability of telecommunications networks at interfaces with end-user systems, carriers, information and enhanced-service providers, and customer premises equipment (CPE). Committee T1-Telecommunications is sponsored by the Alliance for Telecommunications Industry Solutions (ATIS) and is accredited by the American National Standards Institute (ANSI).
TIA	Telecommunications Industry Association tiaonline.org	TIA represents providers of communications and information technology products and services for the global marketplace through its core competencies in standards development, domestic and international advocacy, as well as market development and trade promotion programs.
TTA	Telecommunications Technology Association [Korea] tta.or.kr	The purpose of TTA is to contribute to the advancement of technology and the promotion of information and telecommunications services and industry as well as the development of national *[Korean]* economy, by effectively establishing and providing technical standards that reflect the latest domestic and international technological advances.
TTC	Japanese Telecommunications Technology Committee [Japan] ttc.or.jp	The purpose of this committee is to contribute to standardization in the field of telecommunications by establishing protocols and standards for telecommunications networks and terminal equipment, etc as well as to disseminate those standards.
Unicode	Unicode Consortium unicode.org	The Unicode Consortium is a non-profit organization originally founded to develop, extend and promote use of the Unicode Standard, which specifies the representation of text in modern software products and standards. The Unicode Consortium actively develops standards in the area of internationalization including defining the behavior and relationships between Unicode characters.
VoiceXML	Voice Extensible Markup Language Forum voicexml.org	The VoiceXML Forum is an industry organization formed to create and promote the Voice Extensible Markup Language (VoiceXML). With the backing and contributions of its diverse membership, including key industry leaders, the VoiceXML Forum has successfully driven market acceptance of VoiceXML through a wide array of speech-enabled applications.

W3C	World Wide Web Consortium w3.org	The W3C develops interoperable technologies (specifications, guidelines, software, and tools) to lead the Web to its full potential. W3C is a forum for information, commerce, communication, and collective understanding.
Web3D	Web 3 Dimensional Consortium web3d.org	The Web3D Consortium was formed to provide a forum for the creation of open standards for Web3D specifications, and to accelerate the worldwide demand for products based on these standards through the sponsorship of market and user education programs.
WS-I	Web Services Interoperability Organization ws-i.org	The Web Services Interoperability Organization is an open industry effort chartered to promote Web Services interoperability across platforms, applications, and programming languages.

† The synopses about the organizations come from the respective web pages.

7. Appendix II: A historical note on the economics of information

The traditional idea of the inner workings of the market was handed down to us by Alfred Marshall and other contemporary economists. It was based on the assumption of diminishing returns, in his book *Principles of Economics* (1890, Book Five) he states that 'the notion of the marginal employment of any agent of production implies a possible tendency to diminishing return from its increased employment.' This means that if a company or product gets ahead in a market, it will eventually run into limitations, so that a predictable equilibrium of prices and market shares is reached (Arthur, 1996). For example, in farming, the farmer will first farm the most fertile land with the most valuable crops. To expand the farm's business, the farmer will have to cultivate progressively less fertile land and will have to grow less valuable crops once the demand for the most valuable crop has been met. In general, the bigger a business gets, the less optimal its last venture. This theory was roughly valid for the economy of the 1880s and 1890s – the time of Marshall – where much of the goods were resource intensive (bulk), but light on know-how. Subsequently, the change in the Western economy has seen rapid advancements in the field of technology and the notion that, besides tangible resources, *information* was a valuable good as well. Economist Paul Romer (1996 p. 204) explains this approach, which has been called the New Growth Theory:

> *New growth theorists now start by dividing the world into two fundamentally different types of productive inputs that can be called 'ideas' and 'things'. Ideas are non-rival goods that could be stored in a bit string. Things are rival goods with mass (or energy). With ideas and things, one can explain how economic growth works. Non rival ideas can be used to rearrange things, for example, when one follows a recipe and transforms noxious olives into tasty and healthful olive oil. Economic growth arises from the discovery of new recipes and the transformation of things from low to high value configurations.*

Thus, rival goods are goods that cannot be used by more persons at the same time, such as a chair or sand-belt machine. Non-rival goods are goods that can be used by

more persons at the same time, and are basically a way to talk about information-baring recourses, such as recipes, blueprints, or software programs. The notion that information can have vast economic value has boomed in the last decades. As a result, the underlying mechanisms that determine economic behavior have shifted from ones of diminishing to ones of increasing returns (Arthur, 1996). Increasing returns signify positive feedback and can make markets tippy.

Although networks, both physical and virtual, were present long before the arrival of the so-called information economy, an evident shift has taken place. Sociologist Castells (2000 p. 30) notes that 'the prophetic hype and ideological manipulation characterizing most discourses on the information technology revolution should not mislead us into underestimating its truly fundamental significance'. He sees this shift we have seen in the last decades as 'a true discontinuity in the material basis of the economy, society, and culture'. And although this thesis is not about sociology and culture, economic behavior is rooted in it. Our view has changed over the last decades as we now are able to value information in an economical sense, and see ourselves more and more as – what Peter Drucker (1969) calls – knowledge workers.

8. Appendix III: Organization of the W3C

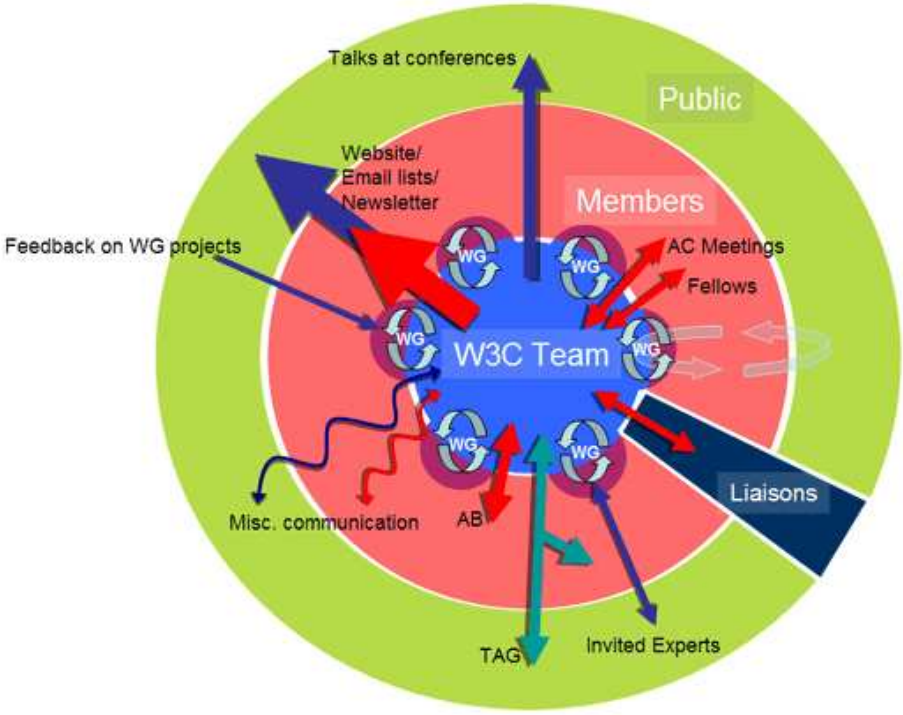


Figure 17 – Communication processes at W3C

Key: WG: Working Group; AB: Advisory Board; TAG: Technical Architecture Group; AC: Advisory Committee.

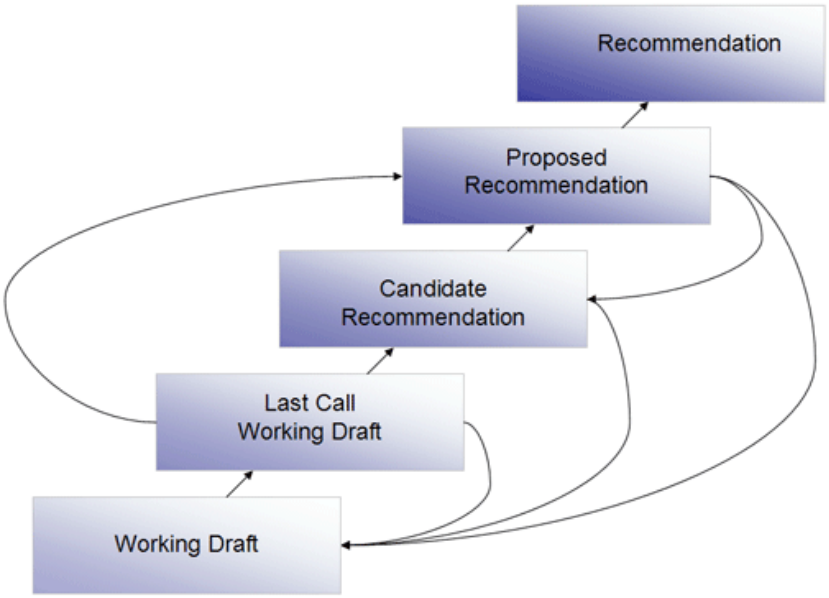


Figure 18 – Recommendation track at the W3C (with feedback loops)

9. Appendix IV: W3C questionnaire

1. Communication is crucial for the W3C and its Members. Rate the value to your organization of the following services.
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)
On the right, please rate the current quality of the services. (Poor, Good, Very Good)

- Public Web site
- Member Site
- Monthly Newsletter
- Weekly Newswire
- Email correspondence (e.g. calls for review, etc.)
- W3C-ac-forum mailing list
- AC Meetings (twice a year)
- Technical Plenary (once a year)
- Workshops and Symposia
- Press Releases
- Coordination with other Standards Bodies

2. The W3C produces many different products and services. Rate the value to your organization of the following.
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)
On the right, please rate the current quality of the products and services. (Poor, Good, Very Good)

- Technical Specifications
- Guidelines (e.g. Accessibility, Internationalization, QA)
- Software (e.g. Amaya, Jigsaw)
- Public Tools (e.g. HTML Validator, CSS Validator)
- Working Group Tools
- Test Suites (e.g. XML, XSL, SMIL, SVG, DOM)
- Member Submissions

3. Rate the value to your organization of the following goals and operating principles, as taken from the W3C in 7 points page.
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)

- Coherent architectural vision and design
- Universal access
- Application-to-Application Communications (Web Services / Semantic Web)
- Trust
- Interoperability
- Evolvability
- Decentralization
- Richer Multimedia
- Vendor Neutrality

4. The W3C work is accomplished largely within Activities and their associated Working and Interest Groups. Please indicate the top five Working Groups (WG), Interest Groups (IG), and software projects in terms of importance to your organization.
(1 being most important, 2 second most important, etc.)

– List of WGs and IGs –

Please list Working Groups (WG) and Interest Groups (IG) in which the work could be completed or the Group closed over the next year.

– List of WGs and IGs –

5. There are a number of steps in the process of producing W3C Recommendations. Rate the value to your organization of the following activities in the standardization process.
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)

- Charter development and review
- Working Group process (including consensus building)
- Cross Working Group review
- Member review
- Public review
- Implementation experience
- Interoperability and Quality Assurance
- W3C Recommendation track process (overall)

6. The W3C membership offers your organization access to many groups of people. Rate the value of access to the following groups.
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)

- Advisory Committee (AC)
- Advisory Board (AB)
- Team
- Offices
- Technical Architecture Group (TAG)
- Management Team
- Other Members of W3C

7. Overall, how important is...
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)

- W3C to your organization?

- W3C's leadership within the standards community?
- W3C's leadership in development of cutting-edge technologies?
- W3C's support of maintaining and improving existing Recommendations?

8. Next, we would like your opinion about future work of the W3C, in areas not already covered by previous questions. Rate the importance to your organization of the following new areas of work.
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)

- Advanced development and prototyping
- Expanded Education and Outreach
- Promotion of best practices
- Certification Program
- Usability
- Extension into developing countries
- Digital rights description and management
- Component extension

(Optional)

- Please indicate any other area of work that you feel the W3C should focus on in the future.

9. Rate the value (to your organization) of your participation in the following W3C activities.
(1:Not Important 2:Somewhat Important 3:Important 4:Very Important)

- Tracking the Working Group mailing lists
- Tracking the Working Group publications
- Reviewing Working Group documents
- Sending comments to Working Groups
- Participating in a Working Group
- Submitting technology to W3C
- Implementing W3C Recommendations
- Promoting implementations of W3C technologies
- Associating your organization with W3C

10. Number of employees of your organization currently active in Working Groups?

11. Number of employees of your organization currently active in Interest Groups?

12. Primary field of business other, please specify

13. Does your organization primarily connect to the W3C as a *PROVIDER* or *USER* of Information and Communication Technology (ICT)?
(ICT Providers are considered organizations that develop technology and/or provide service in the area of hardware, software, communications, content or integration thereof)

14. In which standards bodies does your organization participate? (In the area of Web technology)

3GPP / IEEE / IETF /OMG /ECMA / JCP / OMA /ETSI /ITU / Open Group / OASIS / ISO / WS-I / Others, please specify / None

15. Your organization's annual revenue as reported in your last annual report (in US$, for example: 15,300,000)

16. Number of employees in your organization?

10. Appendix V: Respondent Population

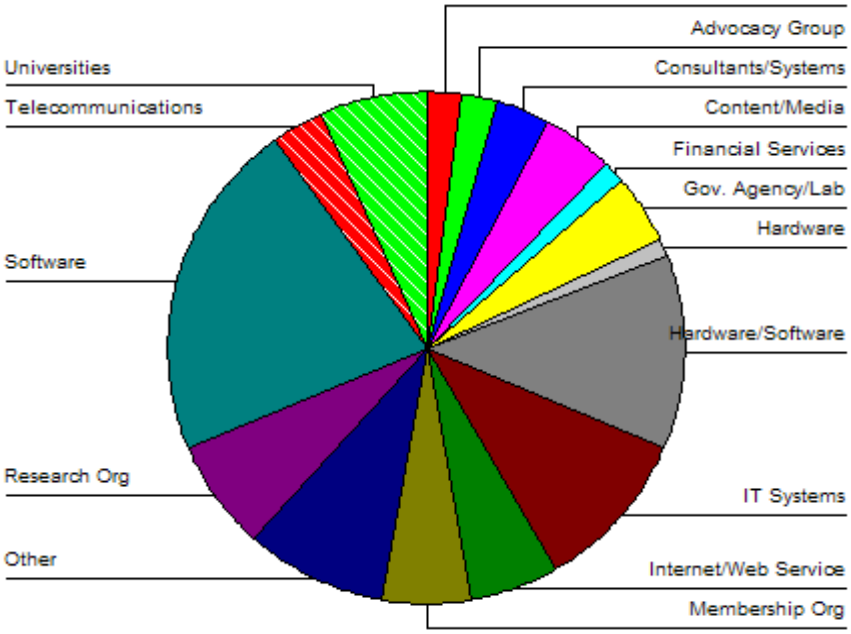


Figure 19 – Respondent population broken down by industry

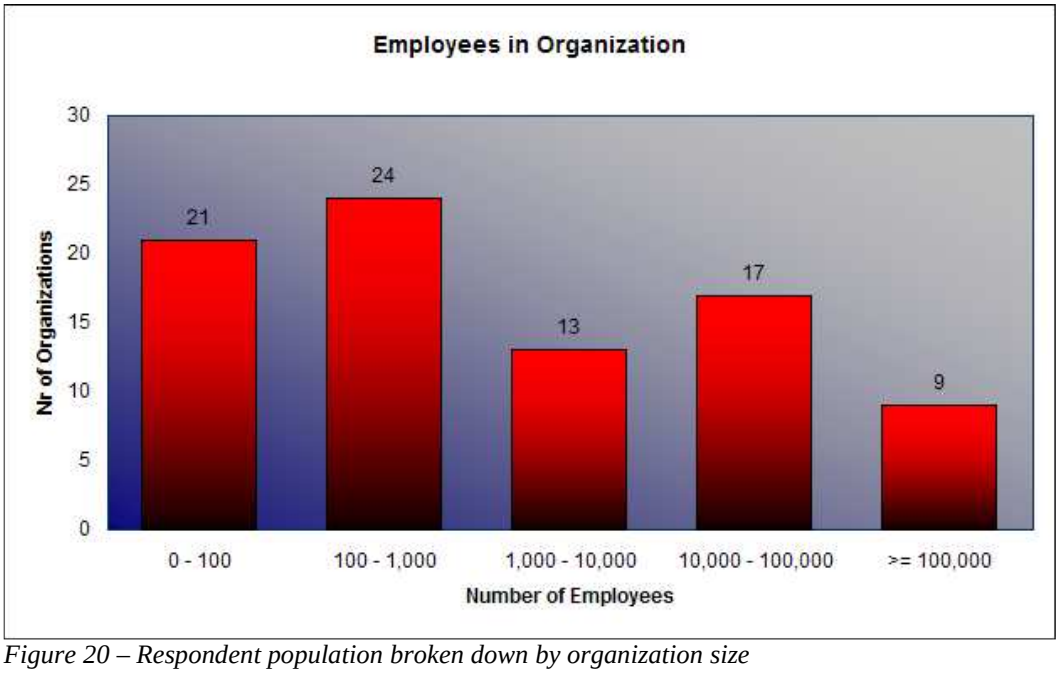


Figure 20 – Respondent population broken down by organization size

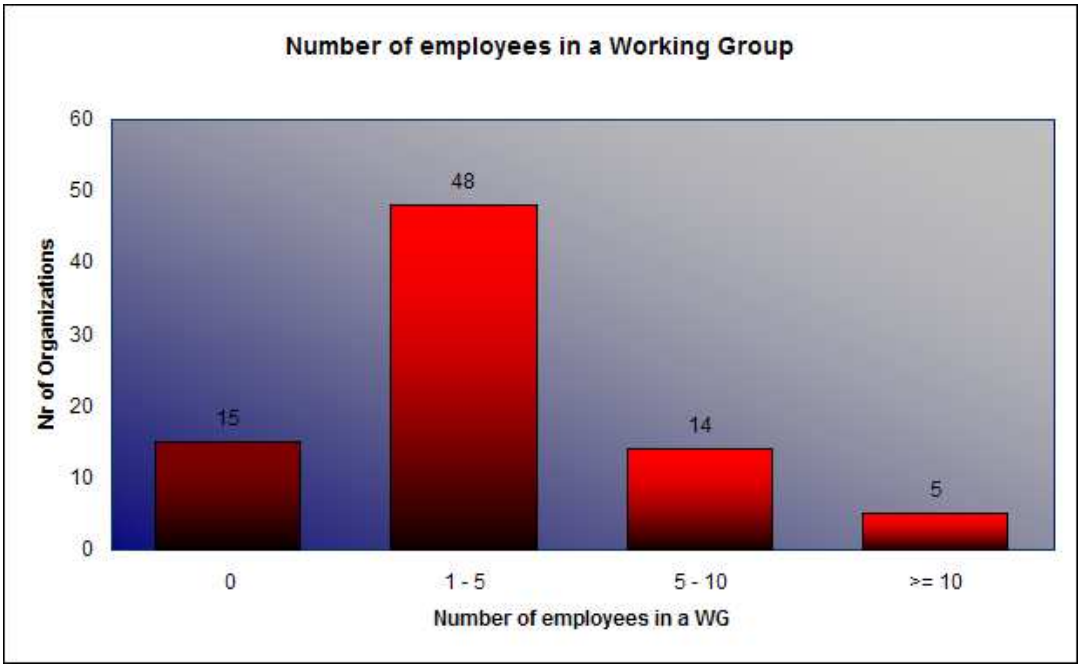


Figure 21 – Respondent population broken down by number of people in Working Groups

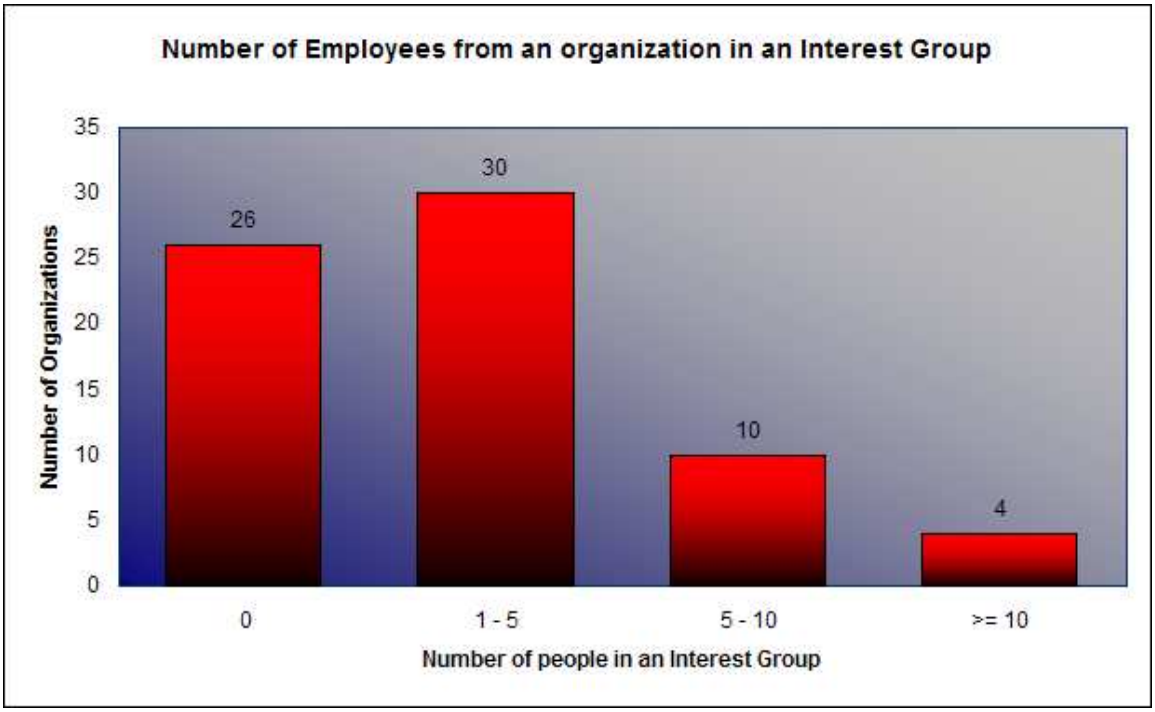


Figure 22 – Respondent population broken down by number of people in Interest Groups

11. Appendix VI: Results

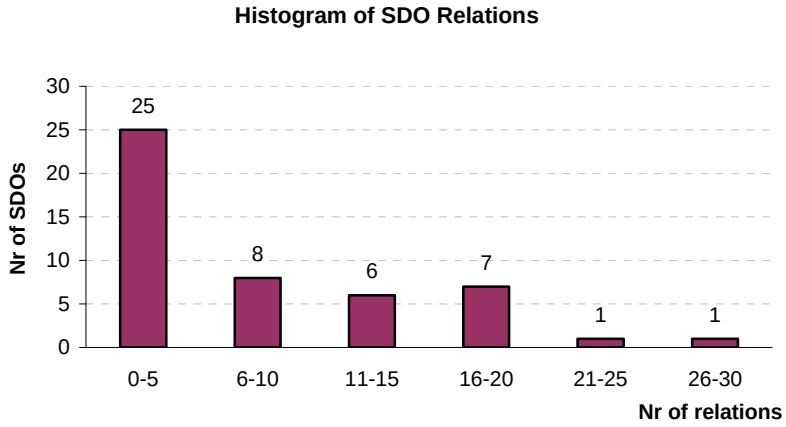


Figure 22 – Histogram of SDO and its amount of liaisons

SDO	Connections	Members
3GPP	18	229
3GPP2	9	72
Acord	4	420
ANSI	7	512
ARIB	5	297
ATIS	3	263
ATSC	4	131
BPMI	3	61
CCSA	7	97
CEN	10	*n/a*
Cenelec	5	*n/a*
DCMI	8	*n/a*
ECMA	11	41
ETSI	19	688
FSTC	5	62
ICC	3	73
IDEAlliance	4	189
IEC	16	*n/a*
IEEE	20	*n/a*
IETF	15	*n/a*
ISMA	4	30
ISO	18	*n/a*
ISOC	5	150
ITU	24	634

SDO	Connections	Members
JTC1	19	*n/a*
Liberty Alliance	3	110
Lisa	1	72
M4IF	3	91
NIST	13	*n/a*
OAI	1	*n/a*
OASIS	14	418
OeBF	4	74
OG	12	178
OGC	5	266
OMA	11	263
OMG	17	345
PayCircle	3	16
PRISM	2	50
SMPTE	3	205
T1	8	83
TIA	6	574
TTA	7	179
TTC	5	134
Unicode	5	51
VoiceXML	2	47
W3C	27	359
Web3D	2	28
WS-I	2	124

Table 5 – SDOs, connections, and number of (voting) members

Core/Periphery Class Memberships

1 (Core): 3GPP / CEN / DCMI / ETSI / IEEE / IETF / ISO / ITU / NIST / OASIS / OG / OMA / OMG / W3C / IEC / JTC1

2 (Periphery): ECMA / FSTC / ICC / OeBF / OGC / SMPTE / Unicode / Web3D / ARIB / CCSA / T1 / TTA / TTC / Cenelec / TIA / 3GPP2 / ANSI / ATSC / OAI / ISOC / Lisa / M4FI / PRISM / IDEAlliance / Acord / BPMI / ISMA / Liberty / Alliance / PayCircle / VoiceXML / WS-I / ATIS

Density Matrix

	1	2
1	0.71	0.18
2	0.18	0.05

Table 6 – Density matrix of the core and periphery of the network of SDOs

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