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Switching Costs and Abstract Compatibility Standards: Are Vertical Standards as Vulnerable as Physical Products?

Rubén A. Mendoza
Saint Joseph's University, rmendoza@sju.edu

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Rubén A. Mendoza
Saint Joseph's University
rmendoza@sju.edu

ABSTRACT

Research shows vendors manipulate open standards for physical products such as routers and switches to introduce positive switching costs. This article explores the possibility of manipulating vertical standards, purely abstract compatibility standards based on the eXtensible Markup Language (XML). Vertical standards use XML to formalize and codify business processes and data formats unique to specific industries. Manipulating vertical standards does not optimize or enhance proprietary hardware capabilities since they are not embedded in physical products, and any manipulation is easily detected and quite correctable, so it is unclear whether positive switching costs can be introduced by any vendor. This paper describes why vertical standards are not immune to manipulation, and explores circumstances which may make the manipulation of purely abstract compatibility standards possible. A series of testable propositions are presented, and potential evidence to signal the introduction of positive switching costs is discussed. Further research in this area is discussed.

Keywords

Abstract compatibility standards, vertical standards, XML, switching costs.

INTRODUCTION

Standards are technical specifications for products and services resulting from formal or market-based agreement (David 1987), and play a major role in the competitive position of a firm (Mitchell 1994). Standards may emerge as the result of free-market forces, legislative authority, or through the work of standards-development organizations (SDOs) (Farrell & Saloner 1988, David & Greenstein 1990). Information technology (IT) standards can help accelerate integration effects between organizations (Malone et al. 1987, Benjamin et al. 1990) and give rise to demand-side network effects (David & Greenstein 1990), but can trap an organization with a substandard choice (Farrell & Saloner 1985) and lock companies out of markets (Schilling 1998) if not chosen correctly. Adopting a successful standard can mean success in the marketplace, but adopting the wrong standard may leave an organization "orphaned" without options for compatibility with the eventual winning standard (Besen 1992). Standards facilitate data exchange between systems, increase the pool of suppliers to a firm, simplify the purchase process, and lower systems integration costs (Bird 1998).

Standards that define interface mechanisms for IT products and systems are known as compatibility standards (David 1987), and there is evidence to suggest that vendors are able to manipulate compatibility standards for physical IT products to raise switching costs for customers (Chen & Forman 2006). This paper explores possible scenarios for the manipulation of abstract compatibility standards, specifically vertical standards based on the eXtensible Markup Language (XML), and describes conditions which may enable the manipulation of emerging vertical standards by vendors. Manipulation of compatibility in physical networking products (switches and routers) has been shown to generate positive switching costs (Chen & Forman 2006), but it is unclear whether the manipulation of purely abstract compatibility standards would result in positive switching costs for the adopting organization.

VERTICAL STANDARDS

Vertical standards are abstract compatibility standards that formally describe industry-specific data formats and business processes for interorganizational use (Markus et al. 2003). Vertical standards are most often implemented using the eXtensible Markup Language (XML), a collection of syntax rules that allows developers to create customized markup tags to provide semantic meaning to data. Firms participating in any particular industry develop vocabularies, data dictionaries, and data models using consistent definitions and usage guidelines for these tags, which are then used to describe products and services, to provide contextual meaning to data, and to exchange data between systems using different formats. The greater the complexity of a product or service, the greater the likelihood a firm will obtain that product via hierarchical relationships than through market coordination (Malone et al. 1987). Vertical standards help foment hierarchical relationships by enabling companies to describe complex products and services to make end-to-end computing possible. Market coordination costs are

also reduced through the use of vertical standards, which permits firms to select a few key suppliers from the market at large, and develop systems that enable greater interfirm collaboration without the risk of specific investments.

Despite the interorganizational nature of data exchange for which vertical standards have been created, they also provide significant internal benefits to organizations (Knox 2003). Research has documented internal use of vertical standards and related technologies for parsing and reformatting data received in multiple formats from various business partners, and for use in corporate knowledge management systems (Mendoza & Jahng 2003). Vertical standards technologies have been customized or extended by these organizations specifically to provide these services.

The adoption and diffusion of vertical standards has been slower than expected, and research has uncovered a variety of organizational and institutional factors slowing their deployment, including conflicts of interest at the development stage in energy markets (Wareham et al. 2005) and financial services (Chang & Jarvenpaa 2005), asymmetrical power in business partner relationships in the automotive industry (Gerst & Bunduchi 2005), and vendor manipulation of product features to manipulate customer switching costs (Chen & Forman 2006).

Vulnerability of Vertical Standards to Manipulation

Vertical standards are context-sensitive interfaces, and are specifically created to address the needs of the industry for which they are developed. It is important to remember that, while vertical standards are based on XML, XML itself is a horizontal standard, and it is not until an industry-specific application is developed that a standard becomes a "vertical" standard. Industry-specific vocabularies, data dictionaries, and data models may be extended as additional functionality is identified, and without compromising the compatibility of previous generations of a vertical standard. These extensions can be developed using the same procedures that resulted in the development and deployment of the original standard, so there is very little risk of incompatibilities with subsequent versions of vertical standards. The modularity and granularity (Benkler 2002) of vertical standards allows organizations to obtain business benefits from the use of segments of a standard, with the option to deploy more of the vertical standard's functionality as required by emerging business needs, and as this functionality is built into the vertical standard. The ability to modularize and layer vertical standard functionality allows organizations to obtain positive returns, even in partial-deployment scenarios (Braa et al. 2007). Organizations are free to implement any portion of the standard they see as suitable to their needs, and can develop internal converters to facilitate data transport between different systems and applications in their environment using the same technologies used to deploy vertical standards.

The vulnerability of vertical standards and related technologies lies precisely in this flexibility. Industry adopters and vendors alike are free to develop extensions, converters, and translators using XML to extend the "official" functionality of a vertical standard. However, research suggests that market compatibility outcomes are more inefficient in the presence of converters than in their absence (Farrell & Saloner 1992). Empirical work shows that vendors are still able to manipulate vertical and horizontal compatibility to increase switching costs in the presence of open standards for data routers and switches (Chen & Forman 2006). Generally, vendors benefit from increased market demand in the presence of standards, but standards can also stiffen competition between undifferentiable products. Vendors may have incentives to extend standards functionality to differentiate their products and increase switching costs to maintain a larger customer base. These findings have significant implications for the development and diffusion of vertical standards. While the ability to manipulate standards is directly applicable to vertical standards, switches and routers are physical products which require product-specific software to offer full functionality. Vertical standards, on the other hand, are a purely abstract collection of syntax rules that do not depend on any specific hardware platform, and whose functionality cannot be extended unilaterally without deviation from the original standard. Since writing XML-based extensions, converters, or adapters does not change the nature of the original vertical standard and does not affect compatibility with it, are vertical standards also vulnerable to the same kind of manipulation that may increase switching costs for physical products?

Vertical & Horizontal Compatibility for Vertical Standards

It is necessary to define what constitutes vertical and horizontal compatibility for vertical standards before embarking on a discussion of vulnerability. In the case of routers and switches, horizontal refers to cross-vendor compatibility, and vertical compatibility is defined as proprietary extensions that may enhance performance within a single vendor's product line. Since vertical standards are simply a collection of product and service descriptions agreed upon by industry members, not hardware or software product lines, *vertical compatibility* refers to compatibility with business processes and data formats directly within the current or planned scope of the vertical standard. Compatibility with these business process and data format descriptions is platform- and system-agnostic, so it depends solely on the definition of the business process and data format elements that make up the core of what an industry wishes to standardize. Given the dynamic nature of vertical standards this scope may, in time, grow to include functionality not originally planned, but the focus of this functionality is always *inter*organizational, platform- and system-agnostic, and *externally*-focused, with respect to the user organization. Thus, modifications that affect vertical compatibility in the context of vertical standards are those which extend the vertical

standard to provide functionality that was not planned or anticipated at the time of the modification. These modifications will reflect firm-specific business process and data formats, but which would easily be identifiable as being firm-specific when first deployed. These modifications are carried out prior to any certainty that the scope of the vertical standard would expand to include them at some later point in time, which it may. Thus, vertical compatibility modifications add business processes and data formats used externally by the firm but not necessarily shared with other industry members other than its business partners. These unique business processes and data formats may be used to support and extend the scope of the firm's supply chain management, order/shipping/billing procedures, or of any business partner-specific systems investment.

Horizontal compatibility is compatibility with existing systems and applications in use by the organization for *internal* purposes, and whose specific functionality is not intended to be covered by the standard. Horizontal compatibility is *intra*organizational, platform- and system-dependent, and *internally*-focused. Modifications that affect the horizontal compatibility of vertical standards are those needed to make them work with various platforms, and which necessarily depend on the hardware and software combinations that make up each target system. Modifications that affect the horizontal compatibility of vertical standards may also be described as middleware, since they specifically seek to translate the vertical standard so as to make it compatible with a specific application or system. These modifications do not necessarily alter the logical content of the vertical standard, but they do enable firms to create compatibility bridges to legacy applications. Thus, these modifications would be developed in-house specifically to support legacy systems, or applications with few direct external compatibility options such as ERP software, MRP modules, or CRM systems.

It is worth summarizing that vertical compatibility of vertical standards may be still, at some point in the future, fall under the purview of development of a vertical standard, but that horizontal compatibility is specific to the internal needs of a firm. In this fashion, vertical compatibility remains in the context of industry-based compatibility, but horizontal compatibility refers only to the internal technical environment and needs of a single firm, and is different from the meaning of a horizontal standard that cuts across industries.

It is reasonable to expect that manipulating either the vertical or horizontal compatibility of vertical standards may increase switching costs for the end-user organization, making it more dependent on the expertise of the external supplier providing the company with standards-related products and services. This makes it necessary to understand the conditions under which such manipulation may take place, and to look for empirical evidence to determine whether this particular scenario is actually taking place in vertical standards development efforts. There are multiple definitions for what a switching cost is, but for our purposes switching costs are costs introduced *ex post* to a product and which prevent the buyer from moving to a different supplier without having to repeat an initial investment made in the first supplier (Farrell & Klemperer 2006).

The more a vertical standard is augmented or customized to work within a firm's existing architecture, the more vulnerable the organization will become to compatibility manipulation by its suppliers. This customization will generally be completed using the same technologies, primarily XML, with which vertical standards are implemented, and may extend the functionality of a vertical standard in the direction in which it is intended to develop (vertical compatibility) by adding elements that describe business processes and data formats specific to the organization. This leads to the first proposition regarding compatibility manipulation

Proposition 1 - The greater the amount of customization work needed to deploy vertical standards and related technologies in an organization, the higher the manipulation risk for vertical compatibility.

The customization work may also serve to allow a vertical standard to exchange information with existing systems and applications via data parsing and reskinning. This work is uniquely dependent on the firm's technical platform on the target technology for which compatibility is sought. Thus,

Proposition 2 - The greater the amount of customization work needed to deploy vertical standards and related technologies in an organization, the higher the manipulation risk for horizontal compatibility.

The effect of these customizations may be to create hard-coded features that remain unique non-standard elements in a company's use of vertical standards. The extent to which these non-standard elements generate positive switching costs will be moderated by the level of expertise of the organization with vertical standards. Low levels of expertise may delay organizational adoption of new technologies (Attewell 1992) and reduce a company's ability to identify and exploit opportunities resulting from emerging technologies (Cohen & Levinthal 1990). The following propositions are made regarding levels of expertise related to vertical standards

Proposition 3 - Lower levels of expertise related to vertical standards increase manipulation risks for vertical compatibility of vertical standards.

Proposition 4 - Lower levels of expertise related to vertical standards increase manipulation risks for horizontal compatibility of vertical standards.

Distinguishing whether the intent of any manipulation of compatibility characteristics is to enhance product features or to generate positive switching costs to ensure customer loyalty is an exceedingly difficult task (Chen & Forman 2006). Vendors may freely claim that any deviations from an official standard are meant to enhance functionality for users of their products, and showing otherwise will be difficult for any organization since either result is "observationally equivalent" (Chen & Forman 2006) in their creation of positive switching costs. Since vertical standards are purely abstract sets of syntax rules and commonly-agreed definitions, all implemented with relatively simple text-based XML files, accusing vendors of creating positive switching costs will be particularly hard. The vendor can claim that a simple XML-based solution may be found to eliminate any incompatibilities introduced either by their extensions or by the development of new standard functionality. SDOs will be pushed to determine when these manipulations to the vertical standards they sponsor are actually taking place, and whether there is a need to publicly identify them as manipulative in nature, or whether they are matters for an organization's internal IS resources to determine. Either way, there are potential legal ramifications for an incorrect judgment on the nature of any work that deviates from the official version of the vertical standard. It is suggested that

Proposition 5 - Identifying the intent of any extensions or manipulations to a vertical standard will be as difficult a task as it is for physical products.

Strong intellectual property (IP) rights protection may strengthen the position of a sponsored standard in the market and discourage competitors in the same domain (Farrell 1989). Standards-developing organizations with relatively successful track records in vertical standards development make strong, clear IP policies a centerpiece of their activities (Rada 1998, Steinfield et al. 2004). Vertical standards present a particular problem in this regard because it is easy to avoid IP issues when manipulating compatibility for firm-specific applications. Since no deviation from the standard by any organization, end-user or vendor, affects the actual logical content of a vertical standard, does not prevent other adopters from deploying the original vertical standard in its entirety, unchanged, and the modifications are generally created for internal purposes, identifying any modifications that may result in positive switching costs is extremely difficult. Any modification is easy to circumvent with relatively simple software development work, and the risk of these manipulations is not necessarily the change itself but the level of embeddedness of the change in firm-specific environments, in particular in light of the propositions described earlier. Thus, it falls on the organizations adopting any modifications to identify the level of risk they may face. Additionally, SDOs lack formal tracking mechanisms for accurately measuring adoption or deployment of their standards (Nelson et al. 2005), which complicates the problem of identifying non-standard features that may create problems for individual organizations. Thus, IP policies may prevent the fragmentation of development efforts in a single industry and ensure the free use of the vertical standard by any SDO member, but it does not prevent supply-side firms from developing firm-specific extensions to a vertical standard , these extension may easily steer clear of any IP infringement and are found to be useful to the firm (or they would not approve of their introduction into their controlled environments), despite the introduction of positive switching costs by these modifications. The following two propositions regarding the effect of IP policies are advanced

Proposition 6 – Intellectual property policies cannot help identify or prevent the manipulation of vertical standards to generate positive switching costs by supply-side organizations.

Proposition 7 – Intellectual property policies cannot protect any end-user organization from the introduction of positive switching costs from vertical standard extensions deemed useful to the organization.

Since modifications to vertical standards for internal purposes do not affect the contents of the original vertical standard, why should organizations be concerned about compatibility manipulation? A simple answer lies with the extent to which the vertical standard has to be extended to provide needed business functionality to the firm, and the importance of the functionality gap between the vertical standard and the business needs of potential adopters. In this case, full participation of industry members in the development stage for the vertical standard becomes critical. However, full participation may lead to fragmentation of efforts (Markus et al. 2006), which will have a negative effect on the diffusion of the finished standard. Thus, it is perhaps more important to the SDOs which sponsor vertical standards to curb the introduction of widespread modifications to the standard, or to act resolutely to ensure they are covered by the scope of the standard. The former case is impractical, if not impossible, due to the business value individual firms will find in the bridging capabilities of vertical standards technologies described earlier. The latter case, extending the scope of the vertical standard, may endanger the focus of the standard and result in an unnecessarily complex standard that does not meet industry needs. This kind of suboptimal development has caused vertical standard failures in energy markets (Wareham et al. 2005), and in the automotive (Gerst & Bunduchi 2005) and financial services industries (Chang & Jarvenpaa 2005). Thus, we propose that

Proposition 8 – The magnitude of positive switching costs introduce by the manipulation of compatibility of vertical standards will be a direct function of the perceived functionality gap between the standard and the business needs of potential adopters.

VULNERABILITY TO MANIPULATION OF COMPATIBILITY

A number of conditions may lead to the differences described in the above propositions. Some of these conditions are described below. Evidence for the existence of any of these conditions does not guarantee that vertical standards will be manipulated to introduce positive switching costs, but proof of the existence of these conditions should alert SDOs to increase their vigilance to prevent manipulation by supply-side organizations participating in the development activities of vertical standards sponsored by the SDO. Additionally,

Participation imbalances

Much higher levels of participation from the supply side (vendors) than from the demand side (end-user or adopter organizations) of an SDO's membership may position vendors well to drive standards development in a direction that favors their incumbent competitive position. By their nature, vertical standards development is supposed to be driven by end-users (Nickerson & Muehlen 2003), and much greater vendor participation in development activities signals something different from what is intended. It must be kept in mind that vendors do not participate in the development of vertical standards because they wish to adopt them to meet business needs, but because they have a vested interest in supplying the resulting market.

Investment imbalances

In a similar vein, vendor investment in SDO activities that is significantly higher from end-user investment signals that vendors are actively positioning themselves to take advantage of the resulting market. Vendors see expenditures in development activities as investments, but because of the public-goods (Olson 1971) nature of vertical standards, end-user organizations are likelier to see any investment in development activities as a burden they would prefer someone else to carry. This can result in a risky lack of expertise with the vertical standard for end-user firms, whereas vendors making this investment can benefit from knowing (and perhaps influencing) the direction of the standards development.

Knowledge Barriers

The ability to identify opportunities afforded by new information or technology is a function of previous related expertise (Cohen & Levinthal 1990). Organizations with little previous expertise in vertical standards technologies may be likelier to cede technical leadership to vendors with this expertise and the desire to expend resources in development activities. Participation and investment imbalances may contribute to the development of higher knowledge barriers for end-user firms than for vendors later on.

Legacy Technology Investment

High levels of legacy technology investment may induce organizations to try to protect it, and the ease with which XML and other vertical standards technologies provide bridging capabilities to continue exploiting this investment may provide ample incentive to introduce extensive customization. With this customization, end-user organizations may introduce path dependencies (Arthur 1994) that will results in positive switching costs later on. Farrell & Saloner (1992) find that when converters are costless and perfect, their value to the organization is maximized, but the introduction of converters that may prevent a firm from adopting vertical standards later on may prove costlier to the firm.

Given that intent will be difficult, if not impossible, to prove, perhaps the best that can be hoped for is to find evidence of the conditions that may lead to compatibility manipulation. While empirical evidence of significant differences between supply-side and demand-side organizations along the dimensions just described can be obtained, they are not a guarantee that the differences will result in the introduction of positive switching costs by vendors or anyone else. The contextual nature of development of extensions to vertical standards means that actual evidence of manipulation has to be obtained on a case-by-case basis, using the case study methodology.

LIMITATIONS AND FURTHER RESEARCH

The conjectures and propositions described in this paper need to be tested empirically in several settings (industries and their respective vertical standards). It is quite possible that manipulation of vertical standards in some industries will not lead to the introduction of positive switching costs, and it is important to tease out which additional effects not described in this paper may lead to that result. Also, identifying the existence of switching costs and quantifying their magnitude properly will be a difficult task, one which is likely to be highly contextual, and will require that qualitative research be conducted. Lastly, the signs of vulnerability described in the previous section may lead to directly testable hypotheses, or may simply form the basis for developing arguments in support of testable hypotheses. Additional theoretical refinement of this work is on-going, and any resulting hypotheses will be tested against an existing data set which measures some of the concepts described here, and several others.

CONCLUSION

Standards for physical products can be manipulated to introduce positive switching costs for adopting organizations (Chen & Forman 2006). This manipulation can lead to adoption inefficiencies, increased market fragmentation, and lower industry-wide compatibility. Vertical standards are purely abstract compatibility standards, and it is not understood how, or whether, the introduction of extensions to manipulate vertical and horizontal compatibility for vertical standards results in positive switching costs for end-user firms.

Vendor behavior may significantly influence the development of vertical standards, and existing research suggests development-stage dilemmas are linked tightly with diffusion stage problems (Markus et al. 2006). Imbalances in vendor participation and investment in development activities may have important implications for vendors, adopter organizations, and SDOs. Vendors may be able to influence vertical standards development to preserve incumbent competitive advantages, while end-users may be left with greater dependence on vendor expertise. SDOs need to understand the conditions under which their standards may be subject to manipulation, and whether the effect of this manipulation is harmless or noxious to industry-compatibility objectives. While vendors willingly submit to standards for physical products like routers and switches (Chen & Forman 2006), vertical standards are purely abstract products, and the effect of vendor intervention is still unclear on this kind of product.

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