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A Qualitative Analysis Of The Role of Users, Vendors, and Governments in the Standards Development Process

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A QUALITATIVE ANALYSIS OF THE ROLE OF USERS, VENDORS, AND GOVERNMENTS IN THE STANDARDS DEVELOPMENT PROCESS

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ABSTRACT

Existing literature on IT standards focuses on the role of technical factors such as network effects and competitive behavior on the creation of standards. However, the role of users and vendors in initiating the standards definition and ratification process is less well understood. Given the advantages associated with standards, all users and vendors of IT products would be expected to be glad to participate in the standards definition and ratification process. However, if that were the case, many fewer proprietary technologies would compete. This paper explains qualitatively why users, vendors, and government bodies choose (or don't choose) to participate in the standards definition and ratification process. A better understanding of their motivations for participating or not in the process should help to attract more participants to the process. The paper concludes by analyzing strategies to recover the cost of standards definition and ratification process, and their impact on the standards adoption rate.

KEYWORDS: communications standards, standards development, standards evolution, IT standards.

I. INTRODUCTION

IT standards dictate the consensus rules for designing, producing, testing, and installing IT products, services, and systems. These standards are important because they:

- lower the costs associated with developing and deploying IT systems, and
- make these systems more efficient and compatible.

Among practitioners, standards development is considered very important. Many large industries are based on standards. For example, the Ethernet standards (ISO/IEC[1] 8802.3 CSMA/CD) built an industry from nearly zero in 1980 to many billions[2] today. Therefore, business organizations and government bodies spent considerable time and effort on the standards definition and ratification process.

The importance of standards is also evident in the amount of academic research on the subject. For example, early work in the industrial organization literature studied the effect of network externalities on de facto standardization [e.g., Farrell and Saloner, 1985; Katz and Shapiro, 1985, 1986, 1992]. Specific issues addressed by these studies include-

- the role of the prior reputation of firms on their compatibility decisions [Katz and Shapiro, 1985],
- the impact of incomplete information on adopting incompatible technologies [Farrell and Saloner, 1986], and
- the role of technology sponsorship on the emergence of de facto standards [Katz and Shapiro, 1986].

More relevant to IS researchers, some of these studies focused on the role of technology sponsorship in creating a strategic advantage when incompatible technologies compete in markets with network externalities [e.g., Katz and Shapiro, 1986].

Another important finding relevant to IT industry is that the strength of consumer preferences for software variety drives the equilibrium outcomes for hardware platforms. For example, when consumers value the variety of available software more than they value the variety in hardware, the equilibrium outcome is a de facto standardization in the hardware market. In these markets, the hardware is supported by the majority of software providers, becomes the dominant hardware platform [Church and Gandal, 1992]. Research in information systems though, is not rich in addressing standards-related issues. However, IS researchers did focus on factors that impact the adoption of IT systems based on particular communication standards. For example, a large body of literature deals with the adoption of EDI systems [e.g., Iacovou et al., 1995; Chau, 2001; Iskandar et al*.,* 2001; Mukhopadhyay, 1995]. These studies provide guidance to practitioners and academics in understanding diffusion of standards.

In summary, the industrial organization literature predominantly deals with understanding the emergence of de facto standards, while the information systems literature focuses on the diffusion and adoption of these standards. While these issues are important, they do not cover the broad dynamics of the formal standards definition and ratification process. In particular, little is understood about the activities that take place during the initial phase of any standards development. In this phase someone - an individual, an organization, and/or a government body - decides to take the first step towards defining and then ratifying a standard. They then attempt to attract others to participate in the process. Attracting more members to participate in the process is important because it impacts adoption directly, and thereby, the success of a standard. Furthermore, the greater the number of participants, the easier it is to recover the costs of defining, developing, and promoting the standard.

[1] International Electrotechnical Commission
[2] A billion in the U.S. is 1000 million but a million million in the U.K. CAIS uses the 1000 million definition.

II. THE STANDARDS PROCESS

This paper takes a qualitative approach to explaining the motivation of users, vendors, and government bodies in initiating the standards development and ratification process. It attempts to address questions such as:

- Who is more likely to initiate the standards definition and ratification process?
- What are the underlying motivations of the participants?
- What are the factors that keep the affected parties from participating?
- What is the cost of participation in the process?

Before addressing these issues formally, we discuss the formal process by which standards are defined, proposed, refined, and finally ratified as national and international standards. The ultimate goal of any IT standard is to become an international standard because international standards enable a single design to

- cross country boundaries without technology barriers,
- build large user pools, and
- reduce product/application design costs.

At the inception/definition phase of the standards development process, an interested party decides to initiate the process either on its own or in collaboration with others. It should be noted at this point that for the remainder of this paper, potential initiators (i.e., those who take the first step and initiate the standards development process) are classified as vendors, user organizations (or users), and government/privately funded organizations (e.g., regional and national SDOs[3]). Vendors are defined as those organizations which can incorporate the standards in the products and services that they sell to the user organizations. This paper assumes that individuals interested in being part of the process do so by being affiliated to one or more of the aforementioned initiators.

Figure 1 shows the multiple paths to an ISO/IEC JTC1 recognized international standard [Robinson, 1999]. For example, the standard could be developed in one of the subcommittees of professional communities (e.g., such as IEEE P802 does in its subcommittee six (SC6)) and then submitted, via one of the national Standards Development Organizations (SDOs) or directly, to the international SDO. Another option is that a standard is developed by a business organization or a group of business organizations (e.g. consortium). This standard is then ratified through the Publicly Available Standards (PAS) process. This process allows the standards developers to bypass the regional and national SDOs and submit the proposed specification(s) directly for inclusion into ISO/IEC standards.

[3] SDOs are organizations that develop and maintain the models, data dictionaries, structure, syntax, and implementation materials for standards.

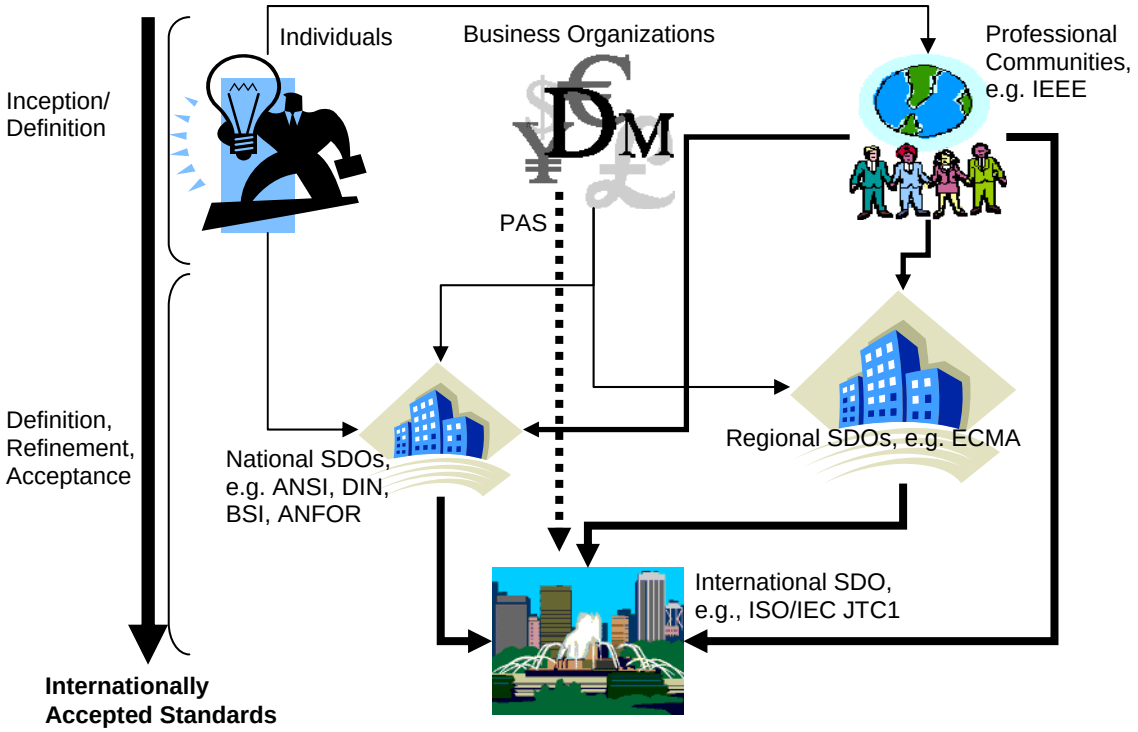

Figure 1: Standards Development Process- From Inception to Acceptance

The following section provides a qualitative explanation of the rationale behind the decision to participate or abstain from the standards definition and ratification process.

II. PARTICIPATE IN THE STANDARDS DEFINITION AND RATIFICATION PROCESS OR NOT?

Figure 1 shows the various stakeholders involved in the standards definition and ratification process. However, for many of these entities (e.g. IT vendors, government organizations) standards definition and ratification is not their primary task. The history of IT standards entities shows that many stakeholders do not become engaged in the standards definition process, even though they may adopt the standards at a later stage. For example, TCP/IP standards were defined by the joint initiative of the US Department of Defense and academic institutions before they became widely accepted and adopted throughout the world, while HTTP standards for online document formats and standards for EDI communication were initially defined by the IT vendors before they evolved into well defined, universally accepted standards. The following subsections explain the decision of these various stakeholders (i.e. vendors, users, and governments) to participate in or abstain from the standards definition and ratification process that goes on in their relevant industries.

USERS AND STANDARDS DEFINITION

Existing literature and anecdotal evidence from industry suggest that users can benefit greatly from IT standards. In particular, two strong incentives to support initiatives aimed at defining and ratifying standards are:

- to commoditize the product, and
- to minimize the cost of deploying and managing communications systems that link them with other users.

Therefore it seems logical to argue that users should be in the forefront of any standards definition and ratification initiative. This, however, is not always the case. All user organizations are not actively involved in the standards definition process.

To illustrate this point, consider a simple strategic game. The game involves two users, who can either decide to initiate the standards definition process. The cost to initiate the process is c. Alternatively, the users can abstain from the process. The important feature of this game, as a model of providing a public good, is that if both players choose to participate in the process they both pay the full cost, i.e. c, as opposed to sharing the cost equally. One interpretation of this assumption is that the two users belong to a committee or consortium of users. The opportunity cost of time spent in attending the meeting is c for each participant and the number of other participants does not affect this cost [Fundenberg and Tirole, 2000]. Once the standards are defined, both benefit from these standards. This benefit is 1 for each user. The payoffs for the two users are shown in Figure 2. The pure strategy Nash equilibriums of this game are that one user initiates the standards development process, while the other abstains from participating in this process.

	Participate	**Abstain**
Participate	(1-c), (1-c)	**(1-c), 1**
Abstain	**1, (1-c)**	0,0

Figure 2: Standards Public/Shared Goods

Thus, in a more general setting, we should expect to find some user organizations getting together to form a consortium and initiate the standards definition and ratification process, while the remaining user organizations abstain from the process. However, the abstaining user organizations may adopt the standards once they are ratified by the national and international standards development organizations. This simple model explains why some user organizations would participate while other would abstain from the standards definition and ratification process. However, it provides no clues about the rationale behind these decisions.

Two reasons why some users may be reluctant to participate in this process are:

1. The users could end up paying a higher price for compatible systems that emerge due to the presence of standards [Shy, 2001]. These price premiums could far exceed any benefits that result from the compatibility brought about by standards [Shy, 2001]. Furthermore, in the absence of relevant standards, the users' desire for compatibility intensifies competition among incompatible systems, resulting in reduced prices [Shy, 2001]. Therefore, some users would prefer to abstain from any process (i.e. the standards definition and ratification process) that would ultimately result in standards.

2. Some users (individuals and/or organizations) want to obtain the benefit of the standards without spending resources on the standards definition and ratification process. This outcome results from the "free rider" problem often associated with providing any public goods.

Why do users participate in the standards definition and ratification process?

1. The user firms that already use some proprietary standards want these standards to be ratified as national and international standards. A good example is the case of Web Services, where firms such as IBM and Microsoft developed technologies to meet their own needs. They then realized that they created something that could be useful in a wider context. This realization prompted them to initiate the standards

definition and ratification process by submitting their proprietary standards to national and international standards development organizations for approval. It should be noted at this point that these users could also act as vendors, in the wider context, when they benefit by selling products and applications based on these standards.

2. If the user firms are dominant in the industry, they can dictate the communication standards that are adopted in their industry. For example, in the automobile industry, the auto manufacturers were instrumental in the adoption of EDI. Another example is the financial services industry where 29 major firms, including Bank of America, Citi Bank, Wells Fargo, and MasterCard formed a consortium[4] to develop financial web services standards. In this same industry, in 1996, Visa and MasterCard jointly developed a single standard, called Secure Electronic Transactions (SET), to secure payment card transactions over insecure networks. Other major card brands, including American Express and NOVUS (Discover), later endorsed the SET standard.

Even if the reasons why a user organization wants to participate in standards development process can be explained, how do we explain their acceptance of free riders? One explanation lies in the very nature of standards. That is, the standard displays consumption or network externalities, and provides significant economies of scale, i.e. larger the number of organizations that adopt the standards, greater is the benefit to the adopters. This rationale is also supported by the economic theory of clubs [Buchanan, 1965]. This theory describes and formalizes the institutional properties of a new category of goods (or product) lying between the public and private polar extremes, i.e., conventionally called shared good (e.g. IT standards). Only members participating in a voluntary association, i.e., a club whose membership may be regulated by some dues, usually enjoy these goods. However, the traditional club model implies that the value generated by the shared good decreases as the number of users increase [Buchanan, 1965]. However, in case of network products (e.g. IT standards) "the performance of the product as well as its utility increases with the increase of the community of users" [Antonelli and Foray, 1992]. Therefore, user organizations that initially get together to initiate the standards definition and ratification process, accept free riders at a later stage when the standards, which are network products, are ready for adoption.

The costs associated with standards definition and ratification can be recovered by charging a licensing fee (if the standards are for sale) from vendors who use these standards in their products and services. Since the license fee generated is proportional to the number of users who use products and services based on the standards, it is in the interest of the users to accept free riders. While the participation of users in the standards definition and ratification process is hindered by the free rider problem, the participation decision for vendors is also not a straightforward issue. The following section analyzes the motivation behind a vendor's decision to participate in the standards definition and ratification process or abstain from it.

VENDORS AND STANDARDS DEVELOPMENT

Previous debates on standardization emphasized the impact of technological compatibility on inter-firm competition [Besen and Farrell, 1994; Baseman et al., 1996]. On one hand, consumers assign higher value to products that give them access to large networks. They therefore are more willing to pay for compatible goods. On the other hand, compatibility may increase product substitutability, thereby leading to increased competition. For example, producing software that is compatible with a dominant hardware yields higher sales. However, doing so will lead to more competition with other software producers [Church and Gandal, 1992]). Thus, tension between standardization (i.e. providing compatibility), and unique capability (i.e. achieving a business/competitive advantage) is inherent. Vendors face a choice between making their

[4] The Interactive Financial eXchange Forum

products compatible with those of their competitors (i.e. competing within a standard), or to make them incompatible (i.e. competing on standards). Vendors cannot postpone the decision for long because, in network markets, the coexistence of incompatible products may be unstable, and a single winning standard finally emerges and dominates the market [Besen and Farrel, 1994].

Competing on Standards

A firm would want to compete on standards for two reasons:

1. It may want to use its technical incompatibility as a strategic tool to gain market dominance. For example, Microsoft used technical incompatibility, as part of its competitive strategy to emerge as the dominant player, and then maintain the dominant position in the market for operating system software [Baseman et al., 1996].

2. If a firm controls a technology that becomes established as a standard at a later date, the firm can achieve an extremely profitable market position [Ferguson and Moris, 1993]. Examples include IBM's historical dominance of the mainframe computer industry, Microsoft's dominance of the desktop operating systems market, Intel's position in the microprocessor market..

There are, however, two major drawbacks to competition between standards.

1. Vendors who compete fiercely to have their technologies become the standard may dissipate part (perhaps a large part) of the potential gains. For example, when users' preferences exhibit network externalities (i.e. users prefer compatibility), and if the competing products are incompatible and differentiated, then prices and profit levels decline due to fierce competition between the vendors [Shy, 2001].

2. A competition between standards may delay market growth by encouraging buyers to wait for the dominant standard to emerge before they make purchase decisions [Business Week, 1993].

The alternative choice for the vendors is that they compete within a standard, i.e. they standardize, thus explicitly or implicitly agree to make their products compatible. Agreeing on a standard may eliminate competition between technologies, but it does not eliminate competition altogether. Instead, it channels it into other dimensions, such as price, service, and product features. However, competition in these dimensions may not be bad. For example, industry profits tend to be higher when firms choose compatibility over incompatibility [Shy, 2001].

Participating in the Standards Process

If vendors decide that it is better to standardize, they face the question of whether or not to participating in the standards definition process. Vendors who decide not to participate in the standards definition and ratification process can still make their products comply with the standards that ultimately emerge at the end of the process. They may, however, be required to pay a higher fee for using the standards (assuming the standards require payment) and incur a significant switching cost when producing/using products and services based on the new standards. In addition, they can be caught unaware when a new standard influenced by competitors is published. On the positive side, non-participating vendors save on the cost of participating in the standards definition and ratification process (e.g. membership fees).

Being a part of the process offers benefits. These benefits include:

1. Influence the direction of the process, leading to standards that are more favorable to (or compatible with) their existing products and services. This compatibility should provide them with significant commercial and competitive advantage in their respective markets.

2. Their products based on these new standards would be backward compatible with their existing products and services. Their existing customers would find ikt easier to adopt the products and services based on the new standards.

3. Vendors that participate in the standards definition and ratification process also benefit from reduced cost of purchasing the standards (i.e. buying the license to use them), and reduced cost of switching to these new standards.

4. By participating in the standards development process, an organization gets an opportunity to develop close relationships with other participants such as customers, competitors and regulatory authorities.

Choosing a Policy

Given the reasons for competing within standards and competing between standards, is it possible to predict if vendors would choose the latter or the former?

Vendors are more likely to choose incompatibility, i.e. compete between standards when-

- they are symmetric in their market and technology positions;
- the standards battle alone does not greatly delay the adoption of the technology by consumers; and
- within-standards competition is especially likely to dissipate potential industry profits [Besen and Farrel, 1994].

If one or more of these conditions are not satisfied, then the firms are more likely to compete within standards. However, before they do so, they need to converge towards a standard through a formal process (e.g. form a consortium to define the standards) or through some informal forces where all the vendors gravitate towards the proprietary standards of one or more of these firms.

One way to study this choice is to model the vendors' decision problem as a strategic form game similar to the "battle of sexes". Consider two vendors each whom would prefer its own technology as the standard, but each would prefer compatibility with its rival's technology to going it alone. This type of strategic behavior is often visible when one vendor has already incorporated an attribute in its products, and the adoption of other vendor's product suffers because of the lack of this attribute. At the same time, both vendors realize that between-standards competition is likely to dissipate potential industry profits.

If the two proprietary standards are denoted by S1 and S2, the payoffs for this game are shown in Figure 3. The game's pure strategy equilibrium occurs when the vendors agree to accept one or the other proprietary standard as the industry standard.

	S1	**S2**
S1	**2,1**	0,0
S2	0,0	**1,2**

Figure 3: Vendor Participation

The pure strategy equilibrium of this game illustrates how the two vendors would agree on one of the given standards. However, it does not tell us which standard these vendors will agree upon. In some cases, one vendor will accept the proprietary standard of the other vendor as an industry standard because that proprietary standard is already well established and the non-compliant vendor does not want to invest resources in defining, developing, and promoting a new standard

to compete with this established standard. This outcome is illustrated by the example of Secure Socket Layer (SSL/TLS) standards. Sensitive online traffic is usually protected by a cryptographic system originally called Secure Socket Layer (SSL). SSL originally was created by Netscape and placed in its Navigator browser. Later, all major browser vendors, including Microsoft's Explore, supported SSL, making SSL a de facto standard. Later, the standardization effort was passed to the IETF, which renamed the standards Transport Layer Security (TLS).

Another way by which the vendors agree on a standard is when the vendor who wants its' standard to be adopted offers some incentive to the other vendors to agree. Incentives can include low-cost licensing, commitment to join future development, and promising timely information about upgrades. [Besen and Farrel, 1994].

A possible outcome, not captured by the game in Figure 3 is that both firms agree on a standard which is a hybrid of their proprietary standard or develop a new standard from scratch. This outcome is most likely, when

- the firms are symmetric in their market and technology positions;
- the standards battle is delaying the adoption of the technology by consumers; and
- inter-technology competition is especially likely to dissipate potential industry profits.

The case of Remote Access Servers (RAS) illustrates this outcome. Early remote users were required to dial into sites using a telephone modem and PPP (Point to Point Protocol).[5] They connected to a remote access server (RAS) at the site. The RAS authenticated them and then gave them access to other computers at the site. The earlier systems for RAS access control used proprietary protocols that differed among RAS vendors. To address the lack of RAS standards and the need to manage multiple RASs, vendors collaborated on a way to implement policy-based authentication on remote access servers. Their standard was the Remote Authentication Dial-In User Service (RADIUS).

GOVERNMENT AND STANDARDS DEVELOPMENT

Governments are involved in standards development process through national standards developing organizations (e.g. ANSI[6]) and professional bodies (e.g., IEEE[7]). Government's are involved because:

- They themselves are major user of IT products.

  As users governments want to participate in the standards definition and ratification process like any other user organization. For instance, they use some proprietary standards, and they want these to be confirmed as national and international standards. In addition, they may want to leverage their position as a major consumer of IT products by influencing standards definition favorable to IT products and services that they already use.

- They are interested in long-term social welfare.

  Governments ensure long-term social welfare by mitigating factors that potentially lead to the failure of a standards definition and ratification process. They do so, by providing an environment (e.g., through national Standards Development Organizations (SDOs)) in which vendors and users can get together to define

[5] Protocol encapsulating a connection to a TCP/IP network through a modem and a telephone line.
[6] American National Standards Institute
[7] Institute of Electrical and Electronics Engineers

standards. The government also claims to take the long-term view (e.g., interoperability, scalability, extensibility, accessibility, etc.) about standards development, instead of satisfying short-term user (e.g. compatibility with their legacy systems) and vendor (e.g. short-term profitability) goals. Governments try to enlarge social welfare through

1. preventing situations where standards could be used for monopolistic gains,

2. keeping the standards process as open and flexible and possible,

3. ensuring that the standards themselves are non-proprietary and interoperable.

From an economics perspective, by participating in standards development, government facilitates the development of interoperable systems. Interoperability, in turn fosters competition which is key to any market economy.

- They are interested in safeguarding the competitiveness of their domestic industries [Jensen and Thursby, 1996].

International R&D competition often results in outcomes where several firms develop and patent products that are close substitutes, but are based on different standards. In this situation, it is not uncommon for governments to set anticipatory standards intended to improve the strategic (competitive) position of their domestic firms. The following are examples:

1. In the United States, the National Competitiveness Act of 1993 and various congressional studies (US Congress 1988 and 1992) recommend the use of standards to support US industry in technology development.

2. Federal Communications Commission regulations required that high definition TV (HDTV) transmission in the US should either be compatible with receivers used in USA, or should allow simultaneous broadcast with existing channels. This regulation was generally considered to be a strategic move to improve the position of US firms trying to develop HDTV against the Japanese advantage in the area. It meant that the Japanese MUSE system could not be used in the United States without adaptation. Similarly, Europe never adopted a single color TV standard because individual governments promoted standards to protect the interest of their domestic firms [Hazard and Daems, 1988; Pelkmans and Beuter, 1987].

III. COST OF PARTICIPATION AND STANDARDS ADOPTION

In Section II, the cost of participating in the standards definition and ratification process emerged as a key variable that affects the decision. In this section, we discuss how this cost could be recovered. We address this issue by qualitatively analyzing the popular cost recovery strategies and how these strategies affect the rate of standards adoption at a later stage.

Participants bear the costs of the standards definition and ratification process. For example, in addition to the costs involved in communication, coordination and administration of the process itself, the standards must be printed and distributed. Furthermore, every few years, a standard must be revised, reaffirmed, or withdrawn to address current technology. Considerable costs are incurred in promoting the acceptance of standards in the marketplace, such as investment in education of potential adopters about the merit and integrity of standards.

One way to recover these costs is through selling standards (e.g. royalties, subscription). For example, both Microsoft and IBM used so-called "reasonable and non-discriminatory" (Rand) licensing to cover intellectual property in some of "their" standards. The companies charged others to use patented parts of these standards. Another example is Apple, which charged for its technology in the FireWire interface for some years. One drawback with selling the standards is that it can delay its widespread adoption. The cost of managing the standards definition and ratification process can also be recovered through membership fees from organizations that decide to participate in the process. A major drawback of this strategy is that it encourages free riders. Thus, any cost recovery strategy needs to find the optimal combination of membership cost and the sales price for the standards in order to minimize free riding and increase the adoption rate (Table 1).

Table 1. Strategies for Recovering the Cost of Standards Development

		Membership Fee	
		Low	**High**
Sales Price of Standards	**Low**	• Difficult to recover costs • Attract more participation • Encourage free riding • Encourage fast standards adoption	• Easier to recover costs • Attract less participation • Encourage free riding, • Encourage fast standards adoption among non-participants
	High	• Easier to recover costs • Attract more participation • Encourage fast standards adoption among participants • Discourage free riding	• Easiest to recover costs • Attract less participation • Discourage free riding, • Slow standards adoption

Most government bodies involved in standards definition generally operate on the strategy of minimal membership fee and minimal sales cost. This strategy encourages both free riding and participation. It also results in faster adoption rates. Governments can afford this strategy by subsidizing the standards definition and ratification process.

If the process is initiated and undertaken by business organizations, it must be fully funded by selling the standards and/or membership fee. Table 1 shows that a good strategy for business organizations is the one in which participating members pay a low membership fee, allowing for a large participation, while the non-participating members pay a relatively high amount to use the standards to discourage free riding. Higher participation also results in a faster adoption rate.

The worst strategy for cost recovery is the one in which the membership fee is high and the standards are sold at a high price. This strategy prevents free riding but also slows down the adoption of the standards. If a few participants want to influence the standards in their favor, they are better off by adopting the strategy where they charge a high membership fee and a then sell the resulting standard at a minimum price (ideally allow it to be used for free). A minimum sale price encourages free riders but also accelerate the standards' adoption rate. A high membership fee reduce the number of members and the fewer remaining members have a stronger influence on the final definition of standards. Therefore, participants with a lot at stake (e.g. a large deployed base of existing products based on their proprietary standard) have an incentive to advocate giving away of the standards for free and recovering the cost of standards development through a membership fee.

IV. CONCLUSION

Standards, once set, are difficult to change. They do evolve with technology. The early participants in the process significantly influence on the standards that we end up with. Therefore, it is important to understand who these early participants are and their motivation for initiating the standards definition and ratification process. This understanding will help to improve the process by –

- getting more participation from relevant organizations,
- increasing the rate of adoption for the final standards, and
- enabling a faster recovery of the costs associated with the process.

A qualitative analysis of the issue shows that users gain the most from standards. However, not all users participate because they either want a free ride or fear that they may end up paying extra for the compatibility brought about by these standards. Vendors' participation depends on whether they want to compete on standards or within standards. This paper identifies macro-level conditions under which vendors would prefer to compete between standards and conditions under which they would prefer to compete within standards. The paper also analyzes strategies to recover the costs associated with a standards definition and ratification process, and the impact of costs on the standards adoption rate.

Admittedly, this paper is qualitative and takes a simplified approach to address complex issues. This approach was intentional so as to be able to analyze the issue of standards development from a broader perspective and tp help explain the macro environment in which standards definition and ratification process is initiated. A discussion of this macro-environment in conjunction with the issues already studied (e.g. factors that affect standards adoption, factors that influence the emergence of one standard over another), and issues still under investigation (e.g. adoption of standards across industries and nations, optimal standards development process, and technical specifications of standards themselves), will provide us with a better understanding of the evolution of IT standards.

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LIST OF ACRONYMS

ANSI- The American National Standards Institute

CSMA/CD- Carrier Sense Multiple Access with Collision Detection

EDI- Electronic Data Interchange

HTTP- Hyper Text Transfer Protocol

IEC- International Electrotechnical Commission

IEEE- Institute of Electrical and Electronics Engineers

IETF- Internet Engineering Task Force

IP- Internet Protocol

ISO- International Standards Organization

IT- Information Technology

JTC1- Joint (ISO and IEC) Technical Committee 1

PAS- Publicly Available Standards

PPP- Point-to-Point Protocol

RADIUS- Remote Authentication Dial-In User Service

RAS- Remote Access Servers

SDO- Standards Development Organizations

SET- Secure Electronic Transactions

SSL- Secure Socket Layer

TCP- Transmission Control Protocol

TLS- Transport Layer Security

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