Technical Controversy in International Standardization

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Abstract

The development of larger technical systems relies on the coordination of autonomous action of a multitude of individuals and organizations. Institutional settings, often neglected in the analysis of technical development, help to achieve such coordination. Our analysis of international technical standardization in telecommunications highlights an institutionalized process aiming at the creation of compatibility standards as the means for coordination. Formal procedural, membership, and decision rules combined with informal sets of expectations constitute the normative basis of the CCITT, the most prominent international standardization organization in telecommunications. Although scientific, political and economic aspects can be equally important for standards, the CCITT selectively legitimizes a technical perspective. Political and scientific reasoning is restricted, an open economic perspective even completely banned, unless they can be "translated" into a technical perspective. This increases the capacity to proceed on a consensusal basis and often facilitates reaching a consensus in a controversy. Standardization of Videotex and Telefax empirically examplifies this, and at the same time demonstrates the limits of pure technical reasoning to resolve genuine political or economic conflicts.

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Die Entwicklung großer technischer Systeme hängt von der Koordination autonomer Handlungen einer Vielzahl von Individuen und Organisationen ab. Institutionelle Arrangements, oft vernachlässigt in Analysen technischer Entwicklung, erleichtern dies. Unsere Analyse internationaler technischer Standardisierung in der Telekommunikation behandelt den Prozeß der Vereinbarung von Kompatibilitätsstandards, die Koordination ermöglichen. Formale Mitgliedschafts-, Entscheidungs- und Verfahrensregeln sowie informelle Erwartungsmuster bilden die normative Grundlage der Arbeit des CCITT, der wichtigsten internationalen Standardisierungsorganisation in der Telekommunikation. Obwohl wissenschaftliche, politische und ökonomische Aspekte gleich wichtig sein können für Standards, begünstigt der CCITT selektiv eine technische Perspektive. Politische und wissenschaftliche Argumentation ist nur eingeschränkt zulässig, eine offensichtlich ökonomische Sichtweise sogar völlig unzulässig, es sei denn eine "Übersetzung" in eine technische Perspektive gelingt. Dies verbessert die Möglichkeit, auf Konsensbasis zu arbeiten, und erleichtert oft die Einigung in Kontroversen. Die Standardisierung von Bildschirmtext und Telefax liefert hierfür empirische Beispiele und zeigt gleichzeitig die Grenzen rein technischer Argumentation auf, um politische oder ökonomische Konflikte zu lösen.

Contents*

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1. Introduction

Technology is often perceived as a link or an interface between the scientific and the economic sphere. Technical developments follow rules of economic efficiency as well as principles of scientific exploration and research. Moreover, central to technology is technical reasoning, which entails autonomous technology-related rules of argumentation and evaluation. Together with the stock of technological knowledge, these abstract rules constitute the crucial cognitive elements of the professional domain of engineers and technicians.

The significance of scientific, technical, political and economic factors in the course of technical development is difficult to approach, both in theoretical and empirical terms. Efforts to conceptually and analytically distinguish the different factors have to consider that they are intertwined albeit their boundaries are negotiable. The non-transparent nature of technical work constitutes a high barrier for social scientists who want to scrutinize its features instead of treating technology as a black box.

In modern industrial societies R&D departments and laboratories in firms and companies appear to be the most relevant locus of technical developments. The more their endeavor aims at constructing larger technical systems, the more collaboration and coordination between firms and other actors is needed. Technical development here relates to the joint specification of technical components, the common definition of interface characteristics or the consensual approval of security and safety requirements. Multilateral negotiations as well as collective standardization within specialized organizations are such coordinative means. Technical standardization in particular provides an opportunity to approach both **institutional and coordinative aspects of technical development**. Here, not market processes, but highly institutionalized committee-based procedures establish an arena in which explicit debates from technical, economic or scientific perspectives take place. Some of them can be observed and examined more easily than the activities in R&D laboratories.

In this paper we refer to standardization processes in telecommunications at an international level.[1] We concentrate our empirical argument on the CCITT, the most prominent and relevant international "producer" of telecommunications standards. Though dominated by engineers and officially confined to technical reasoning, non-technical arguments have never been completely elimi-

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1 Our empirical research project on international standardization in telecommunications focusses on three cases: interactive videotex, facsimile and electronic mail (X.400) standardization. For the conceptual framework and the theoretical perspective of this project, see Schmidt / Werle (1992a).

nated in this organization. In addition to standardization activities at a national level, political interests and controversies are likely to emerge in an international context because the implementation of standards partly relies on national political support or control. The mixture of motives creates problems of institutional overload, triggers hidden discourses and sometimes, though not always, makes it difficult to reach a consensus in standardization committees. We shall exemplify this empirically by presenting standardization cases from the CCITT.

At the same time we will show that an explanation of technical developments, especially in the case of large technological systems, has to take institutional settings and rules into account - a requirement that has been widely neglected in constructivist approaches.

2. Social constructivism and institutional differentiation

Technical standards, like technical artifacts, are **socially constructed**. They result from collective efforts to - at least in an official institutional interpretation - coordinate the development, the construction and the implementation of technical components in order to make more comprehensive systems work. Individual motives and interests for participating in standardization can differ from the official understanding, but standards remain conventions entailing an inherent expectation of compliance. When compliance cannot be policed and enforced, consensus in the process of standard setting becomes a necessary (but not sufficient) condition for a standard to gain significance in technical development, where the standard functions as an "institutionalized feedback" of the development and application of technology (Weingart 1988: 158).

Social constructivism, as an approach to explaining technological developments, was "officially" introduced into social theory by Pinch and Bijker some ten years ago (Pinch / Bijker 1984). Employing concepts like "interpretative flexibility" and "social mechanisms of termination" or "closure", which are derived from the empirical programme of relativism in the sociology of scientific knowledge, the constructivist approach can demonstrate convincingly that the "linear model" of technological innovation processes is inadequate. There is no inherent rationality in technological development. Therefore the question why some technologies succeed and others fail moves into the core of constructivist analysis. In an evolutionary process of variation and selection, technology's development is shaped by "**relevant social groups**", which include "institutions and organizations (such as the military or some specific industrial company) as well as organized or unorganized groups of individuals" (Pinch / Bijker 1984:

414). Their images of technology, originating from different perspectives and interests, are crucial for the profile and the function of an artifact. In this approach even the technical "working" or "non-working" of an artifact no longer appears as inherent in technology but contingent on social perception.

It was not long before this approach was subjected to criticism, especially with regard to the manner in which it introduced and treated the "relevant social groups". Their "structural location" in society, which largely determines their relationship and access to each technology, was seen to be widely neglected. Neither was consideration taken of the fact that "outcomes are produced in specific arenas in a context of economic imperatives, government industrial politics, regulations, legal duties and constraints, political strategies and tactics, bureaucratic procedures and cultural traditions" (Russell 1986: 336). Though this criticism cannot be extended in an equal manner to all constructivist studies in the late 1980s and early 1990s, its general thrust has remained valid.[2] The studies tend to treat political, economic, technical or scientific factors as intermeshed and neither on the institutional nor on the individual (cognitive and perceptive) level clearly distinguishable.

The argumentation of the **technological systems approach** in constructivism, inspired by research into the history of technology, is similar in kind. "**System builders**", as Tom Hughes puts it, never respected "knowledge categories or professional boundaries". In order to create technological complexes they incorporated "such seemingly foreign actors as legislators and financiers, if they could functionally contribute to the system building goal" (Hughes 1986: 285-287). Pinch / Bijker's "relevant social groups" constitute a horizontally interacting ensemble constructing the artifact - typically a "stand alone" device. Network and / or market modes of coordination seem to prevail, and little deliberate coordination seems to be necessary. Hughes' "system builder" creates a technological system, such as an electric light and power system, with many components that have to match the system requirements. The social construction of a technological system through a "system builder" relies on hierarchical coordination while simultaneously integrating different factors and perspectives.[3] "One of the primary characteristics of a system builder is the ability to construct unity from diversity" (Hughes 1987: 52).

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2 Especially the "actor-network" variant of the social constructivist approach, which describes socio-technical configurations as heterogeneous networks of human actors and artificial (artifact-) actors, rigorously ignores institutional meso and macro structures of society (e.g. Callon 1986).

3 Chandler, from a different point of view, argues similarly (Chandler 1977).

From empirical studies of the development of large technological systems, however, we learn that the different factors are typically processed in a sequential and not in a simultaneous pattern, and that they can be distinguished over a period of time. Hughes' own historical comparison of electricity systems in different countries, for example, demonstrates a pattern of development in which initially entrepreneurial efforts dominate. In a next step, these efforts are followed by system design activities of engineers trying to solve technical problems and remove bottlenecks during the period of rapid growth. Later, managers and financiers settle problems associated with rationalization and capital intensification, and in the phase of geographical expansion across regions and nations political intervention and regulation is triggered. The different phases sometimes overlap and backtrack, and they include technical as well as economic or social factors (Hughes 1987).

At least larger technological systems display a pattern of differentiation that rules out conceiving them as seamless webs or tightly meshed actor networks.[4] Therefore, following Burns/ Dietz, we conceptualize them as **socio-technical systems** with analytically clear, but not rigidly defined **lines of differentiation**.[5] On the one hand we have "complex technical and physical structures that are designed to produce or transform certain things (or to enable such production)" including rules that specify the purposes of the technology and its appropriate applications. On the other hand these systems comprise "social institutions, legal orders and organizing principles designed to structure and regulate the activities of the human beings engaged in disposing and operating the technology", with different agents and organizations owning and managing parts of the system, as well as different occupations, professions and bodies of knowledge being involved (Burns/ Dietz 1992: 209).

Social **institutions** and the corresponding "orientation complexes" (Weingart 1984) shape technological development by providing a normative and cognitive frame, a specific rationality of action, and often also an arena, in which institutionally defined and invoked relevant actors create and decide upon different options or paths of development. They create opportunities and constraints, which channel but do not determine individual action. Complex societies have a multitude of political, economic and other social institutions. Their emergence and stability can be explained as socially "constructed". This does not mean,

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4 As long as the materialized technology alone is examined, it depends on the researcher's perspective whether a technology is treated as a single artifact or a system. (With respect to the car, for instance, see Soerensen 1991).

5 This concept is much broader than the organization-related notion of the Tavistock-group (Emery/ Trist 1960).

however, that theories of technological development can neglect their existence or reduce it to a mere feature of social groups or some individual actors (see Langlois 1986: 235-253).[6] The most appropriate strategy for revealing the significance of institutions is comparative research. The introduction of interactive videotex in Western Europe in the 1980s provides one of the very few examples of a systematic comparison of institutional settings with respect to their influence on the "success or failure" of this new telecommunications system (Schneider et al. 1991; Mayntz / Schneider 1988).[7]

Sociological macro-theories in the tradition of Max Weber and Talcott Parsons emphasize the relationship of societal modernization, functional differentiation and institutionalization, and they point to the influence of institutions on individual and collective action (see Lepsius 1977). Some of them also propose typologies of (functional) differentiation. Extending Parsons' famous A-G-I-L typology, Luhmann advances an "open" concept of differentiation which does not a priori restrict the number of functional subsystems to four. He rather treats politics, science, religion, education, law, economy and some other social spheres as "outdifferentiated" functional systems (Luhmann 1984; 1986; 1990). Luhmann refers to evolutionary concepts in order to "explain" their emergence and development, but he does not clearly specify the conditions of their emergence, selection and stabilization. In every subsystem, communication - the elementary unit of social systems - has a specific binary code, entails criteria for the selection and assessment of adequate operations, and provides basic substantive decision-rules. In the economy, for example, communication refers to payments, profits, investments, costs, etc., whereas scientific communication is centred on research programs, "theories" and explanations using the true / false distinction as a pervasive criterion. Functional subsystems display features of "autonomous closedness" and "self-referentiality". Communication, however, can rapidly switch from the economic to the political, or from the political to the scientific code (Luhmann 1986: 87).

For heuristic purposes Luhmann's concept of functional differentiation appears rather attractive because it is not very difficult to correspondingly classify many social institutions as essentially political, economic, scientific, etc.. Basic economic institutions encompass markets, patent rights and business firms; in the polity

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6 As is demonstrated in a newly published volume, "constructivists" still have problems in recognizing the difference between individual actions or strategies and institutions. In a postscript the editors cautiously introduce the concept of institutions showing an initial comprehension similar to our understanding. In their line of argumentation, however, they lose contact with institutions, preferring to speak of structures (Law / Bijker 1992: 299-306).

7 We will refer to the specific role of international videotex standardization later.

constitutions, election systems and regime-like systems of international treaties, including international organizations, are examples of institutions; and in science one finds scientific associations, research programs or universities.

Institutions contextualize situations providing specific rationalities of action, which we prefer to call **perspectives**. According to the lines of functional and institutional differentiation, different perspectives can be analytically distinguished. Empirically not every perspective is equally likely to prevail in relation to the "shaping" of technology. In the special case of international coordination of technological development through standardization, we suggest political, economic and scientific perspectives are prevalent. In addition, an institutionally activated technical perspective, hedged through formal and informal norms and rules, comes to the fore.

Social theories of functional differentiation, but also the sociology of science and economic theories, have some problems dealing with technology, technological knowledge and functional technical subsystems. Abundant discussions on the relation of technology to either science or economy, concerning such properties as basic principles and operations, social organization, function or autonomy, only demonstrate that technology has a two-fold relationship to them. From Luhmann's perspective the degree of systemness of technology is not as high as that of (other) functional subsystems (Luhmann 1990: 259-267; see also Barnes/ Edge 1982). But neither he nor many other authors would deny that we can find many elements distinguishing technology from the other spheres.[8] An institutionalization of **a distinctive technical perspective** through professionalization and organization of a specific knowledge base contributes to the social stabilization of a partly autonomous technical sphere. Its institutional manifestations include professional associations, engineering communities and technological paradigms (see Weingart 1984), but also, as we will see, standardization organizations.

Individual perspectives on technology are often shaped through professional socialization. Engineers certainly differ in their views from politicians, scientists or business managers. When they talk about technology, professionals tend to introduce and generalize their respective concepts of technical artifacts and systems, which include references to actors, principles, specific issues and institutions. These comprehensive concepts constitute the basis for specific **types**

8 Renate Mayntz explicitly argues for the inclusion of large technical systems as functional subsystems: "Funktionssysteme" (Mayntz 1988; 1993). See also Werle (1990: 23-26).

of reasoning on technology. We distinguish four types: technical, political, scientific and economic reasoning.

3. Institutionalized types of reasoning, committees and conflict resolution

In the real world, no type of reasoning exists in its pure form. Many actors and organizations mix them, or they can switch from one to another.[9] We can easily imagine a situation, in which a debate on religious, scientific or economic issues is being held in a circle of engineers. In this context, engineers engage in the respective type of reasoning.[10] On the other hand, it is especially those organizations and institutions which are designed to decide upon conflicting positions that typically maintain rules and mechanisms which aim to attain a certain degree of "purity" of reasoning. Too much diversity in reasoning seems to result in heterogeneity overload which impedes the ability to decide.

The predominance of a specific type of reasoning in a given social constellation does, of course, not preclude that the actors have conflicting ideas, opinions and interests in a specific subject. This was demonstrated more than thirty years ago when a large CCITT study group discussed a standard for data modems for the telephone network. Most of the participants of the meeting either represented companies in the data processing industry or were delegated from telephone network operators. Both groups' perceptions of the problem and the proposed solutions were so different that the meeting "turned into a somewhat theatralic clash of two cultures", as a participant recalls (Wallenstein 1990: xiii). Yet, issues, problems and conflicts that continue to reappear will be of a certain type. In a controversy on such subjects actors will use a common terminology, apply similar rules and criteria and refer to shared principles.

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9 Weyer (1989) shows that strategic switching can be used to forge coalitions ("hybrid communities") between actors from different social subsystems.

10 From this point of view, the argument that for fruitful controversy studies it is necessary "to discard mainstream images of science" (Brante / Hallberg 1991: 390) does not sound convincing. Why should we call a controversy scientific, when in a public debate scientists reason morally or politically using their general prestige as scientific experts to give their arguments a higher weight (see Miller 1992)? Such a controversy could as well be interpreted as a "jurisdictional conflict" (Abbott 1988) in which different professions struggle for more influence in their society, in order to enlarge their jurisdictional domain. This, then, is clearly a political conflict.

Functionally specialized social institutions reinforce this tendency. They constitute the normative basis of organizations, some of which have been explicitly established to enable conflict resolution or early coordination of diverging positions.[11] These organizations as such do not prevent conflicts from emerging, neither do they automatically resolve them. They rather channel conflicts, providing formal and informal procedural rules that are supposed to facilitate a consistent ("pure") type of reasoning on a certain subject. In other words, through these rules an abstraction from other than the formally "authorized" arguments is achieved. The organizations are not, or only in a minor part, corporate actors, acting on behalf of a constituency. Rather they constitute an arena or a system of arenas, in which individual or corporate actors congregate in order to gain information and orientations, coordinate actions and process controversial matters.

Courts as well as committees are examples of such organizations. **Committees** do not rely on third parties like judges when emerging controversies need to be settled, although a "neutral" moderator may chair the meetings and sessions. Participants or members are usually "experts", possibly assisted by supporters, but not depending on them like laymen. Existing rules predominantly serve to govern procedure and do not entail substantial regulations which enable courts to come to binding decisions. Committees as organizations, however, file, store and recall substantial decisions and actions taken in the past, which can be invoked when new problems appear on the agenda.

Committees designed to resolve conflicts or to coordinate diverging positions early[12] employ various modes to terminate these processes. Consensus achievement or variants of majority voting, usually combined with some kind of periodization of activities, are the most prominent ones. When committees not only decide upon facts but issue norm-like judgements, they expect the addressees[13] to comply. Consensus based decisions are easier to implement than those in which a majority dominates. In constellations where no implementation or policing agencies are available, it may become vital to reach a consensus.[14]

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11 Conflict resolution thus can be regarded as some kind of ex post coordination, as diverging positions, which early coordination would evade, have already appeared.

12 Concentrating on these aspects shall not ignore the fact that many committees are also or exclusively engaged in non-conflictive or less-conflictive screening and brain-storming activities.

13 These are, at the least, the committee members themselves.

14 The concept of "closure", frequently used in studies of controversies to designate the termination of a controversy, does not draw a clear distinction between a

Moreover, as long as membership in a committee is voluntary and not remunerated, only the rule of unanimity or of broad consensus will attract participation, especially when the "product" of a committee's decision can benefit a larger collectivity.

Whenever controversies arise, actors invest time and energy, they pursue different strategies in discussions and negotiations on a certain subject, and at the end - even when a broad consensus has been reached - there may be "winners" and "losers". In this case, but also in uncontroversial matters, the requirement for an actor to invest resources if he or she wants to participate coincides with free-riding opportunities of non-participants, thus reducing the incentive for voluntary participation (see Buchanan / Tullock 1971: 43-130; Olson 1971: 33-65).

From the perspective of functional social differentiation, institutionalized coordination and conflict resolution on the basis of consensus seems to be most likely when the controversies are organized along the lines of social differentiation, which increases the concentration on a pure type of reasoning. The selective institutionalization and organization of one "legitimate" type of reasoning generally facilitates decision-making on the basis of consensus substantially, because competing interests emerging from other perspectives cannot officially be introduced into a controversy.[15] When, for example, different optional features of a technology are discussed with respect to their compatibility with a larger technological environment, the argument that option "A" fits better than "B" because "A" is produced in democratic and "B" in authoritarian countries would not be legitimate because it represents an inappropriate political argument in the given situation. After a switch to political reasoning, however, a country's political constitution can be a relevant attribute, whereas specific features of that country's technical proposal will be widely ignored. The status of an argument as rational or at least legitimate depends on institutional and situational circumstances.

In committee-work **the abstraction from perspectives which institutionally do not "fit"** firstly **increases the capacity to proceed on a consensual basis** and secondly **facilitates reaching a consensus in a controversy**. However, **institu-**

"decision" and its "acceptance" or stabilization. This latter aspect, which in committee standardization refers to the problem of implementation and diffusion of a standard, must be regarded separately, because the mode of termination can affect implementation. Therefore we refrain from using the term closure.

15 In an institutionalized pure type of reasoning "deviant" perspectives ideally remain behind Rawls' "veil of ignorance", and competing interests relying on other perspectives do not even emerge.

tions homogenize perspectives and not interests.[16] A common view of a problem as political or economic will not automatically conciliate opposing political or economic interests, but similar perspectives can facilitate what Elster, in a vein akin to Habermas, calls "rational discussion", especially when the institutional arrangement supports a problem-solving style of interaction and decision-making (see Scharpf 1989).[17]

It might be challenging to relate our treatment of institutions, with respect to types of reasoning, consensual processing of problems and termination of controversies, to the more general subject of institutional differentiation and social integration. When institutions internally homogenize perspectives and when a pluralist society entails a multitude of institutions, a multitude of perspectives co-exist. Whether this hampers or contributes to encompassing societal integration, however, must be discussed at another level of analysis. In our case, with the focus on institutionalized processes such as standardization, a main achievement of institutionalization lies in the norms and rules and the corresponding social selectivity designed to secure, within certain limits, homogeneity of perspectives and a pure type of reasoning. Therefore broader considerations as to the possibility or the conditions of consensus when perspectives already diverge go beyond the scope of our analysis.

Particularly in technology whose autonomous status "between science and economy" remains somewhat ambiguous is it difficult to institutionally secure homogeneity of perspectives and a pure type of reasoning. But it would be misleading to directly infer comparatively high rates of dissensus from this potential ambiguity. Moreover, a switch from one perspective to another, or a mixture of perspectives, can even be helpful to escape from a deadlock into which purely technically arguing actors may have maneuvered themselves. Whether in this case technical reasons are replaced by economic or political ones, or one of the latter perspectives is "translated" into technical reasoning,

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16 The most prominent example is the institutionalization of the industrial ("class") conflict in most industrialized countries. It, of course, does not eliminate this conflict or harmonize the contradicting interests of both "classes", but it reduces the conflict to a predominantly economic one. Here similar perspectives help specify the conflicting interests.

17 "In rational discussion, the only thing supposed to count is the 'power of the better argument'" (Elster 1989: 50/51). Problem-solving styles of interaction could even be observed in the industrial conflict during the economic recession in the 1970s. In corporatist institutional arrangements "social contracts" between the government, the trade unions and the trade associations were forged in order to "control" prices and wages and to return to the path of economic growth (see Schmidt 1989).

depends on the constellation of actors, the flexibility of institutional rules and on situational determinants. International standardization, nevertheless, offers examples of consensus in the presence of diverging perspectives.[18] The political interest of a country in promoting its national solution as an international standard can well be in harmony with the engineers' position of some other countries in prefering the same standard from a technical perspective as a good solution for achieving compatibility. A standard which for some actors may be attractive because of its economic efficiency may be preferred by others because of its technical functionality. But in our institutionalized arena these different interests typically have to be "translated" into the institutionally legitimate type of reasoning; they are mediated and, for the most part, will not be clearly expressed, as we will show when we discuss our standardization cases.

4. Institutionalized technical reasoning in international standardization

The International Telegraph and Telephone Consultative Committee (CCITT) was founded in 1956 as part of the ITU.[19] But its origins are much older. Already in 1865 a first organisation was founded by some European countries, out of the need to deal with the technical issues of transborder telegraphy. In continental Europe, telegraphy and later telephony was regarded in most countries as falling under the exclusive responsibility of the sovereign state. For a long time, the interconnection of these separate national networks was the main area of international technical coordination, as national networks themselves were coordinated semi-hierarchically by the PTTs, the Post, Telegraph and Telephone Administrations (Jones 1979). Only comparatively recently, with the growing liberalization of telecommunications, the new variety in services and the pace of technical change, has international standardization become increasingly relevant also for the internal domestic network design. This has intensified the need for technical coordination in the worldwide telecommunications system, which requires that its different technical components and whole networks have to interwork, despite the fact that their design, construction and operation are under the control of multiple autonomous actors. But as we will see, this growing relevance does not always facilitate international standardization,

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18 In a recent article Schimank (1992) calls this type of agreement a "specific interest consensus" suggesting that when perspectives ("orientations") differ, only the possibility to agree on case-specific solutions will remain.

19 See Codding / Rutkowski (1982) on the ITU, or Codding (1991) for a brief recent overview. The ITU is the oldest, and with 174 member states, also the largest international organization.

which is still set in an institutional framework only partly adapted to the changing environment it operates in.

Successful technical coordination characteristically offers a common advantage to all those involved in the production or usage of a large technical system. To a large extent, standardization is a necessary precondition for the building of international networks, which imply interdependencies between independently acting entities. Coordination among these actors is meant to result in a standard guiding the future development of networks. Coordinative aspects of standards make reference to the definition of interfaces, to protocol specifications or to the determination of criteria for the compatibility of different connecting devices. They typically treat technical artifacts as components of technical systems, and therefore address relational properties (see Schmidt/ Werle 1992b). Like regulative standards, coordinative standards contain normative elements, because they stipulate a certain degree of compliance from manufacturers and developers of technology.[20] Often more than one satisfactory solution to a coordination problem is available. An international agreement on one solution helps to prevent an evolutionary emergence and stabilization of different solutions in different regions of the world (cf. Ullmann-Margalit 1977: 116; see also Wärneryd 1990). Once different solutions have been implemented, measures to achieve compatibility between regions will involve costs, and new coordinative efforts are more likely to include distributive conflict.

From the beginning of institutionalized international coordination, there was a pronounced connection between technical and political aspects, which was reinforced in 1947 when the ITU became part of the newly founded United Nations (UN), although the connection was always seen to be problematic.[21]

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20 This, by the way, serves to make clear that standards, though formulated in relation to technical artifacts, are made to direct social action and not technical functioning, because technical artifacts cannot act.
Regulative standards include safety instructions, quality specifications and minimum or maximum requirements regarding noise, stability or use of energy. In contrast to coordinative standards, they typically address technical artifacts as stand-alone devices. Our focus here is exclusively on coordinative standards in a larger systems context.

21 This was expressed, for example, by the Belgian delegate when the inclusion of the ITU in the UN was discussed:
"Our Union is an essentially technical and administrative body and that, as a result, international politics must continue to be excluded from its discussions. Belgium is favourable to our Union being connected with the UN, but under the formal stipulation that the complete independence of the ITU shall be maintained." (cited in Savage 1989: 39)

The other side of this traditionally close relationship is a strong notion that work on **technical issues** can be kept **separate** and independent from the formally institutionalized risk of **politicization**.

The **formal institutional structure** of standardization in the CCITT is largely determined by the larger framework of the ITU. The CCITT is one of 5 permanent organs which operate semi-independently, i.e. within the overall budget but under quasi-independent leadership (Codding / Gallegos 1991). According to the ITU's convention[22], the CCITT's duties are "to study technical, operating and tariff questions and to issue recommendations on them with a view to standardizing telecommunications on a world-wide basis."[23] The legal status of these **recommendations** is **non-mandatory**. Membership and voting rights are nationally organized (one country, one vote), and **formally** the majority principle is the valid decision rule. Equally relevant are the detailed provisions regarding conferences, which in principle not only apply to the Plenary Assembly of the CCITT but also to the meetings of its subgroups. The chairperson is allocated the right to regulate the meeting in relation to its opening, agenda-setting and closure, as well as having a policing function, regarding the content of discussions. The authority is formally assigned **to assure that arguments are closely aligned to the technical purpose of the Union**.

The **operation of the CCITT** is characterised by a hybrid hierarchical working structure. The political mandate lies with the periodically (quadrennial) convening Plenary Assembly (PA). This passes the recommendations resulting from the last study period. It proceeds not on the principle of majority voting among different alternatives but as a simple adoption or rejection of a suggested standard. The PA also formally allocates the questions to be studied in the following period, as well as deciding on the number of chairpersons and study groups (SGs). The technical work takes place in these groups and their subdivisions, the working parties (WPs) and special rapporteurs' groups (SpRs). Technical issues are predominantly discussed and solved at this lowest level. Decisions

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As Geser (1989: 338) shows, the careful avoidance of politicization and the large membership are closely related; the technicality of issues has always facilitated cooperation of diverse political systems in international organizations.

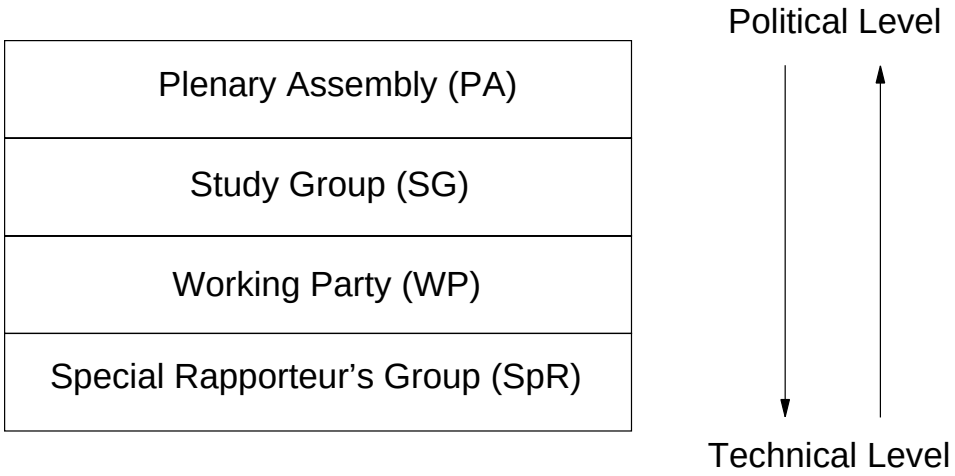
22 This was amended at the Plenipotentiary Conference in Nice in 1989 (ITU - Final Acts 1990). Here the convention was split into a stable Constitution and the (non-permanent) Convention. At an Additional Plenipotentiary in Geneva in December 1992 even more far-reaching changes were decided: the ITU is now reorganized into three sectors (standardization, radio communications and development) with the result that the CCITT does not really exist anymore. Fortunately, these changes can be neglected for our purposes.

23 Constitution, Art. 13 II (ITU - Final Acts, 1990: 16).

taken here are then referred up to the level of the WP and the SG as a whole. If no opposition is mounted at these levels, the technical solutions are adopted and will finally be referred up to the PA. Thus we have **a path of rising political decision competence and declining technical 'content' competence** (Diagram 1).[24]

Diagram 1:

CCITT Working Hierarchy



Membership rules affect the decision process and its outcome, and their selectivity directly impinges upon the inclusion of different types of reasoning. The CCITT has traditionally been dominated by PTT members as holders of the sovereign right of telecommunications operation. Of other interested parties, it is mainly manufacturers who have participated - until recently only in an advisory capacity - under the category of scientific and industrial organisations (SIOs).[25] They now have to pay membership fees which, added to the direct costs of their unpaid participation, restrict the circle of those partaking from the start. With their partly exclusive technical knowledge and the intensity of their input at the level of the technical groups, the SIOs could generally realize a de facto impact on standardization. Yet given the nationally structured nature

24 This institutionalized separation of the political from the technical sphere has increased in proportion to the technical complexity and the pace of technical change, coupled with the growing number of participants involved. This has made it impracticable to take diverging decisions as to the subject matter from the level of the SG to the PA. If dissent still arises, it is therefore only possible to refer the issues back to the appropriate SpR, at the cost of the corresponding delay of the technical solution (Irmer 1990).

25 SIOs were granted full membership status in the CCITT in 1989 (Final Acts 1990).

of the decision-making, the inclusion of a wider range of participants formally affects only the extent of internal coordination in delegations, so that the growing environmental heterogeneity of telecommunications is reflected only insufficiently. The influence of SIOs depends to some extent on the procurement power network operators are able to exert. The principle of nationally organized votes thus transforms standardization into a two-level game, common in international politics (Putnam 1988). Interests are aggregated twice, nationally and internationally, which may also suggest that national technical conditions are likely to receive more weight, particularly if there is asymmetric influence of the network operator.[26] Furthermore, professional homogeneity of participants is significant. The technical purpose of the CCITT leads to the sending of technical personnel, which feeds back a generally technical and often shared perspective on the task.

A comprehensive set of **informal rules** partly complements and partly replaces the formal rules. The **consensus principle**, guiding the CCITT's work despite the formal majority rule, is the most relevant.[27] Its importance is bound up with the difficulty of sanctioning "deviance" in the international realm. A consensual decision adds weight to the non-binding recommendation and makes a widespread adoption more probable (Renaud 1990: 41). The implementation of standards is entirely separate from their definition, and the CCITT neither monitors nor keeps track informally of the degree of compliance. The voluntary nature of standards facilitates consensus as national delegations can agree at no economic cost, as long as no specific contrary interests exist. Although consensus is not identical with unanimity[28], certain dissenting opinions would never be overruled. A consensus would not be declared if, for example, one of the major industrialized countries, who are a focus of the international communications flow, rejected a draft recommendation. An **informal ranking of countries** can be observed.

Informal rules serve to balance conflicting private interests with the joint interest in a coordinated solution. They assure that the decision process and its

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26 The increasing relevance and participation of multinationals clearly shows the ambiguity of this principle. Interests of corporations like IBM cannot be "framed" in a national context. The question is interesting if national representation inhibits their influence in international standardization, or rather increases it since these firms have a "say" in different national delegations.

27 This does not mean that the formal majority rule is as a result obsolete. Rather, its presence as a last resort is likely to speed up decision-making. That no formal votes are taken, moreover, facilitates agreement, because open commitment to a specific position is not necessary.

28 Hawkins (1992: 343) emphasizes that, typically, a 70% majority suffices.

outcome are perceived as being fair, by providing room for the participants to defend private technical and economical interests alongside national ones. The need to reconcile divergent individual positions despite the common interest in coordination has grown as a consequence of the greater heterogeneity of participants. For example, agreement is facilitated by the fact that it is impossible to veto work where one has not participated. Otherwise, work could be obstructed at the level of the Plenary Assembly after years of effort to reach a compromise in the committees. If single participants violate informal rules and obstruct work unnecessarily, there is the formal political level as the last resort: the leader of the delegation to which the disruptive person belongs can be asked to attend to their (his/her) behaviour. In the extreme case, members can face exclusion from the delegation and thus the CCITT.

Up to a point, the institutionalized restriction on technical argumentation facilitates consensus because a common perspective is given. Although a decision may be partly motivated on political or economic grounds, these interests must be translatable into technical reasons. However, when economic interests in particular gain high significance, they cannot be neglected in an organization whose decisions, though technical, have a bearing on market opportunities and profits. With dominant economic interests being in evidence, but not institutionally channelled to any extent, technical reasoning can face "overload" problems with respect to heterogeneity of argumentation and disparity of interests.

With the expansion of heterogeneous membership and interests in technical standardization, distributive conflicts have become more likely. Consensus then is dependent on the prior solution of such conflicts. With the selective focus on formal political or technical reasoning, the CCITT's institutional framework lacks provisions for these cases. At best, "pure" technical controversies can be solved by invoking an upper-level "political" decision to be abided by at the lower level. Over and above that the CCITT must and usually can rely on the expectation that participants will in general behave cooperatively in view of the continuing need for technical coordination (March / Olsen 1989: 21-52). This long term perspective can facilitate other common solutions to distributive conflict, but they are not formally institutionalized.[29] **Package deals**, where participants swap consent ("I agree to your teletex, if you agree to my videotex"), seem to be the solution which is realized relatively often, despite the probable difficulty in finding commensurable trading issues. Also **turn taking**, where the ego surrenders its turn knowing that the alter ego will take the turn

29 'Distributive' conflicts in this context are not constrained to economic controversies, but also relate to non-pecuniary gains and losses. See Scharpf (1992: 65-75) for a detailed discussion of the conditions for side payments and package deals.

next time, is a possibility since the most influential actors in CCITT-committees are long term participants. **Side payments**, finally, are least likely in an organization in which economic argumentation is also informally banned.

Summarizing the, in our view, most significant aspects of standardization procedures in the CCITT, we want to stress their alignment towards consensus where controversies may arise. Legitimate arguments are confined to technical problems with a theoretical possibility of mobilizing politics as a last resort. Formal and informal rules leave little room for other orientations. Scientific reasoning seems to be acceptable as long as it contributes to clarifying or deciding specific technical disputes. "Theoretical" argumentation, however, tends to be rejected. With respect to economic reasoning, the situation is more complicated. Economic arguments and interests appear almost illegitimate. For a long period of time the rather homogeneous membership of the CCITT and the focus on standards for transborder communication facilitated a concentration on technical reasoning. Recently, as our case studies show, this has become more difficult.

5. Controversies: Some Illustrations

In the following, two **standardization processes** will be analysed with regard to the way economic, political and scientific perspectives "invade" technical reasoning. Although we concentrate on controversies, the "usual" procedure at the CCITT is smooth: sometimes slow, sometimes fast, but not highly contentious. For the most part of its operation, the legitimate technical reasoning "absorbs" the other perspectives, so that economic, political or scientific interests become undetectable, since they are fully "translated" into technical arguments. It is in controversies that these "hidden" agendas are revealed and can be analysed.

We will begin with a description of the standardization of **Interactive videotex**, a standardization process that is distinctive in the extent of confrontation motivated by a compound of political and economic interests. It was the first - and up to now only - time where the CCITT experienced difficulties similar to the "Colour-TV War" (Crane 1978) or the current debate surrounding HDTV within the other ITU consultative committee, the CCIR (Cave / Shurmer 1990). Coordination gains were here overshadowed by distributive conflicts. This entire confrontation will be contrasted, secondly, with the standardization of **Telefax**. For most of its history this process was uneventful, and only recently have political and economic perspectives interfered with technical reasoning. To a great extent, as a result of standardization, the "career" of both technological systems has differed considerably.

5.1 Interactive Videotex

In the late 1970s Videotex, the access to computers via telephone networks employing user-friendly terminals, became a central topic of the telecommunication agenda in the leading industrialized countries. Their national PTTs were "looking for new services to increase the traffic in their existing telecommunication networks and for new follow-up products for the time when the telephone expansion would reach its saturation point" (Schneider et al. 1991: 190). Some national governments were, furthermore, concerned with the support of the consumer electronics and computer industry. In 1977/78 when Britain (Prestel), France (Antiope) and Canada (Telidon) initiated international standardization of videotex, each introducing their own system's concept to the CCITT in turn, each system's development was already well advanced and on the point of implementation. More significantly, each country had pronounced interests in seeing its system as the world standard. This concerned hopes for a large equipment market with low terminal costs - aspirations here focussed especially on the USA (Ford 1979). Alongside these economic interests of terminal manufacturers, which were supported by industrial policy, there were strong wider political interests. In the context of rising discussions about the coming "Information Society", Britain and France in particular thought it a matter of national prestige to see their systems proposals become world standards. Also involved was their ambition to see a European development succeed, despite the US American dominance in computing.

The initial discussions ended with a preliminary recommendation ("S.100") in 1980, which merely described all three systems with respect to coding conventions and a few other technical elements. Meanwhile the USA had announced that it would possibly present its own systems development to the CCITT at a later date. Even this first agreement, with its character more akin to an impasse than an emergent compromise, had been difficult to reach. Britain, in what was, for the CCITT, an unusual move of direct confrontation, had demanded at the last meeting that Telidon be deleted from the official recommendation. The other countries then had to take a stand. Interestingly here, France supported Canada and even mobilized Germany and Sweden to do the same, by threatening to otherwise obstruct these countries' teletex standardization efforts.[30] Behind this was France's desire to damage Britain who was perceived as the real competitor, although technically there was more similarity

30 This could not be articulated as a contribution to a technical debate concentrating on Videotex. During informal meetings, coffee breaks etc., however, France had the opportunity to establish these connections and make arrangements for a package deal.

between Antiope and Prestel than with Telidon (Savage 1989: 203).[31] Though these technical similarities and differences were examined and discussed in the meetings, this had little impact on the virtual standstill of the decision-making process.

Standardization continued in the next study period. Here Canada succeeded in merging Telidon with the US proposal into a system called NAPLPS. This gave it a lead over France and Britain.[32] The study period ended in 1984, again with a recommendation ("T.100") that included **several incompatible options** (NAPLPS, the European CEPT standard and a Japanese system). Even after 1984 there was the aim to reach a compromise with the Recommendation "T.101". Finally, the conflict subsided not because a satisfactory common solution had been found, but because the actors had been disappointed in the scale of their political and economic expectations.

This failure of Videotex itself was, to a significant extent, caused by the unsuccessful standardization that had transpired. Because of persistent incompatibilities, the chance for cheap terminals in an international market and for transborder services was foregone. The continued attempts to reach an agreement, moreover, added insecurity on all sides as to how far investment into the system would not become obsolete with a new standard. Videotex is thus an example of heterogeneity overload where the institutional framework could not cope with "breaking" the conflict into something manageable. What does this controversy reveal about the characteristic operation of the CCITT when significant political and economic interests are present?

From a technical point of view, the existing functional **commonalities** between the systems proposals were broad. Each system conceptualized a similar combination of data bases with telecommunication links, and a TV-oriented terminal device, providing a reasonable basis to attempt standardization. Moreover, committee standardization is the "normal" procedure in telecommunications for realizing international interoperability and services. Once such standardization started, however, it could not easily be stopped because the CCITT lacks an institutional provision for ending unsuccessful standardization efforts. This mirrors the institutionalized principle that one single ("the best") technical solu-

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31 Telidon and NAPLPS are geometric systems while both Prestel and Antiope are alphamosaic, albeit they use different coding methods (serial versus parallel).

32 In contrast to these countries, Canada's only aim at the CCITT was to be set on a par with the others, as one standard option among the rest. At the same time, however, it tried to dominate the North American market in a de facto way and achieved this aim with NAPLPS (Savage 1989: 203).

tion should always be agreed on and that the CCITT is the only organization capable of providing the necessary coordination for international telecommunications. When no formal consensus can be reached on where to stop, each party with stakes has to continue. A one-sided exit would pose the danger that another national proposition may be adopted, or of a possible compromise between the remaining actors. The work itself has to be based on technical reasoning, protracting the search for a compromise when the primary interests are political and economic. Each country can only continue to praise the technical merits of its system to protect these hidden interests.

In the concrete case presented here, Britain and France first had to overcome their perception of being in direct competition. As long as both aimed at **world market domination and national honour**, they were in an "all or nothing" situation, with no common gains and nothing to compromise on. Mutual gains from coordination only became apparent when the context changed: the successful North American agreement on NAPLPS in 1982 added enough external pressure for them to realize that there were common interests. It was then feared that North American manufacturers could overtake the European market in a de facto way, with cheap terminals, if the fragmented situation persisted.

The conflict between the UK and France was finally settled within a (former) European standardization organization, the CEPT.[33] This fact illustrates well how the institutional split between technical and political reasoning allows the technical working groups to interpret all conflicts as "political", attributing them to external sources, while the search for the best technical solution is allowed to continue. Videotex standardization had already started in CEPT in 1977. Once there was the political will to reach a compromise, Britain and France were both faced with sunk costs and commitment at home, while there was no provision to negotiate these economic stakes. Months and months of technical discussions finally led to the realization that technical differences between Britain and France were not that great (Childs 1982). In the so called CEPT standard that resulted, both national standards were included as options within the larger context of a general path of future technical migration. Similar to the international level, where the CCITT had agreed on the enumerative listing of different incompatible options, the CEPT standard was no real solution. In view of fixed positions, it established commonality **at a higher level of technical abstraction**, by delineating a joint **future** path of technical development. With both the CCITT and CEPT, the resulting compromise made for an institutional

33 In every important respect, the CEPT's institutional framework is similar enough to CCITT, besides being limited to 24 European countries and being under the almost exclusive control of the respective 24 PTTs.

settlement of the controversy or, at least, a means of surmounting the predominant difficulties. But none of the standards were implemented; they did not have the potential to effect the necessary technical coordination and, moreover, came much too late. While negotiations in committees thus failed, in the alternative institutional context of the market, clear guidelines for coordination ("market standards") did not result either. In the competition of the different national systems, none achieved a large enough network to sustain at least the national technical development without significant government subsidization as in the French case.

5.2 Telefax

Against this conflict-ridden standardization process of Videotex, the standardization of Telefax is almost a counter example. Telefax standardization had started in the early 1960s, directly provoked by the perceived need for an international standard. At the time firm-specific fax standards existed, limiting communication to machines of the same brand. Once started, standardization progressed smoothly, resulting first in the Group 1 standard (6 minutes per page), followed by the Group 2 standard in 1976 which had reduced transmission time by 50%. Economic and political interests in this technical development were almost absent, the technical principle dated back to the last century and expectations of a wide diffusion did not exist. The lack of interest almost led to a dissolution of the responsible study group and a discontinuance of the work in the early 1970s.

Still, interest did not sink below a certain threshold, with the result that work could continue, still uninhibited by non-technical considerations. New technical possibilities made a Group 3 standard with a mere 1-minute-per-page transmission time feasible. Once started, Telefax standardization thus progressed, oriented to the optimization of this single design-characteristic transmission speed. A difficulty which emerged in the work for the Group 3 standard illustrates how problems are processed at the CCITT under such ideal conditions.

Several alternatives existed when a coding method for the Group 3 Telefax had to be chosen, whereas there was an absence of decisive technical, political or economic criteria. In this case, the decision on the Modified Huffman Code (MHC) was reached with the help of several tests of the different methods available, i.e. in a scientific-experimental way. Though **scientific reasoning** is not formally accommodated in the institutional framework, neither is it informally barred, probably due to the close relationship between the scientific and the technical fields. It is unproblematic, as this decision demonstrates, if it

merely supplements and assists technical work, drawing up a decision amongst alternatives.[34]

Larger controversies where non-technical perspectives were relevant only occurred after the significant commercial success of Telefax. The rapid diffusion which took off in the early 1980s with the new Group 3 standard had been completely unexpected. Forecasts of new service growth at the time focussed entirely on Teletex and Videotex. And yet the astonishing success could not have happened without prior standardization; after all committee standardization had only started on the basis of the limits of a brand-only compatibility. Of further significance was the requirement, imposed by some countries and fulfilled by most manufacturers, for Group 3 machines to be downwards compatible with Group 2. This increased security and trust in the development, and thus helped enlarge the network of users. Such features were significantly absent in Videotex with its many incompatibilities.

A small controversy which arose in the mid-1980s shows how formally illegitimate **political lobbying** might assume the role of side payments and thereby overcome economic conflicts that prevent technical coordination. The controversy concerned the decision to adopt an Error Correction Mode (ECM) for the Group 3 Telefax standard. British manufacturers (which licensed Japanese machines) wanted ECM standardized, to improve the service and thus increase the demand for machines. Japanese manufacturers, in contrast, preferred to keep their proprietary methods. Finally, the British Government got the Japanese Government's consent that Japan would not block the ECM standardization in the CCITT.[35]

This conflict was only minor but shows how, in the context of rising expectations, non-technical perspectives infiltrate technical reasoning in standardization. An unusually large controversy was faced in the standardization of Telefax in the last study period ending at the beginning of 1993. With its exceptionality

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34 Whenever scientific reasoning competes with existing technical, economic or political interests, it is less likely to be recognized. People from universities or the PTT research centers in particular are often regarded as promoting solutions that are too scientific to be usuable for practitioners. Interestingly, commercially unsuccessful standards are often labeled "too theoretical", just as unsuccessful standardization was "too political".

35 In contrast to political lobbying, which can bring about a decision and overcome a deadlock, it will obviously not be guided by an economic rationale. While side payments can lead to an outcome that is efficient in the Kaldor sense, a politically struck compromise need not even realize Pareto effiency. See Scharpf (1992: 57) for both concepts.

and duration it reveals well the CCITT's characteristic processing of different types of reasoning.

The controversy started with the British proposal to standardize a Group 3 terminal for digital networks, made possible through a minor adaptation of the existing Group 3 standard for analogue networks. The problem is, however, that a Group 4 standard has already existed for digital networks and particularly the Integrated Services Digital Network (ISDN) since 1984. The Group 4 deviates from the technical principles embodied in Group 3. Instead of being constrained to a stand-alone terminal with ideosyncratic coding and printing technology like Group 3, Group 4 is a much more principled solution. It is based on the new Open Systems Interconnection (OSI) architecture, applicable to all sorts of communication (data, text, voice) in digital networks. This is an abstract standards architecture specifying common principles which, if implemented, will impose comparable structures and allow compatibility between different subsystems.

The controversy surrounding the British proposal, which was quickly backed by a similar suggestion from the USA and had the support of the former USSR, can thus be interpreted as a **conflict with a genuine technical trait**, revolving around the question of overall architectural orientation. Against the principled but complicated OSI solution, the new proposal was based on the evolved telephone network architecture as a frame of reference for choosing between technical options or for a guided search to achieve a certain functionality. Thus, it had the pragmatic capacity to produce a faster fax - like Group 4 - in a cheaper, less principled and more ideosyncratic way.

The proposal was fiercely opposed by a coalition of countries, most of all France, Germany and Japan, joined by some smaller countries acting out of (tacit) political allegiance. They wanted to keep the existing Group 4 standard unrivalled, and rejected the declared superiority of the Group 3 digital standard. It could not be cheaper, they argued, at least not if it was to achieve the same performance. What is more, the Group 4 standard had existed for some time, several manufacturers had sunk investment in it, and some machines were already in use.

Once a standard has been recommended by the CCITT, it cannot be changed or even replaced by a different technical alternative. It was therefore impossible to suggest that the new proposal be simply used instead of the Group 4 standard. This stability of recommendations protects the long term confidence in the work of the CCITT. In a controversy this institutionalized principle provides a legitimate argument to oppose new proposals without having to refer to detailed technical or economic reasons. From this point of view, a second op-

tional standard impedes the development of technological systems and worsens their economic prospects. The high degree of self-commitment can also be seen as the only institutional safeguard protecting economic interests and investments. Arguments about costs and general efficiency, sunk investment and installed base of machines are only allowed at a very general level. Precise figures are not given at the CCITT in order to give the work a technical, rather than an economic focus, thereby furthering the search for the most appropriate technical solution instead of the most profitable one.

Only a limited range of technical arguments was therefore exchanged. Moreover, it was apparent that both sides differed in their **assessment of possible parallel standards** for the next generation of Telefax: while the promoters of a Group 3 digital standard believed the market would cope and that two coexisting standards offered a positive choice for consumers, the opponents regarded two standards as dangerous for the future development of Telefax. A further standard would imply that there were incompatibilities between the different standards and could cause insecurity in the market, which so far was based on the ease of interoperability of Telefax.

These different evaluations, similar to the two existing architectural orientations, were incommensurable and thus incapable of negotiation. The CCITT had no institutional means to surmount this deadlock, besides re-opening discussions at subsequent meetings to see if positions had changed. **Important hidden economic, political or simply personal interests were attributed** by the participants to be the cause of the conflict. For example, it was said that the US promotion of the Group 3 digital was the attempt to break the Japanese dominance in the production of Telefax equipment, and that there were overall trade interests involved. The opposition of France and Germany was ascribed to the purchase of a large order of Group 4 machines, while Japanese firms, some believed, were secretly developing the digital Group 3 machine but could not promote it openly since the Japanese delegation leader would loose face, were Group 4 given up. Such accounts were matched by the suspicion that Group 3 digital really lacked any fundamental backing. The British person who had first promoted it - interestingly employed by a Japanese firm in England, which added more confusion - only wanted to prove he still had ideas, it was said. In the US, the other strong proponent, likewise one person was seen to be responsible. He - a consultant to AT&T - merely prolonged work on this subject as a way to extend his contract.

Such and similar interests were attributed to each other amongst the participants. If, on the one hand, they could have been negotiated openly, side payments, for example, could have been used if sunk investment really stood in

the way of adopting a "superior" Group 3 digital standard. On the other hand, the institutional limitation on technical reasoning clearly transferred all other possible interests to the realm of speculation, furthering the concentration on the openly technical aspects. This facilitates consensus, as most arguments are screened out as illegitimate; they may be relevant as a means of attributing and explaining actors' behaviour, but they are not allowed to have an explicit bearing on the CCITT's operation. Changing positions in international trade, manufacturers' competition or industrial policy are not meant to affect the course of international standardization. In Telefax, therefore, only the legitimate procedural rules could be employed to achieve an agreement. In this situation, the proponents of Group 4 made the attempt to oust the Group 3 digital with a compromise proposal for a Group 3 standard using Group 4 protocols (UDI), which would be less harmful to the Group 4 developments. However, this strategy failed as the compromise was not accepted. The way the debate was then closed is highly interesting.

After the controversy had to some extent blocked other work for a study period, a conclusive decision was deemed necessary. Not being able to progress with technical arguments, the political level of the CCITT was activated. All delegation leaders participating in the responsible SG VIII were called to a meeting to draw up an agreement. The "technical people" had to abide by the decision. Here both the Group 3 digital and the UDI proposal were accepted as new options to the Group 3 standard, to coexist with Group 4. Thus, what was introduced as an attempt to restrict the number of options as far as possible, the UDI proposal, became in the end an additional option. The way this controversy ended nicely illustrates **how institutional constraints and process dynamics may combine to generate a new standard**, which need not actually - as UDI demonstrates - have any real backing. Moreover, together with the other coexisting standards, namely the old Group 3, the old Group 4, and the new Group 3 digital, UDI may have the effect of causing the technical development of Telefax systems to run completely out of the CCITT's control.

6. Conclusion

Technical coordination is a specific aspect of technical development. It refers to the problem that, at least in a non-hierarchical constellation, autonomous actors must take into consideration what others do when they design, manufacture, operate and, sometimes even, when they use different components of a more comprehensive technical system. Network technologies like telecommunication networks obviously require such coordination, which compatibility standards are designed to facilitate. Although a means of technical coordination,

the definition of the several features of a standard can be motivated and influenced by other than "pure" technical concerns.

Theories of functional and institutional social differentiation offer criteria to distinguish social systems on the basis of not only their structural, but also their institutional, cognitive, normative and action-related aspects. Building on these theories and on empirical studies of technical development, we introduce a distinction between technical, economic, political and scientific perspectives. These perspectives typically guide actions in the international standardization of telecommunications.

Whether or not these perspectives can directly affect standard-setting processes depends to a great extent on institutional and organizational factors. In telecommunications a considerable amount of international standardization is concentrated in the CCITT. Membership and decision rules, but equally rules regarding the legitimacy of different types of reasoning, govern the work of the standardization committees in this international organization. Technical reasoning is the officially most appropriate form in standard-setting. The institutionalized requirement to abstract from non-technical perspectives facilitates standardization. Scientific, economic and political interests have to be translated into technical reasoning, establishing a common denominator for negotiations. The range of valid arguments is restricted. The extent to which actors' motivations are non-technical is a matter for speculation and as such is dismissed as irrelevant for the work of the CCITT.

Only in exceptionally few cases does the CCITT's normally smooth operation, secured through the institutionalization of technical reasoning, fail. Typically the problems result from recent technical, economic and political-regulative changes in international telecommunications. In such cases, every participant is still interested in having a common standard, but as the benefits of different options are distributed unequally, the actors reveal strong preferences for different solutions. With the consensus principle being standard operating procedure of the committees, the actors risk ending up without a standard at all. Such dilemmatic situations, as yet still infrequent, have become more relevant for the CCITT. In the broader controversies emerging, one can discern the limits of mechanisms absorbing non-technical perspectives or translating them into technical perspectives.

But in the exemplary analysis of standardization processes at the CCITT, we can also see that officially pure technical controversies can sometimes be brought to a conclusion when an institutionally "deviant" perspective is introduced. Besides the formally accepted means of this intergovernmental organiza-

tion coming to a political solution as a last resort, scientific arguments are accepted informally as a neutral way of reasoning. In other instances, "hidden" economic, political or even idiosyncratic interests remain obscure. But their translation into technical reasons makes it possible that negotiations in specific cases result in agreement.

Finally, there are rare cases, as Videotex standardization vividly demonstrates, where political or economic perspectives dominate to an extent which technical reasoning cannot absorb any more. Under these circumstances, the CCITT's operation is blocked. Interaction turns uncooperative as the prevailing hidden interests cannot be exposed and dealt with openly. In these cases of heterogeneity overload, the restriction on the technical perspective leads to practically irrelevant ceremonies of technical reasoning. Institutionalized provisions to handle this kind of situation, like authorized discussions on side payments to overcome economic conflicts, are not available. Thus standardization fails, and the development of a technical system can be neither technically nor otherwise coordinated and controlled by the CCITT. However, an institutionalization of additional instruments for these cases would need to take into account that the normal successful operation of the CCITT builds on the abstraction from non-technical arguments.

Our emphasis on problems of technical coordination and the role of institutions in the coordination process points to crucial elements of a theory of technological development which are missing in most social constructivist approaches in the sociology of technology. We have tried to show how institutionalized rules and procedures of standardization can shape technological systems. International standardization is one important phase in the development of telecommunication networks and services, determining to some extent their future existence and success. The standardization processes demonstrate, we argue, that institutions generally privilege and stabilize selectively a certain - in our case a technical - perspective and a corresponding type of reasoning, which is clearly distinguished from non-technical perspectives. The latter are never absent, but through translation they are often accommodated to the institutional context. Institutional frames thus influence the way actors coordinate technological developments and, in doing so, they shape technical systems. This institutional embeddedness of individual action has to be taken into account if constructivist explanations are to escape the charge of voluntarism.

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