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Institutional Aspects of Standardization: Jurisdictional Conflicts and the Choice of Standardization Organizations

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Abstract

Standardization organizations in the area of information and telecommunications technology have mushroomed in the last two decades. In addition to new official organizations at the regional level, many private consortiums and forums have been set up that complement and compete with the incumbent national and international organizations. The organizational landscape and the relations between the standardization organizations are examined, and institutional reasons that could explain why the frequency and intensity of jurisdictional conflicts has remained low are considered. Institutional features do not only frame a standardization organization's behavior toward other organizations, they also account for speed, exclusiveness, costs and market acceptance of standardization and thus influence firms' decisions as to which organization to turn to with a standards issue.

Zusammenfassung

In den letzten beiden Jahrzehnten ist die Zahl der Standardisierungsorganisationen im Bereich der Informations- und Telekommunikationstechnik rasch gewachsen. Neben neuen offiziellen Organisationen auf der regionalen Ebene sind viele private Konsortien und Foren entstanden, die sich mit den bestehenden nationalen und internationalen Organisationen ergänzen oder auch mit ihnen konkurrieren. Die Landschaft der Standardisierungsorganisationen und die Beziehungen zwischen ihnen werden untersucht und zudem die institutionellen Faktoren aufgezeigt, die dazu beitragen, dass Kompetenzkonflikte relativ selten auftreten und nicht sehr intensiv sind. Die institutionellen Merkmale kanalisieren nicht nur das Verhalten der Standardisierungsorganisationen untereinander, sie beeinflussen auch Geschwindigkeit, Exklusivität, Kosten und Marktakzeptanz der Standardisierung und leiten damit die Entscheidung der Unternehmen, an welche Organisation sie sich mit einem Standardisierungsproblem wenden.

Contents

1 Introduction

In the last two decades we have observed a proliferation of standardization organizations. In telecommunications and information technology in particular – the focus of this paper – changes have been far-reaching. Both the globalization of markets and the blurring of technical boundaries have induced an overlap of the domains of international and regional standardization organizations. At the same time, standards organizations at the national level are losing significance. Traditional organizations have been restructured, and – assisted by governments – new official standards organizations have been created at the regional level. Most dramatic, however, has been the growth of private consortiums and forums which were set up by business groups to whom it appeared more promising to establish their own forum than to take their interests in creating technical standards to the incumbent organizations (cf. Drake 1994). Thus, "official" standard setting is confronted with an "informal sector" of standards development, the evolution of which indicates some discontent with the traditional organizations and entails an inherent potential of jurisdictional conflict.

In the first part of this paper I examine how the structure of the global landscape of standardization organizations developed, how the organizations deal with one another, and whether competition or collaboration prevails. I argue that the level of jurisdictional conflict between the organizations has remained comparatively low – not simply because scarce resources demand avoiding duplication of work, but also due to institutional similarities of old and new standardization organizations.

Telecommunications and information technology are network industries where standards – or more specifically compatibility standards – play a crucial role (Shapiro / Varian 1999). Both industries together with the electronic media sector form the core of the information society, which is characterized by an increasing need for standards (Williams 1997). In fact producers as well as users can benefit from standards, although they are usually developed by producers because they have the greatest potential economic benefit from setting standards. With the convergence in technologies between telecommunications, information technology and broadcasting, there is likely to be common interests in standards between different organizations. The multitude of standards organizations offers

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firms a choice as to which organization they can turn to if they want to initiate standardization. This raises the question of which factors the decision is guided by. Some of these factors rooted in the institutional shape of standards organizations are illustrated in the second part of the paper.

In a short section preceding the two main parts of this paper, the role and the dimensions of compatibility and its relation to the process of standardization are clarified in order to illustrate the ambivalence of this process between collaboration and competition.

2 A theoretical view of standardization

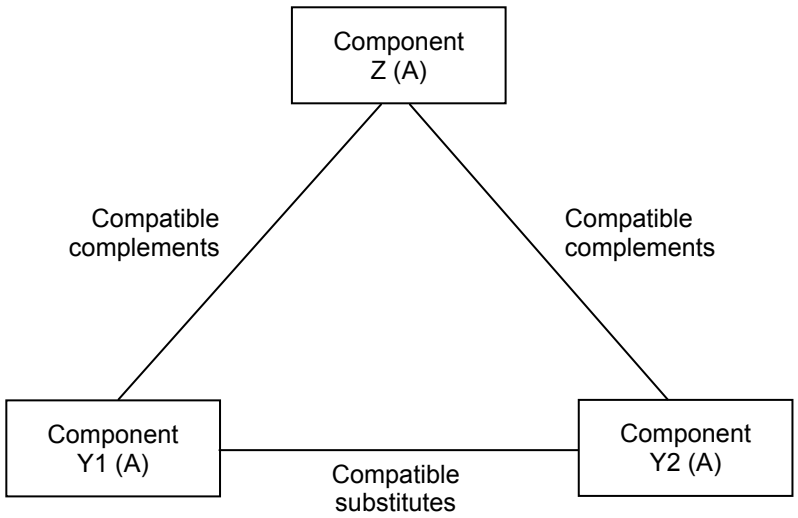
This paper is concerned with organizations that develop compatibility standards. These standards define protocol, code, and interface specifications and aim at interoperability of complementary technical components. Compatibility allows different products and services to work together in networks. Compatibility standards are coordinative standards: they facilitate coordinated manufacturing of network goods and thus help reduce transaction costs.1 This is why in many cases producers of network goods who acknowledge technological interdependence are interested in coordinating with others, and it is at the same time one *raison d'être* of standardization organizations, which provide an arena to collectively develop and negotiate on standards. Getting involved in standardization requires "membership" in a standards committee. Such a committee may be a unit of a classical standardization organization or an industry consortium or forum outside the official organizations. However, only a fraction of all coordinative standards result from committee work. Some emerge in markets where bandwagon and imitation processes can be observed. Others are imposed by dominant firms, leaving smaller competitors and users of a technology no choice. The latter indicates that standardization is not always a low-conflict business.

The tension between collaboration and competition inherent in standardization is revealed by a closer look at what might be called the two faces of compatibility. Compatibility has a vertical and a horizontal dimension. Technical components based on the same standard are either "compatible complements" or "compatible

1 We have suggested drawing an analytical distinction between regulative and coordinative standards. While regulative standards for, say, environmental protection are defined and mandated by hierarchical political governance, coordinative standards, say for a specific modulation procedure, may emerge in markets or be adopted by committees on a voluntary basis (Schmidt / Werle 1998: 119–120).

substitutes" (David / Bunn 1988: 171). If the components Y_1 and Z in Figure 1 are designed according to standard A, they are vertically compatible and complementary because they can be used with each other. A specific format of a film (e.g. 35 mm) is compatible with specific cameras, or a certain word processing program runs on a certain PC operating system. Often a single component is useless unless it is interoperable with a compatible complement. Producers as well as users of these components have a vital interest in compatibility. However, if not only Y_1 but also another functionally equivalent component Y_2 is compatible with Z, then from the users' and the producers' point of view it makes no difference whether Y_2 or Y_1 is employed. Thus, with respect to interoperability with Z, both components are horizontally compatible substitutes if they are designed according to the same standard. WordPerfect, Word and other word processors, for instance, are horizontally compatible because they all run on Windows.

Figure 1 Two faces of compatibility



(A) Compability standard A

Economists often have only the aspect of horizontal (substitutive) compatibility in mind when they talk about the effects of compatibility (Katz / Shapiro 1985: 425). Horizontal compatibility is indeed a precondition for competition (cf. Tirole 1988: 298–301). Producers of substitutive technology compete; those of complementary components do not.

These complementary components can be combined into composite goods or systems. It is complementarity rather than substitutivity that creates the network

characteristics of goods (cf. Economides 1989; Economides / Salop 1992). If goods or services are complementary, their production or consumption can have positive network externalities, implying that individual actions affect the utility of other actors (Gilbert 1992).2 This can result in a "critical mass" dilemma. Unless, as vertically integrated manufacturers, they are able to provide complete systems, producers (of components) of a network technology tend to wait and see what others decide to provide because they do not want to become "stranded" with incompatible products (Rogers 1995; also Granovetter 1978). Stranding can be avoided by establishing a consensus on the interface characteristics of the components. Convergence on one single compatibility standard would be the most efficient solution (cf. Church / Gandal 1992).

The common interest of producers of complementary products in compatibility does not guarantee that it will be achieved. Only if the producers of components Y and Z have no diverging preferences as to which technical specification they choose, will they easily agree on one single compatibility standard. In this case, which describes a pure coordination problem, standardization requires no more than communication to avoid isolated action resulting in accidentally diverging choices. Standardization organizations open to all interested parties provide such an opportunity to communicate. As soon as the producers of component Y begin to prefer standard A, while the producers of Z are tending toward solution B, it may be difficult to achieve compatibility although both sides do not dissent on the high value of a common standard. In terms of game theory, this situation entails a "battle of the sexes" type of conflict. Coordination on a common solution promises the highest total payoff, but reaching this solution requires one of the parties to settle on its second preference only. This party will also gain from a standard, but the payoff will be relatively smaller than that of the other party. Battle of the sexes has been identified to be the typical conflict in compatibility standardization (Farrell / Saloner 1988; Schmidt / Werle 1998: 98–108). Arthur Stein (1982: 309) speaks of a "dilemma of common aversions". The parties have a strong common aversion to incompatibility, but they lack a common recipe for preventing it if they prefer different standards, which imply different relative gains.

Whenever the relative gains at stake are high, the battle of the sexes can escalate and the game can be transformed from a positive sum to a zero sum game or to a "prisoners' dilemma" (Snidal 1985). Often the actors involved change their interaction orientations and pursue more conflictive standardization strategies (cf. Scharpf 1997). But game theory need not be overstressed. If we return to the two faces of compatibility (Figure 1), it is easy to imagine the producers of the func-

2 Network technologies contrast with the conventional assumption in economic theory of diminishing returns to scale. They are subject to increasing returns (Arthur 1989).

tionally equivalent components Y_1 and Y_2 regarding each other as competitors. From their angles, the standard to be adopted will lay the groundwork for competitive advantage and disadvantage. Thus, for each producer of the Y components compromising with the producer of Z is more likely than reaching an agreement with their competitor.

It is against this background of the specific tensions resulting from the two faces of compatibility that standardization organizations and standardization strategies shall be analyzed. The analysis includes a feature that is neglected in the game-theoretical view on standardization. In many cases the technical solution to a compatibility problem and / or the economic implications of different alternatives are uncertain. In consequence, firms' preferences stay indeterminate and ambivalent during parts of the standardization process. Therefore "the efficiency aspect" of standardization, i.e. finding an adequate solution to a compatibility problem, often overshadows its "distributional aspect" (cf. Schelling 1960: 21). First, value must be created through joint action before it can be claimed individually.

3 The landscape of standardization organizations: Competition, coordination, co-existence

The examination of the concept of compatibility and its two faces suggests that producers of complementary goods are better off with compatibility than without. Unless they are able to secure compatibility by vertically integrating or controlling the production of all components of a system, they can achieve it through voluntary standards. The best solution *ceteris paribus* would be striving for one single standard, which implies concentrating standards development for a specific system and the respective market in one standardization organization. As a matter of fact, standard developing organizations hesitate to define more than one standard or a standard with too many options for a specific technical function. The principle of parsimony of standards options has developed into an institutionalized value of these organizations. All this leads to the conclusion that the standardization business comes close to a natural monopoly, which means that the co-existence of more than one standard-developing organization is inefficient (see Genschel 1997). This suggestion, however, contrasts sharply with what has been observed in standardization of telecommunications and information technology, two network industries in which compatibility standards play a crucial role. The number of organizations developing standards has grown significantly in the last two decades, and there can be no doubt that their jurisdictions overlap, which entails conflict potential.

It is impossible to give a comprehensive overview of all standardization organizations in telecommunications and information technology, and in this sense Figure 2 is inevitably incomplete. Figure 2 refers to the organizational landscape of standardization in the middle of the 1990s, drawing on a more comprehensive diagram provided by Rutkowski.3 Only a few features of Figure 2 – with the focus on the formal status of the organizations – shall be discussed.

Generally, three dimensions according to which standardization organizations can be grouped appear to be relevant:

- The level (scope) of standardization: We find organizations with national, regional or global significance.

- The sector or industry affiliation: Although the boundaries are blurring, we can still distinguish organizations with a focus on information technology from those focusing on telecommunications.

- The formal status of the organizations: We have official standards organizations – recognized and often supported by governments. And we have "private" groups and committees (forums, consortiums) based on informal agreements or multilateral contracts.

In addition, three distinctive roots combined in different proportions characterize each standards organization (Schmidt / Werle 1998: 56):

- A political root indicates governments' control interests. They include safety aspects, technology and industrial policy objectives, and national welfare goals.

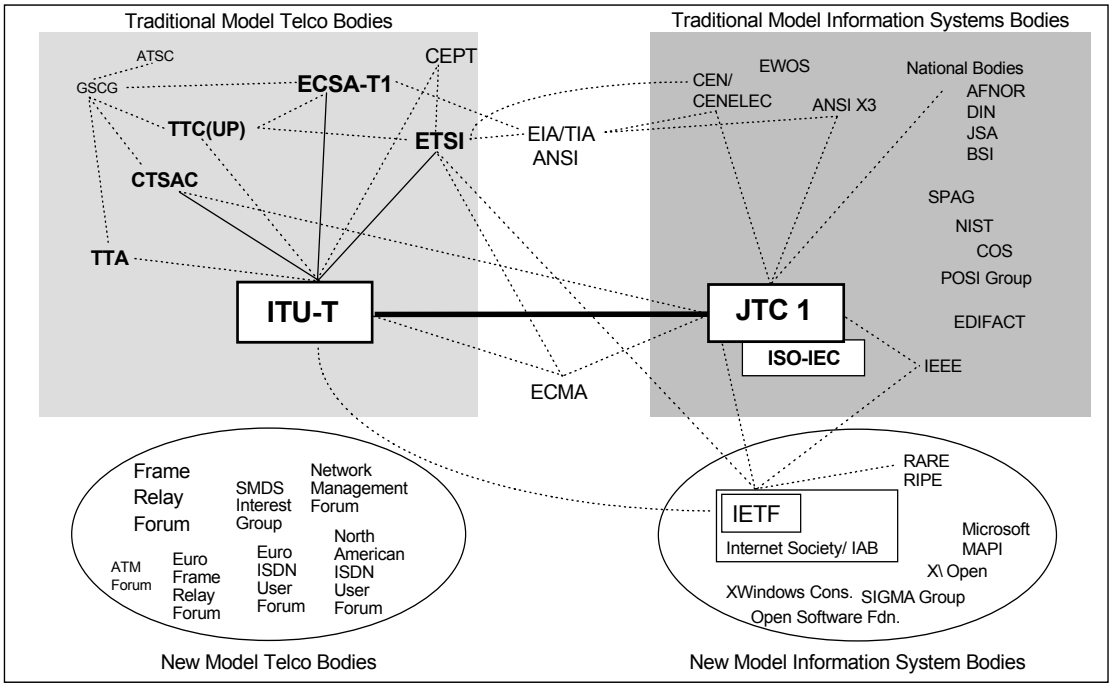
- A commercial root that expresses business and profit interests including the reduction of transaction costs and positive coordination externalities.

- A professional root that indicates a collective interest of the engineering profession to enhance, consolidate and codify technical knowledge and safeguard professional control of the development of technical systems.

These roots are not included in Figure 2, but they will be identified when the origins of official and private standardization organizations are examined.

3 Rutkowski published it in 1994. It was found on the server of the Internet Society: http://www.isoc.org/images/univers.gif.

Figure 2 The organizational landscape of standardization in the middle of the 1990s



AAFNOR	Association Française de Normalisation
ANSI	American National Standards Institute
ATSC	Australian Telecommunication Standards Committee
BSI	British Standards Institution
CEN	European Committee for Standardization
CEN/ CENELEC	European Committee for Electrotechnical Standardization
CEPT	Conference of European Posts and Telecommunications Administrations
COS	Corporation for Open Systems
DIN	Deutsches Institut für Normung
ECMA	European Computer Manufacturers Association
ECSA-T1	Exchange Carriers Standards Association, USA
EDIFACT	Electronic Data Interchange For Administration, Commerce and Transport
EIA	Electronics Industry Association
ETSI	European Telecommunications Standards Institute
EWOS	European Workshop for Open Systems
GSCG	Global Standards Collaboration Group
IAB	Internet Advertising Bureau
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JSA	Japanese Standards Association
JTC 1	Joint Technical Committee
NIST	National Institute of Standards and Technology
POSI Group	Promoting Conference for Open Systems Interconnection
RARE	Résaux Associés pour la Recherche Européenne
RIPE	Réseaux IP Européens
SPAG	Standards Promotion and Application Group
TIA	Telecommunication Industry Association
TTA	Telecommunications Technology Association, Korea
TTC(UP)	Telecommunications Technology Committee, Japan

Official organizations

The two "official" organizations with the broadest range of responsibilities for standardization at the international level are ITU-T, the standardization branch of the International Telecommunication Union (ITU), and the Joint Technical Committee 1 (JTC1), which was set up in 1987 by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Although ITU, on the one hand, and ISO and IEC, on the other hand, have a different legal status, they can be regarded as classical international organizations with national membership and one-nation-one-vote decision rules. ITU-T issues telecommunications standards (called recommendations), whereas JTC1 covers information technology. Their standards are international, which means in the area of telecommunications that they are used to coordinating international networks and services. At the national or regional level, other standards or "substandards" with a specific profile matched to the particular area and market may apply. They are issued by organizations with respective responsibility. A similar differentiation, though not that clear-cut, was also aimed at in information technology. The traditional horizontal and vertical separation of jurisdictions helped avoid conflicts between standards organizations and prevent more than one standard from being issued where a technical specification was needed.

The creation of JTC1 has to be seen against the background of overlapping organizational domains. Since the early 1970s ISO and IEC had difficulties in clearly separating their jurisdictions in the area of equipment and components of information technology. An agreement in 1976 concerning the division of labor in this area indicated that both organizations gave agreements and coordination preference to competition from an early stage. As a consequence, in 1987, both organizations institutionalized collaboration by setting up JTC1 and transferring tasks and competencies from ISO and IEC committees to this unit (Schmidt / Werle 1998: 46–50; David / Shurmer 1996: 792).

Another example of cooperation instead of competition relates to the famous Open Systems Interconnection (OSI) frame of reference adopted by both ITU and ISO in the early 1980s. OSI was meant to provide a framework for developing open, i.e. non-proprietary, standards for computer networks at a time when vendor-specific proprietary networks prevailed. ITU and ISO claimed competence in this area because public networks (ITU) and computers (ISO) were the constituent components of computer networks. Drawing undisputed distinctions between the jurisdictions proved to be difficult. The case of e-mail standardization provides an example (Schmidt / Werle 1998: 229–262). In the early 1980s, experts in both organizations worked at the same time on what was called message handling standards. After a short period of mutual ignorance both sides started to

coordinate work. They organized co-located meetings of the standards committees and, later, most of the work was consolidated under the roof of ITU, although no official agreement was striven for. As a result, both organizations published many identical standards in message handling and, in doing so, avoided duplication of work. Even more important was the fact that adopting competing standards was avoided, because this would not be compatible with a basic rationale of standardization organizations aimed at converging different technical solutions into one single standard. However, in this case collaboration was initiated by members of the standards committees, not by the top-level executives of ITU and OSI. Some of the members also participated in pre-standardization work on message handling in the International Federation for Information Processing (IFIP), where they had an opportunity to exchange information concerning the work of ITU and ISO. As both organizations shared the goal of developing an open non-proprietary standard, one might expect them to have found a way to get along with each other. The ISO and the ITU committee had invested time and energy in developing standards, but they preferred different draft solutions, though both were far from a final solution. Thus, the friction between the committees was akin to a battle of the sexes where the relative gains were not very high yet. Overlapping membership in ISO, ITU and IFIP, the emerging personal networks and the common interest in a standard fostered collaboration.

Many other instances indicate that ITU and ISO/JTC1 have avoided conflict and competition not only through informal cooperation but increasingly on a formalized basis. The intensity of cooperation is indicated in Figure 2 by the black line connecting ITU and JTC1. Especially in the areas of standardization relating to the OSI standards architecture, cooperation became a matter of routine (Genschel 1995: 162–168). Even when diverging standards were adopted, they did not necessarily lead to incompatibility of systems as long as they were integrated in the overall OSI frame of reference. Seen from this angle, OSI – although a failure in many respects – can be regarded as an early example of what has been called the "meta-standards" approach by David/Shurmer (1996: 810). Meta-standards stipulate technical performance features rather than definite specifications, thereby leaving room for different standard options approved by different organizations. This helps avoid conflict. A recent, more visible move to coordinate standardization activities at the global level was the creation of a Joint Committee on Global Information Infrastructure Standards by ISO, IEC and ITU in 1995. Cross-representation and sharing information are also features of the pattern of coordination between these organizations.

A new potential source of conflict for ITU in the 1980s – apart from the convergence tendencies of telecommunications and information technology – was the emergence of telecommunications standardization organizations at the regional

level, which reflected the growing significance of regional markets in this liberalizing area at the end of this decade. A certain degree of regional diversity of standards in telecommunications appeared to be inevitable, and it expressed the competitive concerns of regional companies. The European Telecommunications Standards Institute (ETSI), the US Exchange Carriers Standards Association (ECSA T1)4 and the Japanese Telecommunications Technology Committee (TTC) were established. ECSA T1 and TTC are virtually national organizations (i.e. representing the USA and Japan) that have regional significance. Foreign members are admitted. Their membership structure is company-based. Each company has one vote. ETSI has a mixed system with some decisions taken by company-based and others taken by nation-based weighted voting. The appearance of the regional organizations threatened to undermine ITU's authority (cf. Hawkins 1992). However, early on, the three regional organizations and ITU opted for coordination and division of labor instead of competition. A first step towards work-sharing was finalized at a conference at Fredericksburg, Virginia, in 1990 (Genschel/Werle 1993). The common goal to prevent organizational competition, because it might violate the institutional rule to avoid conflicting standards, was invoked to facilitate the agreement.

In 1991, also ISO and IEC and their respective European counterparts CEN and CENELEC reached a consensus on cooperation between the two levels of standardization with the so-called "Vienna Agreement" and the "Lugano Agreement". The latter was followed by the "Dresden Agreement" in 1996, which additionally specifies the way in which new work is taken up by IEC or CENELEC (Falke 1999). Horizontal coordination of the three official European standardization organizations ETSI, CEN and CENELEC is provided by an Information and Communication Technology Standards Board (ICTSB) with representatives from these three organizations.

If we look at the national level of standardization, we find that official organizations operate in most of the industrialized countries. While they are politically independent, they are more or less closely linked to governments. The national organizations (one per nation) which are most representative of standardization in their respective countries are members of ISO or IEC. In contrast with most other industries, telecommunications has no tradition of formally independent standardization in many countries. After consulting with manufacturers of telecommunications equipment and service providers, the national PTT monopolies used to set the standards in their own right. In the wake of liberalization the PTTs lost their predominance, but this did not lead to the creation of national standardiza-

4 The name has since been changed to The Alliance for Telecommunications Industry Solutions (ATIS). Before ECSA T1 developed into a regionally significant organization, it was called Standards Committee for Telecommunications (ANSI T1).

tion bodies in Europe. The manufacturers of telecommunications equipment preferred regional or international standards. Therefore European firms supported the plan of the European Commission to establish ETSI (Werle / Fuchs 1993).5 In general, purely national standardization work has significantly decreased in Europe, as it has in other parts of the world (cf. Rixius 1997). National organizations, however, play an important role in transposing regional into national standards (cf. de Vries 1999). This requires coordination between these two levels, which in Europe is provided, for instance, by the so-called "Vilamoura Procedure,"6 which was adopted in 1988 to govern the relationship between CENELEC and the respective national organizations in Europe (David / Shurmer 1996: 808).

Although they represent only a minority of all organizations involved in standard setting, the official organizations of standardization have most visibly shaped the landscape's institutional structure.7 Many of these organizations have political roots (cf. Olshan 1993). Figure 3 shows the prevailing institutional features of this organizational field which have been explored in several studies using different research methods.8 Not all of these features shall be discussed in detail. Compatibility standards adopted by committees in official and less official standardization organizations are voluntary and not mandatory. Their implementation cannot be imposed and their diffusion in the market is not guaranteed. Thus, in constellations with a leveled playing field (symmetric power relations), the standards that are most likely to diffuse are the ones that have been adopted on the basis of consensus by committees open to all interested players. Formally the decision rules of the official standards organizations allow for some kind of qualified majority voting. De facto, however, their work is also consensus-based because at the working level, i.e. in the technical committees and study groups or their subgroups where the developmental activities take place and each participating organization has one vote, no decision is taken against explicit and serious opposition of any single participant.

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5 ETSI has concluded more agreements with other standardization bodies than any other organization. Apart from avoiding duplication of standardization activities in overlapping areas, the agreements are also intended to facilitate discussion of common problems or collaborative research. (For an overview, see: http://www.etsi.fr/cpm/agreement/list.htm).

6 For the USA, see OTA (1992).

7 The institutional features of the standardization organizations, among other factors, guide the companies' decisions as to which organization they turn to if they want to have their preferred standard adopted. Therefore some of the features will be discussed in more detail in the next section.

8 Schmidt / Werle (1998: 56–59); David / Shurmer (1996: 793–795); Egyedi (1996: 111–120); OTA (1992); David / Greenstein (1990); Cargill (1988); Robinson (1986); Cerni (1984); Jones (1979); Verman (1973: 150–188).

Figure 3 Prevailing institutional features of standardization organizations

1. Participation is open to those who are "substantially interested," but it is subject to certain membership requirements.
2. Members are organizations rather than individuals. Individuals are regarded as "delegates" of organizations.
3. The work is committee-based, cooperative and consensus-oriented. It follows formalized rules and procedures.
4. Organization and working procedures are impartial, unsponsored and politically independent ("due process"). The organizations are non-profit organizations.
5. The work is based on technological knowledge and follows the principle of parsimony of standard options. It is not remunerated, and it is conceived of as being superior to market selection of standards.
6. Standards are non-mandatory and public goods. However, they are not necessarily provided to the public free of charge (but on equal terms).

Inclusiveness of committees and the rule of consensual decisions – two rather undisputed institutional features of the organizational field – facilitate the diffusion of a non-mandated voluntary standard. On the other hand, negotiation processes in these constellations can be time-consuming, and they easily lead to deadlock or to unattractive compromise solutions which at the end nobody wants to implement (cf. Buchanan / Tullock 1971; also Scharpf 1997).

More exclusive standardization organizations with fewer players promise to be more efficient and also more effective given that their membership is restricted to technology leaders and firms with substantial market power. Setting up new standards organizations, instead of taking a standardization issue to the incumbent ones, is often motivated by the potential benefits of exclusiveness. However, other objectives have also guided the establishment of new organizations, as we can see when we look at some of these forums and consortiums in more detail. All these organizations differ in one way or another from the incumbent official ones, though they share with them more institutional features than one might expect. Some observers fail to notice this phenomenon of institutional similarity or "institutional isomorphism" of the organizational field of standardization, as it is termed in sociological new institutionalism (DiMaggio / Powell 1991). Institutional similarity, on the other hand, does not rule out jurisdictional conflicts and struggles for predominance or even hegemony in standardization.

Older private organizations

If we look again at Figure 2 we can see that the majority of standardization organizations do not have an official status. Most of them are private consortiums and forums. A few formally unofficial standardization organizations are positioned in the upper half of Figure 2 close to the official ones. This indicates that they are regarded as an integral part of the official standardization regime. A prototype of this kind of standards organizations is the European Computer Manufacturers Association (ECMA).9 Being what we would call a private consortium today, ECMA was established in 1961, with the objective of becoming active in standardization. Early on its membership was restricted to computer manufacturers engaged in Europe, but associate members from other parts of the world were accepted when they had a general interest in the association's work. Moreover, all vendors who owned manufacturing facilities in Europe could join ECMA. Thus, it was no problem, for instance, for American multinationals such as IBM, Xerox, Honeywell and DEC to be accepted as regular members. ECMA has a number of technical committees and task groups in which all members – regardless of their national basis – have full voting rights. ECMA's standards are usually meant to complement official international standards or to be fed as proposals into ongoing standardization work of the official international organizations. The European thrust in ECMA, which is aimed at leveling the playing field in information technology, was moderated by opening the organization to global players with a base in Europe. Thus, ECMA quickly established itself as a recognized standardization organization with stable links to ITU-T, JTC1 and ETSI. In a settlement between ECMA, ETSI and CENELEC in 1991, ECMA was recognized as a standardization organization in its own right and at the same time a feeder organization for the official regional and global standardization organizations. In contrast with these organizations, the principle of national representation in the standard setting process is irrelevant in ECMA.

The initial interest in neutralizing existing differentials in market power between European and North American vendors underlying the creation of ECMA also became apparent in other efforts to set up standardization committees. Examples are provided by several facets of the so-called Open Systems Movement, which is linked to the efforts of ITU and ISO to promote OSI. In 1983, the European Standards Promotion and Application Group (SPAG) was set up by eight major manufacturers of information technology based in Europe. SPAG aimed at facilitating the implementation of the base standards issued by ISO/JTC1 and CCITT, a predecessor of ITU-T, through the specification of "functional profiles". In 1987

9 ECMA is now called International Europe-Based Association for Standardizing Information and Communication Systems.

SPAG initiated the formation of the European Workshop for Open Systems (EWOS), which was created "by the most representative European federations of technology suppliers and user organizations" and was meant to coordinate work and provide for collaboration (Macpherson 1990: 269). They included CEN/CENELEC and also, as a member of the steering committee, DG IX (General Directorate) of the European Commission (Genschel 1995). Like many official standardization organizations, SPAG, ECMA, EWOS and some others have a political root. However, their creation does not reflect a general (national) political interest in controlling standardization; it was rather motivated by industrial policy goals. These goals corresponded with the business interest of European manufacturers. Thus, these organizations have also a commercial root. As they specify general standards rather than define new ones, their relationship to the official international organizations is complementary rather than competitive.10

Younger private organizations

The idea of open standards, with a different connotation though, has also left its mark in the landscape of the younger private standards groups, consortiums and forums.11 Most of them were set up in the 1990s and only a fraction of them are included in Figure 2. Those we find in the lower part of Figure 2 are quite prominent and have existed for some time. From a point of view of organizational change as a consequence of pressure towards institutional similarity, the case of the X/Open Group deserves to be mentioned. Similar to EWOS, but even more explicit in its strategic orientation, X/Open was an alliance of five European computer manufacturers forged (in 1984) to counterattack non-European vendors (Gabel 1987). However, after a few years, – similar to ECMA – all major international computer vendors became members of X/Open. With its general objective being to level the playing field by supporting or creating non-proprietary, or at least non-discriminatory, open standards, X/Open was committed to industry-

10 Arrangements of coordination expressing this complementarity in the standardization of functional specifications (profiles) were established between EWOS and respective North American and Asian workshops on the one hand and JTC1 on the other (Genschel/Werle 1993: 219).

11 Initially only specifications within the Open Systems Interconnection (OSI) frame of reference were regarded as open standards. Later, virtually all non-proprietary standards issued by official standardization organizations and some private units were accepted as open. In 1994, for instance, a US Panel on Federal Internetworking Requirements, established by the National Institute of Standards and Technology (NIST), recommended accepting standards developed by the Internet Engineering Task Force (see below) as open international standards (Radack 1994; in more detail CSTB 1994: 70–111).

wide cooperation and could not refuse applications for admission by the large non-European computer manufacturers. Thus, X/Open lost its exclusive character and was opened for many new members. Other private forums and consortiums such as the Corporation for Open Systems (COS), the X-Window Consortium and the Open Software Foundation (OSF), all set up in the late 1980s, relied on even broader membership. OSF in addition received large contributions from a rather small circle of big influential members who created the organization (cf. Dunphy 1991).12 Like the official organizations, some of the private ones have been confronted with the problem of jurisdictional overlap. In order to avoid open competition, OSF and X/Open consolidated their activities by creating a new organization called The Open Group in February 1996. It coordinates and partially merges the operations of the two units.

The tendency to set up new "para-standardization" bodies of regional and global significance, instead of dealing with new standardization problems in the traditional official organizations, has gained momentum in the 1990s – not only in the area of information technology but also in telecommunications (OECD 1991: 84–86).13 Many new consortiums and forums were created, while others extended their domains. The Asynchronous Transfer Mode (ATM) Forum and the Frame Relay Forum are two examples. Others are related to the Integrated Services Digital Network (ISDN). Many of these forums cover areas in which committees of ITU-T have also been active.

Internet standardization has developed quite differently, being completely detached from any official standardization. Internet standards are developed by the Internet Engineering Task Force (IETF), which is split into numerous working groups covering eight to ten functional areas. Working groups can be easily created, and most of them are wound up after they have finished their task. The groups are managed by area directors. In contrast to most standardization organizations, participation in IETF and its working groups is open to anyone, and a broad and unrestricted discussion of proposals via electronic mailing lists is possible. A steering body, the Internet Engineering Steering Group (IESG), is formed by the IETF Chair and the area directors. IESG coordinates the activities of the working groups, assigns group chairs and approves the results of the groups' work. To be adopted as a standard the draft must be accepted by IETF

12 Not included in Figure 2 is another big consortium, the Object Management Group. OMG was founded by eight companies in 1989 to develop software specifications. Today the consortium includes over 800 members.

13 An initial incentive was provided in the USA in 1984. Congress enacted the National Cooperative Research Act which relaxed antitrust sanctions against cooperative research and development of otherwise competing firms. This made it easier for private companies to jointly develop standards outside the official ANSI-accredited organizations.

and IESG on the basis of consensus. The Internet Architecture Board (IAB), the highest committee in the hierarchy of Internet self-governance, only becomes involved in the standardization process if conflicts at the working level cannot be resolved. All the work is done by volunteers – as it is in most other standardization organizations.

With many researchers and engineering professionals as active members, IETF is comparable to professional associations involved in standardization at the national or international level such as IEEE. The Institute of Electrical and Electronics Engineers has its core membership in North America but is a transnational society with about 300,000 individual members in over 130 countries. IEEE has achieved the status of a recognized standardization organization, both in the US and in the context of the official international organizations. Like IEEE, most of the professional organizations rely on individual and not on organizational membership.

With the Internet's take-off into a global dimension and its increasing commercial viability, the number of individuals involved in standardization has increased enormously. The latest IETF meetings were attended by a thousand or more people. IAB and IESG reacted to this trend by formalizing their working procedures.14 Some observers regard these changes as an adaptation to the "traditional" international standardization organizations (cf. Lehr 1995). For many years Internet standards were almost completely ignored by JTC1 and ITU-T. Only recently has the Internet been officially recognized, and links of coordination have been established between IETF and other standards organizations including JTC1 (Radack 1994) and ITU-T.15

The success of the Internet has very much contributed to the changing official understanding of open standards because it has demonstrated that the old idea of a coherent system of open standards for computer networks according to the Open Systems Interconnection (OSI) frame of reference has failed. The failure of this undertaking, which was supported by many governments in the world, but in particular by Europeans including the Commission of the European Union (Bucciarelli 1995), has proved that government intervention into coordinative

14 This is indicated, for example, by the length of a memo on the Internet standards process these two bodies jointly issued. The document, published in March 1994 (RFC 1602), is 36 pages long, but this is only one-third the length of a comparable directive of ISO / IEC from 1995 dealing with the procedures of technical work of JTC1 on information technology.

15 In September 1998 the Telecommunication Standardization Advisory Group (TSAG) of ITU agreed on a set of procedures to allow ITU-T to develop technical specifications for Internet Protocol (IP) based networks in cooperation with IETF (and the Internet Society as representative of IETF).

standardization is an extremely sensitive business (cf. Werle 1997).16 The recent dissolution of EWOS which focused on the production of OSI standards profiles confirms this assessment.

In the middle of the 1990s, the number of private standardization organizations in the computer and related industries was estimated at 200 (Updegrove 1995). A recent survey of the Information Society Standardization System (ISSS)17 identified over 140 consortiums and forums which claim to be open organizations (CEN / ISSS 1999). Most of the consortiums and forums are vendor-driven, and they are only loosely linked to politics, if at all. Thus, they belong to the category of standardization organizations which are regarded as being "openly responsive to commercial market concerns" (National Research Council [US] 1995: 37). Not all of these private groups are transformed into stable institutionalized standardization committees; many disappear once a particular task has been finished.

Institutional isomorphism and peaceful co-existence

The landscape of official and private standardization organizations has been characterized from different angles. Rutkowski (1995) – with a view of standardization in the context of the Internet – regards the organizations as being both cooperative and competitive at the same time (Rutkowski 1995). Cargill (1999: 37) has observed "a struggle for hegemony" between private and official organizations with some decline in the importance of the latter. However, in his view, the "majority" of corporations accept both as "equal partners in standardization" (Cargill 1999: 41). The CEN / ISSS (1999: 7) survey also comes to the conclusion that there has been a relative decline in the role of formal standardization, which has been matched by the development of consortium standardization. Other authors stress the stability and efficiency (Genschel 1997), the symbiotic nature (David / Shurmer 1996) or even the synergistic quality (Walli 1999) of the relationship between formal and informal standards organizations.18

16 Indeed: "Standards should not be seen as a simple way to implement industrial policy" (Grindley 1995: 225).

17 The ISSS was created by CEN with the aim of combining "the rapid process of informal specification with the security offered by the formal open consensus of traditional standardization" (Boyd 1999: 44).

18 This includes "a trend to take advantage of the willingness of manufacturers … to become more fully integrated in the standards process. Industry driven bodies develop technical specifications, usually in focused areas, that are then passed to formal standards bodies for ratification" (Grindley / Salant / Waverman 1999: 33, 39, 40).

We find very few instances of open conflicts between the official standardization organizations and most of the private ones.[19] The majority of the private units only claim competence in narrow areas of standard setting, some of which are not adequately covered by the official organizations. Even IETF has never officially expressed imperialistic claims with respect to international standardization although the Internet has developed into the most significant global computer network. IETF has also accepted that standards for the World Wide Web (WWW) are developed by the W3 Consortium, which has been established outside IETF with the aim of developing, supporting, testing and disseminating the WWW protocols.[20] This, however, does not mean that there is no overlap with an inherent potential of conflicts. Given the rapid technological change in information technology and telecommunications, it is almost inevitable that different organizations decide to develop standards for a new product or service simultaneously. A recent example is provided by Internet telephony. The opportunity to use the Internet as a cheap telephone network or even as a means for real time multimedia communication has been discerned by a number of vendors. At the same time standardization organizations have started to develop standards for different features of such new services. The incomplete list of organizations involved includes:

> ITU-T, ETSI (Tiphon), the Voice over IP (VoIP) Forum, the Interoperability Now (iNow) Group, the International Multimedia Teleconferencing Consortium (IMTC), IETF (IPTEL working group), the Enterprise Computer Telephony Forum (ECTF), the Internet Telephony Interoperability Consortium at the MIT and, to a minor degree also, the ATM Forum, the ADSL Forum, the Object Management Group (OMG), and a technical subcommittee of ECSA-T1.

All these organizations are not only aware of each other's involvement in this area; they also report to maintain coordinated liaisons or other links of coordination and exchange. While some organizations focus on developing standards, others see their role in the selection and promotion of standards for specific applications in this innovative field. This indicates that indeed a "symbiotic coexistence" has emerged (cf. David / Shurmer 1996: 804). Although the organizations coordinate their activities with each other, it appears indispensable to some firms such as Vocaltec, Cisco or Lucent to be present in most of them at the same time (cf. Just / Latzer 1999: 22).

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19 There was some turbulence, however, at the national level in the USA at the end of the 1980s (cf. Cargill 1999).

20 The Consortium is open only to organizational membership. More than 150 member organizations contribute to the budget of W3C, out of which the activities of the consortium are financed.

If – due to overlapping jurisdictions – conflicts occur, such as those reported by the Office of Technology Assessment (OTA 1992: 12–14) in the USA involving the IEEE Computer Committee, X3 and TC1, they are pacified through formal or informal cooperation agreements.21 In the international realm, informal mechanisms are usually activated at the working level of the standardization organizations to avoid conflict (Gibson 1995). If a group in one organization learns that people in another organization are working on a similar problem, they try to concert the activities without involving the top executives of their organizations. More often than not, this is facilitated by personal networks cross-cutting organizational boundaries or by individuals who are members of several standardization organizations (overlapping membership).

However, formal committees have also been set up to avoid conflict and coordinate standardization activities. The already mentioned Europe-based Information and Communications Technologies Standards Board (ICTSB) provides an example. Initiated by the three official European standards organizations, ETSI, CEN and CENELEC, it coordinates the work of these with other member organizations such as the ATM Forum, ECMA, The Open Group and many other consortiums and forums in this area. The European Commission and the EFTA Secretariat are affiliated as observers.

Also, many bilateral or multilateral agreements between private consortiums and official standardization organizations indicate a preference for cooperation on both sides. The agreements range from formal liaisons and memorandums of cooperation to occasional issue-specific links initiated by individual members of the organizations. The CEN / ISSS (1999) survey gives an impression of the frequency of links of private consortiums and forums to other standardization organizations – private as well as official ones. Figure 4, based on data of this report, provides an overview of the frequency with which (selected) official standardization organizations are mentioned as partners of the private consortiums and forums. If we add to this picture all the links among these private organizations, we arrive at a hugely complex web of official and unofficial organizations which has upset the traditional hierarchy of standardization organizations. One result of this development is that the organizations use an increasing part of their manpower to coordinate with others.22

21 OTA explicitly pleads for "cooperation rather than conflict" (OTA 1992: 12–14).

22 CEN / ISSS stresses the need for cooperation on its homepage: "ICT standardization / specification activities have to be collaborative. With the convergence in technologies between telecommunications, IT and broadcasting, we must all recognize that there are likely to be common interests between different organizations. Furthermore, the sheer number of different organizations, whether in Europe or elsewhere, active in ICT specification, makes co-ordination an absolute imperative in the interests of the

Figure 4 Number of forums and consortiums reporting links to official standardization organizations

Official Organizations	
ANSI[a]	20
ECMA[b]	5
CEN[b]	10
CENELEC[b]	6
ETSI[b]	22
IEC[c]	13
ISO[c]	18
ITU[c]	21
JTC 1[c]	8

N = 135
a National (USA)
b European
c International
Source: CEN/ISSS (1999)

The overview of the landscape of standardization organizations and their relationships suggests that, with the evolution of many private standardization units, the potential of jurisdictional conflicts has increased. However, the level of conflicts has remained low, which has led some observers to the conclusion that the development does "not call for a re-structuring of the national and international standards system" (Rankine 1995: 566). For others, it comes as a surprise that only few open conflicts occurred between standardization organizations.

If we look at standardization organizations from the angle of collective action and organization theory, they appear to be what Coleman calls corporate actors (Coleman 1974; 1990). Members of the organizations transfer resources to the corporate actor to reach their common goals efficiently. Corporate actors develop an interest not only in autonomy and organizational survival, but also growth and domain expansion. This interest prevails in large corporations as well as in smaller organizations and it is not identical with an interest in profit maximization. Therefore, we can expect standardization organizations to struggle for predominance in their area of responsibility. However, due to institutional features, including the non-profit orientation which most organizations in the standardization field have in common, the corporate actors – even if they have hundreds of members – are comparatively weak. The resources directly available to the or-

effective use of industry's scarce resources" (http://www.cenorm.be/isss/partnerships.htm).

ganizations are small. They rely on volunteers and have to grant them autonomy in the process of standard setting. Members expect their fees to be used to provide resources for the work of task forces and for the dissemination and implementation of standards, rather than for organizational politics and domain expansion. As a consequence, many standardization organizations only have a small team of full time employees running the organization. They appear as action arenas rather than powerful corporate actors. The majority of consortiums and forums have limited scale and scope, while the official standardization organizations likewise cannot adequately cover all areas of standard setting. Therefore, any threat on the part of a single organization to invade other organizations' territories should be seen as only so much rhetoric.

Not only organizational weakness and scarce resources, but also positive institutional commitments on the part of standardization organizations trigger peaceful co-existence rather than competition. The most prominent institutional features the majority of standardization organizations have in common are included in Figure 3 above. The principal of parsimony of standards has already been emphasized. The organizations' common interest in converging on one single standard is linked to the phenomenon of critical mass and positive externalities of network technologies. New private consortiums and forums share this principle with the incumbent ones.23 Also with respect to other features, many new organizations appear to be designed according to the model of existing ones. Similarly, if we look at the bylaws and charters of many consortiums and forums, as well as at the internal organization of work, we come across what is called *mimetic isomorphism*, as defined by DiMaggio and Powell (1991), referring to processes of imitation and copying of organizational models. Standardization organizations do not duplicate the strategies and structures of business firms, but of other standardization organizations.

This includes the consensus principle, which, however, in combination with the principle of the openness of organizations to all interested parties, has proved to be most critical with respect to a smooth process of standard setting.24 As mentioned earlier, it is difficult to reach consensus on a standard if all interested par-

23 So does the World Trade Organization, which emphasizes the benefits of having not more than one international standard in the Agreement on Technical Barriers to Trade (cf. Falke 1999).

24 The consensus principle has one root in the engineering profession, whose normative basis includes a strong orientation towards consensus coupled with the general belief that most problems have one optimal technical solution which can be approached through a technical discourse (cf. Schmidt / Werle 1993; 1998). The normative influence of the engineering profession on standardization, which has remained a technical business, tends to be underestimated. Di Maggio / Powell (1991) call this mechanism *normative isomorphism*.

ties can easily get access to an organization. Official standardization organizations are often charged with being too slow, also because they may be "too open". Less open, i.e. more exclusive, new consortiums and forums may step in to develop and approve standards more quickly. Incumbent organizations may regard this as a competitive move, but usually have only limited capacity to speed up their standardization work. Therefore they accuse new consortiums and forums of not being open and thereby assert an institutionalized value to which new organizations have to adapt. The pressure on these organizations to be sufficiently open is often reinforced by governments who conclude that exclusiveness stifles market competition. To a certain degree, standards organizations have to be open to new members if they do not want to be perceived as an anti-competitive closed shop.25 Thus, there is also a mechanism of *coercive isomorphism* (DiMaggio / Powell 1991) at work, which brings about institutional similarity and coordination rather than competition between standardization organizations.

Although the organizational landscape of standardization has changed considerably, competition has not increased accordingly. The institutionalized values of the organizational field of standardization change rather slowly. Their dominant effect is one of de-legitimizing and reducing competition and jurisdictional conflict between organizations which, at the same time, only have limited resources to devote to competitive strategies.

As has been shown above, the typical conflict in compatibility standardization has a battle-of-the-sexes structure – within standards organizations as well as between two separate organizations if they work on the "same" standard, i.e. a functionally equivalent technical specification. In this type of conflict, in which the actors share the aversion to ending up without a standard, it is likely that they will try and coordinate their work. This can be achieved through some kind of division of labor, as in the example of Internet telephony, or by combining forces, as in the case of message handling, or simply by granting the right to conclude the development of a standard to those who first started working on it. These and other mechanisms embedded in the prevailing set of institutional norms have proved beneficial to international compatibility standardization in developing into a complex and hybrid self-coordinated "coordinative regime" (Stein 1982), where competition is avoided, if possible, and at the same time not too much collaboration is needed because this would prove difficult to manage. The dominant pattern of the organizational field is peaceful co-existence.

25 Often firms struggle to get access to a consortium because they want to prevent new technologies from falling under the proprietary control of sole vendors.

4 The choice of standardization organizations

The analysis of the changing landscape of standardization organizations has shown that coordination and co-existence rather than competition between organizations is the prevailing structural pattern. This appears to be inconsistent with reports on spectacular standards battles which trigger the impression that hostility, antagonism and mistrust are the rules of the game. We already referred to a few instances (OTA 1992; David / Shurmer 1996). One of the most spectacular cases of a standards conflict which ended in a complete deadlock and standard setting failure was provided by Interactive Videotex – an effort to adopt a common standard for systems such as the French Teletel / Minitel, the English Prestel, the German Bildschirmtext and North American (Telidon, Prodigy etc.) and Japanese (Captain) systems (Schmidt / Werle 1998: 147–184). It would be easy to present further examples, including the ongoing "standards wars" related to the Third Generation Wireless Telecommunications Standards (Grindley / Salant / Waverman 1999). Many participants in committee processes of standardization recall such conflicts. However, most of these conflicts occurred *within* standards committees during the process of negotiations on standards. They can be explained through reference to institutional and procedural features of the standards organizations, on the one hand, and actor and interest constellations in the negotiation process, on the other hand (Schmidt / Werle 1998, also Werle 1998).[26] Conflicts *between* standards organizations over their claims of competence or their involvement in overlapping areas of standardization have been rare. They have usually been settled by formal agreements or by informal coordination based on overlapping membership or informal networks. However, these settlements do not determine any division labor which rules out jurisdictional overlap. For a company interested in the development of a standard, this overlap provides a choice as to which organization it can turn to in order to initiate standardization. On the other hand, what is going on in many standards bodies requires monitoring if a company does not want to risk being leapfrogged by competitors in one organization or another.

26 The actors' interests can be personal and idiosyncratic or representative of the organization which has delegated the individual to a standards committee. A small survey of individuals in subcommittees of the US standards committee X3 (information technology) revealed "strikingly personal" motivations for participation (Spring et al. 1995: 228). Asked to pick a statement that best described their motivation in participating in and contributing to the standards process, two thirds of the respondents stated prestige, curiosity or a desire to positively influence future events. Only one fourth stressed employer benefits (ibid.).

Although at times vendors have tried to impose standards on the markets for telecommunications and information technology, no single firm has managed to keep control over the technical specifications in large segments of this innovative market for a long period of time (cf. Gabel 1991; Grindley 1995). Despite the transferability of basic hardware and software components, even large corporations such as IBM, Microsoft or AT&T normally do not have the competence to produce complete systems for data processing and telecommunications. Firms that usually compete feel compelled to collaborate or at least coordinate the development and design of technology.

There is a growing tendency to design and treat single technical artifacts as parts of larger technical systems. Innovation and enlargement are "less the application of separate inventions than the integration of different new products and processes into new systems" (Van Tulder / Junne 1988: 219). Technological leadership does not enable any firm to design and assemble a (large) technical system independently from others, although each firm may try supplying as many components as possible and bundle or package them into a systemic product (Teece 1988; Matutes / Regibeau 1992; Robertson / Langlois 1992). Many technical devices are manufactured by specialists who regard their products as components of more encompassing technical systems (Tassey 1992: 169–202). Interdependencies and complementarities of large systems imply a growing need for coordination on the production, operation and use of technical components. This has stimulated and accelerated the work of standards committees with the result that more and more standards – as a means of coordination – have been adopted by official standardization organizations and by private consortiums and forums. They include basic standards, as well as specific functional standards and standard profiles.

Thus, business firms including technology leaders recognize a need to coordinate with others, and they often opt for collectively developing compatibility standards to achieve coordination. From interviews with employees of firms involved in standardization, we have learned that membership in standardization organizations is seen as a normal and often necessary element of business activity (Schmidt / Werle 1998: 85–98). Firms act with decreasing intensity at the national level and increasing intensity at the regional and the international level, both in official and in informal organizations, and they often consider it necessary to be present in standardization in telecommunications as well as information technology. About 30 generalist firms participate in virtually all major consortiums, forums and official standardization organizations. Large companies have reported participation in not far short of 100 separate standards bodies of all kinds (see ISSS 1999 at http: / / www.cenorm.be / isss / partnerships.htm).

This does not mean that in each case these companies, and those which are members of only a few standards organizations, intend to actively contribute to the development of a standard. Frequently, as mentioned, they only monitor standardization processes to screen technical innovations and to intervene if potential competitors are about to agree on a "hostile" standard which threatens the firm's market position. IBM, for example, as one of the big players, already participated in message handling (e-mail) standardization in CCITT, a forerunner of ITU-T, in the early 1980s, although at the time the corporation was not heavily interested in supporting open standards in this area, where it relied on proprietary solutions.

Companies' options and the limits of organized standardization

Generally, a company has different options concerning standard setting, some of which I will illustrate here. One option is trying to bypass organized standardization and set a de facto standard in the market. Many standards in telecommunications and even more in information technology can be regarded as market standards. They have been imposed by market leaders or have evolved in uncontrolled market processes. A second option is participating in the work of an official or a private standards organization if the company gains access to the organization. If the work on a standard has already been initiated by a company, other interested companies usually have no choice but to join the standards committee that has started developing the standard. In specific cases, companies may decide to initiate parallel standardization in another organization. A third option is setting up a new consortium or forum which deals with the standards project.

The attractiveness of the different options primarily depends on three groups of variables. The first group includes company features such as the market position, the capability to develop advanced technology and the general business strategy. The second group is related to the nature of the technology and the relative significance of a specific standard in the architecture of a technical system. The third group includes characteristics of standardization organizations such as those discussed above. The relevance of this last group, the institutional features, is what I will focus on after a brief look at the role of a standard's significance in the choice of a standards organization.

It has been stressed in the theoretical introduction that compatibility standardization in general is an undertaking in which companies that usually compete now collaborate. However, the tension between collaboration and competition remains an inherent strain on compatibility standardization. If the conflicts take the form of a battle of the sexes with moderate relative gains, the organizations' rules of negotiation designed to transform the battle into a pure coordination game pro-

vide opportunities for compromise. The size of the relative gains is often linked to the relative significance of a standard. Many technical systems are asymmetric in the sense that a technical periphery is grouped around a few core components. The standards of these core components largely determine the shape of the systems (Henderson/Clark 1990; Anderson/Tushman 1990). As a result, relative gains tend to be high when standards of core components are involved. If manufacturers of functionally equivalent core components prefer different standards, the conflict will be similar to zero sum (the case of substitutive compatibility). Such a standards conflict compares with a conflict of two companies which sell complete systems and therefore do not rely on compatibility with the competitor's technology. Many spectacular standards conflicts are indeed what has been called battles of the systems (Hughes 1983; David/Bunn 1988; Schmidt/Werle 1998). In such conflicts as the struggle for a standard for Color TV (1960s), Interactive Videotex (early 1980s) or High Definition Television (HDTV – 1980s), it is highly unlikely that a compromise can be reached in any of the existing official or private standards organizations as long as they are open to all competitors. If one company initiates standardization in one organization, the competitors will also enter the organization and block the standards process. Conversely, if companies are highly committed to the same system, it is likely that they will reach an agreement on a standard notwithstanding the organization to which the issue is taken. The "Internet Community" provides such an example of individuals and organizations committed to what can be called a dominant design, in this case the TCP/IP protocol stack. For a long time the Internet Engineering Task Force had only few problems achieving consensus on a standard, and we can assume that the same people would have agreed on the same standards in another standardization organization, too.

Market acceptance of standards and costs of their production

The vast majority of standardization activities focus on components rather than systems standards. In many of these cases, specific features of the standardization organizations are considered by companies when they have an option to choose where they are going to put the standards issue on the agenda. One criterion which guides the decision concerns the implementation or market acceptance of a standard. This problem is, of course, inevitably related to all non-market processes of standardization. An example how organizational features are assessed when implementation is expected to be a crucial issue is provided by message handling standardization (see Schmidt/Werle 1998: 229–262). Preparatory work started in the late 1970s, in the International Federation for Information Processing (IFIP), a federation of national technical and professional societies dealing

with information processing. Although it is not a standardization organization, IFIP has always conducted pre-standardization work directed towards providing input into the formal standardization processes of other organizations. In the late 1970s, IFIP's Technical Committee 6 (data communication) discussed technical design issues in the field of electronic mail and message handling systems. The organization was particularly suited for this kind of initial work on a new project because it relied on a broad membership. From the outset, there was a consensus that a completely new system was needed which should complement and subsequently replace proprietary systems.

Given this consensus, the question remained as to where to turn to initiate official standardization. Both the International Standardization Organization (ISO) and CCITT, a forerunner of the International Telecommunication Union's standardization branch (ITU-T), were regarded suitable to provide an appropriate arena. Preferences, however, were split, although the most influential participants opted for CCITT. In particular, people from Canada's Bell Northern Research Corporation (BNR) were in favor of the top telecommunications standards organization.27 This has to be seen against the telecommunications background of BNR and the traditional affiliation to CCITT, although BNR's conviction that global implementation of message handling standards would virtually be guaranteed by a CCITT endorsement also played an important role. In the early 1980s, most public network operators enjoyed a national monopoly. They regarded CCITT as "their" international standardization organization even though other companies were not formally excluded from membership anymore. Usually the network operators were committed to implementing CCITT standards in their networks.

In the eyes of those who had reservations about opting for CCITT, this advantage was compensated for by the fact that cooperation in an organization which was dominated by the operators of public networks would in effect stabilize their monopolies. In addition, these companies – computer and software vendors –, which were more familiar with computer messaging than the network operators, feared becoming involved in useless controversies in CCITT, with monopolies lagging behind the front line of innovative technology and products. In their view an inappropriate "outdated" standard might be developed in CCITT which would be implemented by the network operators but not be accepted by the users. Therefore, several computer companies turned to ISO, where public network operators were not represented or played a minor role. This shows that the standards organizations' membership structure and its relevance concerning the implementation and user acceptance of a standard guided the companies' choices.

27 At the time, BNR was a joint R&D organization belonging to Bell Canada (30%) and Northern Telecom (70%), with a strong focus on telecommunications networks technology for both public and private networks.

The ensuing work on message handling standards in CCITT and ISO had different results. Work progressed continuously in CCITT, and a series of standards (the X.400 series) was adopted in 1984. However, although network operators gradually implemented the standard, X.400 message handling did not take off, partly because the standard was indeed not user-friendly. Within ISO, work focused on a standards system called MOTIS (Message-Oriented Text Interchange Systems). However, not much progress was made because those computer vendors who already had proprietary messaging systems slowed down the speed of work. Meanwhile, the activities in CCITT and ISO gave rise to a jurisdictional conflict between these organizations, to which I have already referred. This conflict was resolved by those activists in both organizations doing the standardization work and sharing the commitment to one open standard which had evolved in the days of common IFIP sessions. Diverging views between manufacturers and operators in the telecommunications domain, on the one hand, and computer vendors, on the other, concerning the domain name system in particular delayed the work several times. But most of it consolidated under the roof of ITU, and virtually identical standards were adopted by CCITT and ISO.

To complete the story: Around 1984 standardization was reinforced when the European Computer Manufacturers Association (ECMA) started work on message handling standards as a kind of by-product in the context of office communication and document exchange procedures (MIDA – Message Interchange Document Architecture). For the participants in ECMA, it was a matter of routine, rather than an explicit strategic move, to deal with standardization in this area. Jurisdictional conflict with CCITT was avoided because at the working level ECMA's activities could be influenced by and partly aligned with those of CCITT due to overlapping membership of specialists from Xerox and Siemens. As a unified international standard for message handling was in the interest of both firms, they carried out the necessary work to adapt MIDA to X.400.

Once adopted, standards reduce transaction costs. At first, however, their development induces such costs. The expenses incurred by the companies multiply if they must delegate experts to different organizations working on the same standard. This occurred in message handling, and it led to a consolidation of work in one organization. Similarly, transaction costs increase because standardization at the international or regional level is often coupled with concomitant activities at the national level. Global players striving for an international standard benefit from the support at the national level. However, this makes it vital to also get involved at this level in order to ensure that the preferred standard is developed "at home".28 At times, national measures of coordination are more contentious than

28 Multinationals often try to gain influence on the standardization process in several countries (Cargill 1999).

the international negotiation process. This could be observed in the USA in the early years of message handling standardization. In the early 1980s, the National Bureau of Standards (NBS, later NIST), an agency of the US Department of Commerce, started work on message handling standardization. NBS prepared a standard which it intended to feed into the CCITT process. The conflict arose from work done for NBS by BBN – a company which had been much involved in the ARPANET work on the basis of government contracts. The results of BBN's work (related to message formats and encoding) were already approved by the NBS when Xerox announced opposition because they ran counter to the work done by Xerox in the CCITT context. The difference between both proposals need not be substantiated. However, within the US context, these different proposals led to a memorable confrontation. As Xerox received much stronger backing than NBS from the other members of the national delegation including the Electronic Mail Association, NBS eventually withdrew its proposal. Thanks to its activity at both the national and the international level, Xerox managed to stabilize its position in CCITT and receive approval for its standard proposal.29 The resource-consuming requirement of simultaneous involvement in standardization at the national and the supranational level was an important reason for multinationals in Europe to support the establishment of ETSI as the central official European standardization organization in telecommunications and by this prevent the establishment of many national bodies after liberalization of this industry.

Speed and exclusiveness of standardization

Thus far we have seen that considerations concerning the market acceptance of a committee standard and transaction costs incurred in the process of standards development guide the choice of standardization organizations. Standards adopted on the basis of consensus in official standards organizations with a broad membership are very likely to diffuse in the market. Seen from this angle, the official organizations appear attractive to companies. At the same time, in order to minimize transaction costs, companies prefer that work on a standard is concentrated in one organization. Thus, companies should choose a supranational offi-

29 It is ironic that, after all the struggles on message handling and e-mail, not X.400, but a standard developed by IETF (SMTP – simple mail transport protocol), i.e. from outside the official standardization organizations, turned out to be the one which is most widely used. For many years, neither ITU-T nor ISO/JTC1 reacted officially to the growing popularity of e-mail communication in the Internet based on SMTP. In view of the potential competitor, however, both organizations made efforts to streamline X.400 and to add some functionality (see Schmidt/Werle 1998). This, however, did not help X.400, which apart from its technical complexity suffered from the delays in the early process of development.

cial standardization organization if they become involved in the development of a standard.

However, standardization in official organizations often proceeds slowly. In these organizations political, business and technical interests are blended. At the same time, the organizations rely on a broad membership. Where different dimensions of merit guide the evaluation of standards and many experts with diverging interests are involved, it is difficult to achieve consensus – at least it takes considerable time. Moreover, companies cannot be sure of being able to control the process. Those with a high interest in a standard, therefore, prefer to standardize "faster and better" in a private consortium or forum (Cargill 1999: 38). And, with network technologies, faster often means better. More exclusive private consortiums and forums are often as international in scope as the official standardization organizations. With a membership at least initially restricted to technology leaders and firms with substantial market power, they have the potential to be more efficient and more effective than the official organizations.

Setting up new standards organizations, however, also involves transaction costs. Consortiums and forums are based on multilateral contracts including membership and decision rules, cost-sharing principles, and other statutes and bylaws. Transaction costs can be reduced if a new consortium is established after the model of existing ones – another source of institutional isomorphism. It may also be attractive to use a consortium, once established, for new standardization projects after the initial project has been concluded.

It is difficult to trace in every single case the reasons companies have for setting up a forum or consortium. To some observers, the companies' standardization strategies including the creation of new organizations appear to be "erratic and unstable" (Krieb 1999: 95). But this may simply be a correlate of the struggle for standards in cases where the stakes are extremely high because core components of a technical system are involved. In these cases, companies try to exclude rivals and include allies through setting up new consortiums and forums. But they have to be aware that formal exclusion of rivals is not sustainable, because this violates anti-trust rules. Opening up standardization for rivals to participate in, on the other hand, makes it unattractive to continue the work because a consensus is unlikely to be reached unless a competitive advantage is sacrificed. As a result, companies may choose to submit their standards plans to another standardization organization where the rivals are not present yet. This phenomenon can be called committee-hopping.

An early example of committee-hopping has been provided by Sirbu and Hughes. It draws on standardization of local area networks (Sirbu / Hughes 1986). The process began in a subcommittee of IEC (PROWAY) in 1975, but failed

to make any progress in subsequent years. Approached by several semiconductor merchants, IEEE's Committee 802 stepped in and began standardization in 1980. Three subcommittees started work involving many experts. The apparent initial progress being made at IEEE convinced the chairman of PROWAY to redirect efforts and switch from IEC to IEEE. In the past, IEEE had usually succeeded in achieving consensus on one single standard. All relevant US and, subsequently, European computer manufacturers, chip producers and retailers, as well as academics, government officials and several users, participated in the enterprise. But in this case with so many divergent interests and high stakes involved IEEE also ran into difficulties. The main proponents of the standardization project – DEC, Intel, and Xerox – therefore decided to initiate a parallel procedure in the more exclusive ECMA. There a draft standard for local area networks (ethernet) – very much in line with the main sponsors' preferences – was adopted in June 1982. This agreement could only be achieved because in the context of ECMA – unlike the "open marketplace" of the inclusive IEEE – it was possible to compromise with Ethernet's main opponent IBM, who was also active in ECMA. The proponents had to accept IBM's standard (token ring) as well. After this solution was reached, the standards were fed back into the IEEE process and were also approved there. But this was only a formal act, as was a later adoption of these standards by ISO.

Another more recent example is related to the standardization of Java from Sun. This company, traditionally committed to open standards, originally submitted Java specifications to ISO/JTC1 to become an open standard. After a short time Sun became concerned with losing control over the process. Java in different variants appeared attractive for consumer electronics manufacturers and operators such as Sony or Philips, who generally backed Sun (cf. Krieb 1999; Cargill 1999). As Java's design provides an encompassing alternative of a networked system, "hostile" to the PC-centric model of Microsoft and its PC-focused allies, it was taken on by this group. Sun, therefore, switched standards efforts to ECMA and – assisted by the Open Group and the Object Management Group – submitted a proposal for a JavaScript standard which was adopted as ECMAScript. However, this standard, which was fed into the JTC1 process and quickly adopted there, has no central significance with respect to the battle of the systems mentioned above. Parts of this battle may take place within the confines of ECMA because not only Sun, but also Microsoft, is a member of this organization. The exclusiveness ECMA provided in the past in regard to the absence of Microsoft has been lost since this company – realizing that its enemy UNIX was pushed by others within ECMA – became a member in the second half of the 1990s. Again, no standards organization, official or private, will be able to facilitate a compromise in the battle of the systems between Sun and Microsoft as the leading contenders on either side.

No choice for small and medium-sized enterprises?

Committee-hopping – in the foregoing examples from large inclusive and heterogeneous organizations to smaller, more homogeneous and exclusive ones – requires resources and often full-time standardization experts. Other standardization strategies which include different arenas at different levels are also only available to large companies. Examples from many countries show that other firms cannot afford to get involved in standardization in many organizations at the same time. Small and medium-sized enterprises often rely on the official national standardization organizations and only participate in private consortiums and forums if they have a national or a regional focus. In Europe, the opportunity for small and medium-sized enterprises to participate in standardization became an issue in the early 1990s after the European Commission had published a Green Paper (COM(90)456) on the reorganization of standardization aimed at accelerating the process of economic integration and at increasing the efficiency and effectiveness of the European system of standard setting (cf. Voelzkow 1996). Some national standards organizations, such as the Deutsches Institut für Normung (DIN), regarded this plan as a maneuver of the Commission aimed at increasing the influence of European standards organizations at the expense of the national ones. Arguing that small and medium-sized enterprises would only turn to national, and not to supranational, organizations in standardization matters, DIN and its allies managed to stop the European plans.

Yet DIN and the other national standards organizations in Europe could not stop the process of erosion of purely national standardization which can also be observed in the USA. In Europe, the problem of under-representation of small and medium-sized companies at the European level, and even more so at the international level, of standardization has turned into a political issue, as has the absence of users in many standardization processes.[30] For the time being no institutional recipe, apart from government assistance and subsidies, seems to be available to increase participation of these groups in official as well as private standards organizations at the regional and international levels.

30 For a broad discussion of the potential role and institutional integration of users in standardization, see Foray (1992; 1994).

5 Conclusion

The global landscape of standardization organizations is shaped by political, professional and business interests. Elements of these three aspects are present in all standardization organizations. In the last decade in which an increasing proliferation of standards organizations could be observed, business interests prevailed. Strategic business concerns were driving forces towards setting up new consortiums and forums which were meant to bypass or complement the incumbent official standardization organizations. The result, however, was not fierce jurisdictional competition, but rather increasing efforts to coordinate between these organizations in particular where jurisdictions overlap. Institutional mechanisms and values guided this development. Their rationale lies in the need for and positive economic effects of compatibility in network technologies such as telecommunications and information technology.

To companies and other actors the proliferation of standardization organizations whose domains partly overlap provides a choice. Companies can choose to which organizations they turn if they want to submit a standards proposal. Most standards organizations are quite open to new members. Formal membership rules do not erect insurmountable barriers to entry. Certain standards organizations will look attractive or appropriate, depending on the specific standardization issue (and related concerns such as speed and cost of standard setting), the market acceptance of the standard to be developed, and the conflicts connected with the development. If companies expect that broad consensus will be difficult to achieve they will prefer to take the issue to a more exclusive arena with a small circle of participants, often one of the new specialized private consortiums and forums. If the diffusion and implementation of a standard is regarded as the central problem, firms prefer submitting a proposal to one of the official organizations. They are officially recognized by governments, and their products enjoy high legitimacy. As problems – often unexpectedly – change during a standardization process, companies consider switching from one organization to another or proceed simultaneously in different organizations – an option which is only available to large companies. Many small and medium-sized enterprises are more constrained – primarily as a consequence of limited resources. To them, only participation in official and private organizations with a focus on national or regional markets is affordable.

No standards organization combines all the merits which are required for the smooth development and successful market diffusion of standards. The landscape of organizations, however, which has developed into an organizational network with partly institutionalized links of coordination, offers many useful

complementarities, the most visible being the tendency of consortiums and forums to feed their standards into the adoption process of the official organizations where they are approved without intensive further negotiations. Spectacular standards wars of the battle-of-the-systems type, however, cannot be pacified by today's standards organizations. Their resolution is left to the market.

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