STANDARDS FOR NETWORKED EQUIPMENT AND SERVICES

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Summary

This chapter presents a methodology to understand the role of standardization in networked services and how to take them into account in technology planning and management. In particular, we show how successful standards depend on the integration of several streams of information, such as the nature of the innovation, the life cycle of the technology, and the level of details needed in the standards. We take advantage of studies on the management of innovation to gain insight into the role that external and internal standards play in the development of networked equipment and services.

1. Introduction

Whereas common understanding, procedures, rules and references are useful in many situations, public telecommunications services require specific agreements among the parties involved (equipment manufacturers, network operators, service providers, and end-users). In other words, standards are essential in a networked environment. Manufacturers depend on standard interfaces to build equipment that can talk to similar equipment made by other manufactures and that can be used by different network providers. Network providers, in turn, rely on standards to reduce uncertainties concerning equipment availability, their performance and interoperability. Service offers that are overlaid on these networks benefit from standards in reducing the complexities of day-to-day operations to focus on the service delivery process. Moreover, service providers depend on standards to define the framework of their agreements with other service providers or network operators, and to ensure end-to-end connectivity. Application developers need standards to achieve independence from network hardware and software systems. Finally, content providers and content managers (such as aggregators) depend on standards to have a uniform presentation of their products and to facilitate its distribution through multiple transport and distribution channels. In all these situations, increased standardization shifts the criteria on which competition is based from the basic functionalities to the overall service quality and performance. The diminishing role of governments in mandating the rules for telecommunications means that these agreements will be based on voluntary standards, i.e., there are no legal sanctions for not following them (even though the penalties may be economic). The consequence of their being voluntary is that standards reflect the business strategies of a particular industrial sector.

Inter-firm standardization in telecommunications has focused on the network elements and their subcomponents because the standardization is more obvious than in the case of network management or operation support systems. It is known that the value of a network increases with the number of its users – the so-called network externalities. The absence of a common interface standard is a burden on all parties. For example, having a dual digital transmission standard (the μ-law at 1544 kbit/s in North America and Japan with the A-law at 2048 kbit/s for the rest of the world) adds a step to all digital transmission equipment. Similarly, the fragmentation of the market for cellular telephony in the U.S. into islands of competing digital standards (IS-95, IS-136, GSM –

Groupe Spécial Mobile – as well as Nextel/Motorola's proprietary systems) increases the cost of interconnection and prevents the consolidation of the industry.

Standards can be internal to an organization or external across an industrial sector, in which case they can be formally issued by a standards development organization or by a public agreement – typically, but not necessarily, through consensus – of interested parties assembled in an ad-hoc group or consortium. Standardized routines within each company define the various methods and procedures that eliminate the idiosyncrasies of relying on subjective judgments, which is exceptionally important in the case of emergencies or disaster recovery. Internal standards are therefore proprietary to a specific institution, with the goal of streamlining operations and increasing efficiency so as to reduce cost or to improve response.

The common thread of standards is the sharing of engineering information among all parties in a given supply chain (suppliers, distributors, content providers and end-users), whereas other ways of information sharing, such as licensing or patents, are legal ways to declare ownership and exclude others. Without a standard, the information sharing is typically secretive and selective. Furthermore, without a standard document, it may be difficult to satisfy the regulatory requirements of providing "complete and accurate" documentation, as in the protracted case between Microsoft and the European Commission. Because standards are one way of breaking the monopoly of knowledge, while patents enforce that monopoly, their overlap creates a predicament for standardization that, particularly for networking applications, is irresolvable unless the common good is given primacy over individual property rights.

Clearly, the technical aspects of standardization do not take place in a vacuum; the environment is defined by a combination of commercial and political factors. Furthermore, the way that people look at standards depends on their vantage point. As a consequence, it is important to define the parameters of the discussion in order to reach meaningful conclusions that can lead to decisions. Otherwise, we can only repeat obvious statements that standards can encourage or block innovation, foster trade or impose barriers by creating regional standards, etc.

2. Management of Standard Production

The standard production process can be approached on several bases, such as the nature of the standards setting organization (government–sponsored, professional, or private), the criteria for participation, access to the documentation, the decision-making process, how intellectual property rights are considered, and how standards are managed throughout their life cycle. With globalization, the distinctions based on geographic locations, such as for country-based and regional standardization, are becoming less important because most standards have now a global scope.

2.1. The Nature of the Standards Setting Organizations

There are three basic ways that an external standard is produced:

- A body recognized one way or another by governmental authorities, in which

case the standard is denoted as *de jure*

- An ad-hoc organization (a consortium of companies or a loose federation in the case of the open source movement) formed as a private initiative of interested parties
- The market power of a single supplier leading to a *de facto* standard.

The ad-hoc nature of a consortium means that its existence is tied to a specific technology, e.g., the Frame Relay Forum was focused on frame relay technology and the World Wide Web Consortium (W3C) is reserved the Web. When the scope of a consortium activity expands and it becomes recognized by various authorities, it moves closer to *de jure* organizations, as in the case of the Internet Engineering Task Force (IETF).

Irrespective of the nature of the standards body, it typically appoints a rapporteur (or convener) nominated by one of more members to manage the process for standard development. Thus, the rapporteur's selection is not an open process. Standard setting requires the availability of experts, i.e., knowledgeable, motivated and committed individuals that carry out the necessary work of drafting the standard. Their contributions represent the views of the various institutions that are sponsoring the standards development by proposing technical designs and selecting their delegates. The rapporteur's authority among these experts is of an informal nature. It is based on the respect of other participants gained through experience and knowledge, as well as on the fairness exhibited in conducting the proceedings. The rapporteur organizes the meeting agendas at his or her discretion but has very little formal authority over the content or the quality of the contributions that drive the activities. The same institutions have no control over the conduct of the negotiations and discussions in hallways. The main control that a standard organization has is to revoke the mandate of the rapporteur. The description of this process highlights several important points. The costs of making these experts available are borne by companies and institutions that sponsor their participation, but the sponsors have loose control over their representatives and what they agree to. Next, not all attendees can be active contributors so they join as interested observers. The standard organization that owns the standard has no direct control over the end product in terms of timing, quality, etc. It only monitors whether the rules were followed during the standards process. 'End-users' only very rarely participate in the process; either directly or indirectly. Similarly, public institutions at large, which may have to face the consequences of the standard in terms of education, quality of life, health hazards, environmental impact, job loss or creation, etc., are less likely to be represented than commercial interests.

It is clear that in the development of external standards, the overall chain of authority is very weak. At any one time, none of the stakeholders has complete information or direct control over the outcome of the process. More explicitly, the assumption of transparency that is essential for a perfect market is not satisfied. In addition, except in some de jure situations, where the process can be theoretically under the control of the representatives of the people in their government, technical standardization enshrines the power of an oligarchy of technocrats with limited accountability. This fact can be obscured by the rhetoric about "democracy" and "openness."

2.2. Participation

The barriers to participation in standardization activities are threefold: technical expertise, cost, and the governance of the standards body. Regarding governance, the various standard organizations differ on the criteria for membership and how open they are to different categories of members. For example, to ensure worldwide representation, the International Telecommunication Union (ITU) sets its membership fees through a sliding scale depending on the country revenue. In contrast, during the Cold War, participants in the IETF had to be vetted by the US Federal authorities. In the end nevertheless, the main contributors are always from advanced countries. Finally, the IETF maintains the fiction that attendees do not represent anyone but themselves.

2.3. Access to Documentation

The output of the standard process falls into two general categories: work-in-progress documents and final standards. The work-in progress relates to individual proposals, meeting reports, attendance lists, draft documents, etc.

The various organizations differ in how they make their documents available in terms of format and cost. Among the major standards organization, the IETF is unique in that both its work-in-progress documents and its final texts are published without restriction. The documents, however, are only available in English. Other international organizations publish their output in several languages.

2.4. Decision-Making Process

The decisions on approval can be made according to several criteria:

- The vote in the ITU is on a country basis, a fact that could lead to some distortions. Block voting of the European Countries would put at a disadvantage other interests such as the US, Japan or Canada. To counteract this situation, a US multinational may try to establish a presence in European countries (joint ventures, acquisitions, etc.) to influence the decision process in national delegations of one or more European countries before participation in the ITU deliberations.
- The decision can be in the hand of a general assembly of paying members.
- The IETF encourages participation through open mailing lists; however, the discussions are conducted through a specific protocol with the peculiar variant of English used among "net heads." The final decision, however, is the prerogative of "enlightened despots," the areas directors who have an unchallenged control over the standardization decisions in their respective areas on the presumption that only technical considerations will be their guide.

The expression "due process" is used whenever the process is transparent and decisions are taken after considering the various views, objections and balancing arguments based on experimental data or facts. Typically, this includes an appeals mechanism to review procedural complaints regarding any action or lack thereof. However, while it is true that the governance processes differ with respect to who is a member, how a design becomes acceptable to the parties interested in a solution, and how the minority

opinions are treated, the ultimate decisions remain in the hands of technocrats reflecting the political and economic biases of the times.

2.5. Intellectual Property Considerations

Patent protection and licensing of intellectual property rights (IPR) affect standardization in several ways. First, standard bodies have to define a policy for dealing with any claimed rights that participants may have on the standards, such as disclosure of patents, as well as the licensing conditions for that knowledge. Without such an explicit policy, there could be unpleasant surprises after a standard has been approved. Such a policy, however, does not prevent long negotiations to license what has been standardized. One main reason is that complex systems include ideas from many parties, so that licensing becomes a time-consuming task, unless some licensing pool is established. Second, IP conditions are not uniform across standard bodies, which may stymie document exchange across standard bodies, thereby increasing the hurdles to industry-wide collaboration. In general, however, standard development organizations do not want to get involved in patent litigations. It is clear that there are linkages between IPR and standards and that, through these linkages, laws and regulations affect standardization.

2.6. Standards Maintenance and Retirement

Standards are not only developed and issued; they have to be maintained and updated to reflect field experience and then finally withdrawn. Formal organizations have a long-term perspective, in terms of time and technologies, which allows them to take into account multiple interests and to manage the on-going support of standards through updates, revisions, corrections, etc. A standard consortium refers to an ad-hoc alliance of companies and organizations financed by membership fees to resolve a specific interoperability problem, typically when a new networking technology is being developed. The focus can be technical, marketing or a combination of the two to build the network externalities through standard promotion. The single focus of an alliance allows it to have results quickly, at least initially, but the consortium life-span is limited, irrespective of the technology success in the market place: it is sustained as long as the members are willing to support it. Once a consortium disbands, the specifications that they have adopted become orphaned, i.e., the standards that were developed will not be supported in terms of fixing defects or supporting migration to future systems. In other words, the lack of accountability is inherent in the structure of consortia.

3. The Management of Standard Development

From a process viewpoint the management relates to the procedures exercised to ensure that the output of the work is logically consistent with itself and that it meets the scope and the technical requirements that the various stakeholders have defined.

3.1. Stakeholders Analysis

The process of standard development has many stakeholders, as illustrated in Figure 1. The list of stakeholders includes the following: members of the technical committees

that develop the standards; the technical organizations that carry the expenses of developing technical contributions and/or sending their representatives to these standards bodies; the standard development organizations that host the meeting space and approve the specifications; the product or service organizations that will use the standard; the end-users of the products incorporating the standards; the public and political institutions concerned with the outcome, etc. One way to organize these various elements is to use typical marketing terminology. Here, the 'suppliers' are the participants that bring in technical contributions, thereby shaping the direction and content of the standards. Members of the committee usually represent the interests of the 'sponsors,' the various companies or official entities that finance their participation. The 'producer' is the technical committee that merges various contributions into a coherent text to be approved by the attendees. The 'owner' of the standard, at least from the copyright perspective, is the standards body. Once the standard document is published, 'consumers' use it to design products or services that will embody the specifications and put them in the hands of 'end-users.' End-users may be in a large firm or institution, a small or medium enterprise or individuals at large.

It is worth noting that, although the suppliers and the consumers may come from different divisions of the same company, their concerns are not necessarily identical or totally congruent. The developers of a design may be seeking compatibility with existing product lines, cost reduction, or ease of implementation, while other stakeholders may give priority to the robustness and quality of the specification. Furthermore, the timeliness of information and communications technologies (ICT) standards may depend on the time window of interest, which is not the same for manufacturers or service providers and which depends on the target audience of the product or service that embodies the standard (large consumer market, specific industrial sector, etc.). Governments may be representing several of these constituencies, particularly those that are not participating in the process, or they may be totally captured by some specific dominant interests. In any event, their interest may not be necessarily congruent with that of large multinational manufactures or service providers.

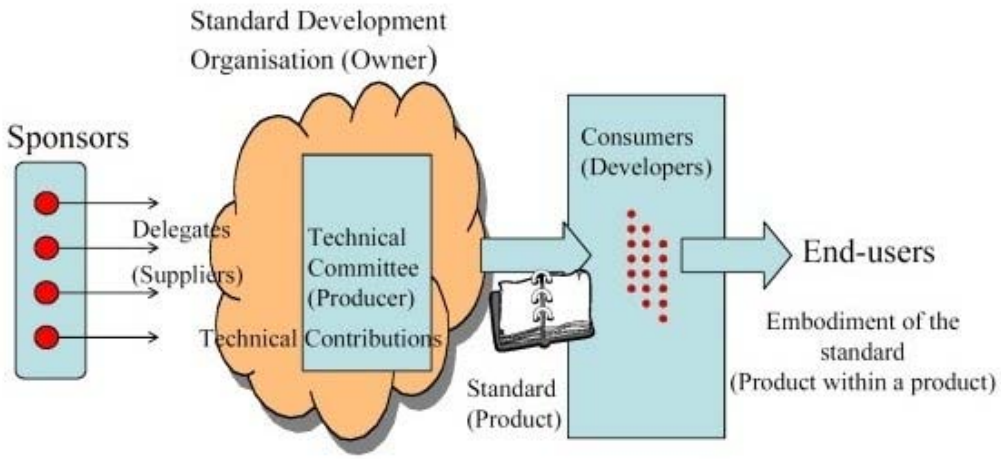

Figure 1: Supply chain in standard development

ICT standards attempt to meet a multiplicity of needs that have different time horizons (time to market, time to scale, time to profitability, etc.). For example, as shown in Figure 2, there is a difference in the time windows of interest of equipment vendors and service providers that use the same technology.

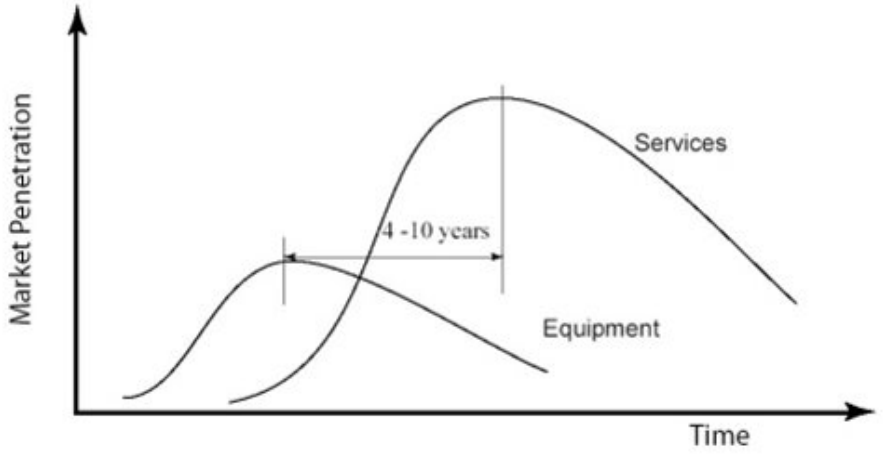

Figure 2: Phasic relation of the technology cycles for equipment and services (Copyright 2006, Idea Group Inc., Advanced Topics in Information Technology, Standards and Standardization Research. Reprinted with permission)

3.2. Standards Quality

Readability, completeness and correctness of the standard are essential characteristics. Complex specifications, however, are written over a period of time and typically involve many compromises. Inevitably, ambiguities can creep in, sometimes intentionally, but more often because of the way the concepts have evolved while the standard was being developed. Frequently, justifications for the choices made and any supporting documentation could be useful in resolving these ambiguities. Some technical editors solve this problem by including explanatory material; however, because this is not considered an essential part of the standardization process, the information in these notes may be incomplete. Internal inconsistencies or ambiguities typically cause erroneous and/or incompatible implementations, a problematic result in networked applications and services. These deficiencies can cause significant damage if the equipment and/or services developed according to them have to be retrofitted.

Specifications with pseudo-code or formal languages are unequivocal and can be checked with automatic verification tools. Methods for structured software design such as reviews (“walk-throughs”) can be used to identify inaccuracies and inconsistencies. Lastly, translation into a different language has the positive side-effect of forcing an independent and thorough analysis of the semantics.

A complementary approach to manage specification quality is to test the interoperability of different implementations to determine if the desired end-to-end functionalities can be achieved. In a perfect world, implementations of new specifications should be able to

interoperate with those already being used and with other specifications being developed. This adds another layer of needed cooperation among the various active committees of a given standard organization and with other organizations as well. This often means that the various sponsors should harmonize the various development initiatives within their own development teams.

Attempts at improving the governance of standards have focused on automation and electronic document submission to enhance collaboration and reduce costs. This is perhaps because all stakeholders would agree on that step. Digging a little bit deeper, one would discover that the meaning of quality is not the same for each of the stakeholders of the standardization process. For example, operators tend to select the standards that are:

- implemented by more than one vendor,
- as transparent to the end-user as possible,
- flexible in their evolution,
- simple to maintain and support, and
- able to interwork with other operator-networks and end-user equipment and devices

On the other hand, equipment vendors would like to dominate markets with unique products and would like to market their products as quickly as possible.

It is tempting to extend the principles of Total Quality Management (TQM) to improve the quality of the standard process; unfortunately, these principles are oriented towards internal processes within a firm to ensure mass delivery of products or services and do not consider collaborative efforts across firm boundaries. If we measure quality as conformance to requirements as advocated by Crosby, we face the fact that standards development organizations write their own terms of reference based on participants' contributions. Moreover, the commercial and strategic goals of the participants are never explicitly stated, so the technical requirements may be silent on specific constraints related to their marketing plans or their technological capabilities. Deming's approach emphasizes the uniformity and the predictability of the production process to reduce cost and increase reliability. 'Uniformity' and 'predictability' would then mean that the rules are constant across all standards, that all standards pass through the same approval process and that the layout and organization of the final documents are the same. It is not clear, however, what advantages these characteristics that apply to mass production would give to the one-of-a-kind operation that characterizes standards production.

Juran's measure of quality stresses fitness for use. This measure was generalized by the 2nd edition of the ISO 9000 standards series to the satisfaction of the needs and expectations of stakeholders. Unfortunately, not all stakeholders are equally involved in the standardization process. Even when 'user requirements' are available, they are usually high-level expectations that need to be translated into requirements for sub-systems or components. Clearly, the traditional criteria for TQM do not address collaborative efforts performed outside the firm.

If the production of a standard is treated as a project, then the methodologies used for project quality management can be adopted to the unique effort of producing interface specifications. One obvious difference of the standard setting process from other projects is that the participants and the necessary expertise depend on the willingness of the various sponsors, even though they are often competitors in the market place.

4. Subject Matter Classification of ICT Standards

The typical way to classify standards is to refer to the subject matter that is being standardized. Accordingly, there are basic or reference standard, interface standards, verification standards and quality standards.

Basic or Reference standards are standards related to terminology, quantities or units, data elements, reference models, etc.

Interface standards define the functional specifications and/or the design requirements of various entities to enable them to function together, and/or how to evaluate the performance of the implementations. They can be further defined into several subcategories based on how strict is the interface protocol:

- *Similarity standards* define aspects that have to identical on both sides of the communication link, as well as the allowed variations or tolerances, if any. Examples include the nominal values of signal levels, the shapes (or masks) of current pulses, coding algorithms for streams of interactive speech or video, algorithms for line coding for transmission of signals, encryption algorithms, error-correction codes, and so forth.
- *Compatibility (interoperability) standards* are typically in the form of profiles, functional specifications, interface templates, user agreements or implementation agreements to designate a fixed subset of options that are needed to perform a given service using the same technology under standardization. It should be noted that there is a difference between compatibility standards and portability standards. Interoperability is related to networked applications while portability is an attribute of a software product that can be used with different hardware platforms.
- *Flexibility Standards* focus on the capability of a single network element to interoperate with legacy or future systems by negotiating the parameters of communication. In other words, flexibility is an attribute related to the effect of time and technology differences on compatibility.

Verification standards consider the observed behavior of the implementation under test. They include:

- Performance standards that define the boundaries of acceptable behavior
- Measurement standards that describe methods to be used to verify whether the performance criteria are met
- Conformance standards to assess the implementation of complex communication protocols

Quality standards define the set of requirements that a process has to meet to ensure a certain level of quality. The series of ISO 9000 standards is a good example; but there are many others that define, for example, the quality of a billing system or of network operations, etc. In particular, the quality of a telecommunication service results from the collective effect of the performances at several layers. Assessment of the performance involves a mixture of subjective and objective parameters to assess the quality of transmission in the presence of impairments. It covers the user-interface to the service offers, the network performance from the aspects of switching and transmission, as well as the operational aspects and the service support functions. As explained earlier, these quality standards do not assist in having a high quality standard production.

The subject matter classification of standard is extremely useful for bibliographic and reference purposes because it facilitates the search of information after the standards has been defined. However, such a classification does not help in planning for standardization in terms of the nature of the content or the speed of development. A forward-looking tool for standardization planning that uses the technology life cycle is explained in the following section.

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Biographical Sketch

Mostafa Hashem Sherif was born in Egypt in 1950. He obtained a B.Sc. and M.Sc. in electronics and communications from Cairo University, Egypt, in 1972 and 1975 respectively, a Ph.D. in Engineering from the University of California, Los Angeles, USA in 1980 and an M.S. in the management of technology from Stevens Institute of Technology, Hoboken, New Jersey, USA in 1996. He is also a certified project manager from the Project Management Institute (PMI).

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