UC Berkeley
Recent Work

Title
Understanding Service Systems Through Standards

Permalink
https://escholarship.org/uc/item/8jk7f1ms

Author
Mathew, Ashwin J.

Publication Date
2008-04-01

Understanding Service Systems
Through Standards

By
Ashwin Jacob Mathew (ashwin@ischool.berkeley.edu)
School of Information, UC Berkeley

Abstract:
When service systems span multiple firms, possibly in multiple geographies, they can be difficult to model effectively, as they become subject to the complex legal, economic, political and social forces of the environment in which they operate. We must consider, therefore, the structure of institutions mediating the links amongst services in order to gain an understanding of the *quality* of these links, and how varying link quality contributes to the overall structure and efficiency of a service system. This paper explores an approach towards studying the structure of such cross-firm service systems by critically examining the nature of the standards used to expose services to one another.

Introduction

As firms have adopted information technology, and started to automate internal and cross-firm processes, the notion of the "service system" has evolved. Spohrer et al (2007) define service systems to "comprise service providers and service clients working together to coproduce value in complex value chains or networks." Much of the growth of these service systems is driven by information technology standards, and the manner in which they define interfaces, through which services may interconnect to form a service system.

Standards are, in many ways, the lifeblood of service systems. Across firms, standards are required for multiple parties to pass information to one another, allowing for environments where network forms of businesses can evolve. Within firms, standards are essential to enable "chunking" or "modularization" of business processes, allowing different business units to pass on data in firm-wide processes.

In turn, firms comprising service systems may cooperate to create standards. The resultant network effects can increase the size of the service system as a whole, passing on benefits to all firms in the service system. This may have the additional benefit of creating a secondary market for standards-compliant products that enable firms to participate in the service system.

To coin a term, standards are the "means of coproduction" in service systems. Individual agents in a service system may provide their own implementation of a standard in their services, but it is the standard which ultimately mediates interactions across the service system. This paper examines the effects that the modes of ownership and governance of standards have upon the structure of markets mediating service systems.

Motivations and Benefits

Governments may impose mandatory standards to guarantee the quality of goods, or to maintain public services. A classic case is that of the Gauge Act, which the British Parliament enacted in 1846, requiring all railroads to conform to a standard gauge (Kindleberger 1983). While companies may oppose such standards for the associated costs, there are overall benefits to the economy; in the wake of the standardization of railway gauges, for instance, transshipment was no longer required between railway lines of different gauges.

Benefits to consumers accrue in a number of ways (Farrell and Saloner 1985). Network effects may increase the value that consumers accord to a good. The canonical example of telephone networks serves to illustrate this point: as more consumers have telephones, the value of the telephone for each individual consumer increases, as the network of people they are able to reach by phone increases. In addition, compatibility standards can spawn a market for services (e.g., telephony) and complementary goods (spare parts, servicing, etc.) which has the effect of reducing costs to consumers through price competition.

Firms can benefit from standards through reduced transaction costs. These may be realized through a variety of means such as standardized parts for assemblies and common data formats.

Firms, therefore, have an incentive to make their products and services compatible, to reduce transaction costs and increase the size of a market through network effects, so providing benefits to all participating firms. At the same time, however, they may be reluctant to do so in the face of potential price competition. These two opposing drives lead to a range of market structures, which is explored later with particular regard to service systems.

It is important in this analysis to consider the qualities of excludability and rivalrousness for the setting of standards, and for the licensing of standards. Standards are information goods, and therefore have the quality of being non-rivalrous: a standard may be distributed without decreasing its availability. Standards are not necessarily non-excludable, and therefore cannot always be considered public goods; depending on the ownership and licensing terms for a standard, it may be possible to exclude selectively agents from using or adopting a standard.

Even if a standard is freely licensed and so non-excludable for adoption, the process of standard setting is typically excludable, as only a limited number of firms may cooperate to set a standard. Firms which have a say in how a standard is set can gain competitive advantage, as they may be able to encode details of their particular skills and knowledge base into the standard. In this regard, Antonelli (1994) differentiates between adoption costs (the costs associated with adopting a standard) and sponsoring costs (the costs associated with standards setting activities).

Markets exhibiting network effects, such as those for compatibility standards, are "tippy": given a small advantage, a single winning standard may come to dominate the market. As Arthur (1989) tells us:

> ... a technology that by chance gains an early lead in adoption may eventually 'corner the market' of potential adopters, with the other technologies becoming locked out. Of course, under different 'insignificant events' – unexpected successes in the performance of prototypes, whims of early developers, political circumstances – a different technology might achieve sufficient adoption and improvement to come to dominate.

Firms therefore compete to set standards, as the firm, or coalition, that controls a standard controls the structure of the market for products and services organized around that standard.

Fears and Repercussions

In some cases, governments may even *avoid* setting standards for fear that they will have negative effects on innovation. The American National Bureau of Standards, for instance, declined to write standards for the computer industry, fearing that such standards would retard innovation (Hemenway 1975, quoted in Farrell and Saloner 1985).

The negative repercussions of successful standards are most visible in issues of "lock-in", where an old standard is so widespread and entrenched that switching costs are sufficiently high to dissuade agents from adopting a new standard. Apart from switching costs, the network effects involved may also cause coordination problems, as agents will have to coordinate a move to a new standard. This is particularly true for compatibility standards used in service systems.

A modern example in this regard is the problem of switching routers and computers across the Internet from Internet Protocol Version 4 (IPv4) to Internet Protocol Version 6 (IPv6). In spite of the advantages that IPv6 offers, network operators have yet to shift from IPv4, both due to switching costs, induced by the scale of the network, as well as coordination problems. Since IPv6 network traffic cannot flow over an IPv4 network,[1] all machines connected to, and running, the Internet must be upgraded at the same time.

---

1   There are newer protocols that allow IPv6 traffic to be tunneled over IPv4, but these have yet to gain adoption amongst network operators.

Classifications

Antonelli (1994) provides an overview of standards, with different classification schemes which speak to those abstract qualities of standards which are useful for modeling.

First, there is the classification into product standards, document standards and compatibility standards. Of these, compatibility standards are most useful in analysing modularization in service systems, as these are essential to the definition of standard interfaces between different services, or components, in a service system.

Next, there is the distinction between mandatory and voluntary standards. Mandatory standards, such as building codes, are imposed by public authorities. Voluntary standards, on the other hand, arise from the effects of market forces.

Of voluntary standards, de facto standards emerge as a result of interactions amongst "clubs" of agents, or through the actions of a single agent, while de jure standards are specified by standards bodies prior to their adoption in the marketplace. De facto standards may be proprietary or non-proprietary – some authors also use the terms "sponsored" and "unsponsored" for this purpose (Antonelli 1994). Proprietary standards have the quality of being excludable, as the proprietor of a standard has control over the licensing of the standard. Non-proprietary standards, on the other hand, are non-excludable, and so may be considered public goods.

This last set of classifications are, in my opinion, the most significant ones for service systems, as they mediate the definition of interfaces, and hence the flow of information, across services in a service system. The manner in which compatibility standards are produced and licensed, therefore, has material effects on service system market structures. Accordingly, I propose an analysis of service systems along these two axes – de facto/de jure and proprietary/non-proprietary.
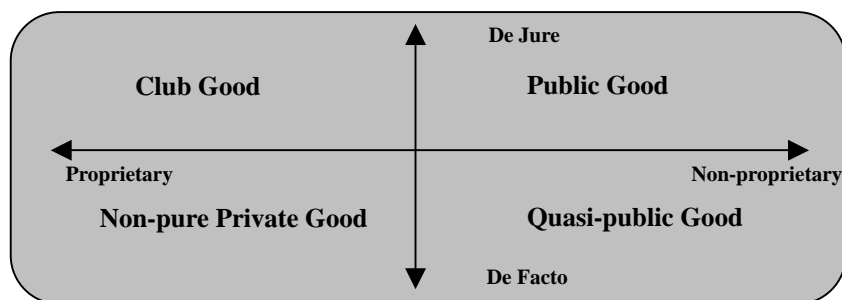
I follow the literature in economics to name the four quadrants, each of which corresponds to a particular mode of governance for standards.

There are other kinds of standards that may also apply to service systems, such as those for defining quality of service. I treat these as "secondary" standards, since they can be brought into play only once a service system evolves using the "primary" compatibility standards described here.

Evolving Strategies

As pointed out earlier, firms are subject to two opposing forces with regards to standardization: the drive to standardize, leveraging increasing returns from network effects, and the drive against standardization, fearing price competition. There are a variety of strategies that firms may adopt in the face of these conflicting drives, which Besen and Farrell (1994) explore at length. I draw from their analysis, and build on it to illustrate how these strategies affect the structure of service systems.

In this section, the processes by which standards evolve are examined, along with the choices presented

to firms in this process. Possible strategies that firms may adopt are elaborated, without details of why they adopt them; the motivations which may drive a firm to adopt specific strategies are examined in the next section.

If the proprietary interfaces or data formats associated with a firm's services or products gain widespread acceptance, they effectively become de facto standards. Firms have a variety of choices at this point:

1. Maintain the standard as a proprietary good, without licensing it to other firms.

2. Maintain the standard as a proprietary good, with controlled licensing to other firms.

3. Maintain the standard as a proprietary good, with free licensing to other firms.

4. Release the standard to the public domain through the offices of a standards organization, making it a de jure standard.

If a firm makes choice 1 or choice 2, the standard can be considered a non-pure private good, since the standard remains proprietary, with restricted, or no, licensing. If a firm makes choice 3, the standard may be treated as a quasi-public good, as it is made freely available; a firm may have to offer a covenant not to sue implementors of the standard, or a similar legal promise, in order for the standard to gain traction. Choice 4 results in a standard that may be effectively treated as a public good, as it has been released to the public domain. These choices are by no means cast in stone – firms may move from one competitive position to another in response to the actions of competing firms.

These choices need not apply only to a single firm; coalitions of firms may come together to create a standard in order to expand their collective market, or as a competitive response to a proprietary standard.

Implications

Non-pure Private Good

A standard can be considered a non-pure private good under monopoly conditions, where a single firm, or coalition of firms, sets a proprietary standard by itself. Sponsorship costs are high in this case, as firms cannot spread the risk of the investment in a standard. To offset high sponsorship costs, firms may then seek to extract monopoly rents from the market. This can be achieved in a number of ways, following the choices outlined earlier.

A firm may choose to position itself as the sole provider of products and services in a service system based on its proprietary standard. Apple's iTunes music store, coupled with the ubiquitous iPod, provides an excellent example of this kind of positioning. Apple maintains the proprietary digital rights management extensions to the open AAC format in which music is stored on the iPod, and maintains strict controls on the service, iTunes, required to load music onto the iPod. This creates a monopsonistic market, where any firm wishing to sell music to owners of iPods must channel their catalogues through Apple's iTunes store, paying Apple for this privilege.

A firm may choose not to participate directly in the service system enabled by its standard, but rather function as the sole provider of products enabling this service system. Microsoft Office, for instance, provides the DOC, XLS and PPT formats which have enabled countless service systems in which

Microsoft itself may not participate. Microsoft has never released complete format specifications[2], in order to maintain itself as the monopolist provider of tools based on these formats. This intention to avoid interoperability with other office suites comes very clearly from the top of the firm; as then-CEO of Microsoft, Bill Gates, wrote in a confidential memo, released as part of the Comes vs. Microsoft (1998) court case:

> ... allowing Office documents to to be rendered very well by other peoples browsers is one of the most destructive things we could do to the company. We have to stop putting any effort into this and make sure that Office documents very well depends on PROPRIETARY IE [capitalization in original] capabilities. Anything else is suicide for our platform. This is a case where Office has to avoid doing something to destroy Windows.

Finally, a firm may choose not to participate in the service system enabled by its standard, but gain revenues from licensing its standard to other firms which will act as providers of products enabling the service system. For instance, Qualcomm owns sufficient patents related to the CDMA standard for cellular telephony that any manufacturer of equipment for CDMA networks has to license the technology from Qualcomm. Coalitions of firms may also operate under this model; for instance, the Blu-ray Disc Association exists for the sole purpose of maintaining and licensing the specifications for the Blu-ray disc standard.

The problem with standards positioned as non-pure private goods is that their competitive position may be brittle, especially when a standard is encoded purely in software, rather than a combination of software and hardware. This distinction is important, as new software tools may be written to reduce switching costs to a competing standard; for instance, the office suite from OpenOffice.org reverse-engineered Microsoft Office formats to interoperate with the ISO Open Document Format standard. Switching costs are inevitably higher, sometimes prohibitively so, where hardware is involved, as in the case of manufacturers of telecommunications equipment based on Qualcomm's CDMA standard.

Reactions to the monopolistic and monopsonistic structures of service systems outlined here often take shape in the form of competitive standards framed as public or quasi-public goods.

Public Good

Standards which are formed as the outcome of negotiations within standards bodies may be treated as public goods, as they are typically freely licensed, resulting in low adoption costs. Depending on the specific governance structure within a standards body, however, sponsorship costs can be significant, though not as high as those associated with standards treated as non-pure private goods.

According to David and Shurmer (1996), standards bodies generally share a set of principles: due process, fairness and transparency, consensus and voluntarism. These are designed to ensure that standards bodies serve the public interest, rather than narrow commercial interests. With the increasing involvement of firms in standards bodies, this view certainly needs qualification; however, the principles outlined here remain useful in the analysis of the functioning of standards bodies.

Examples of standards bodies include the International Standards Organization (ISO), the International Telecommunications Union (ITU) and the Internet Engineering Task Force (IETF). All of these bodies have been responsible for drafting standards which have enabled service systems on a global scale. The

---

2   Microsoft is currently attempting to standardize a new XML-based representation of these formats, OOXML; however, documentation remains unavailable for the original binary file formats used in Microsoft Office.

IETF, for instance, is responsible for the TCP/IP protocol standards which form the backbone upon which the Internet functions.

As noted earlier, public goods may also arise as reactions to monopolistic and monopsonistic market structures. For instance, not wanting to be beholden to Qualcomm for its telecommunications infrastructure, China proposed its own variant of CDMA, TD-SCDMA.

The story of the Open Document Format (ODF) standard follows a similar trajectory. In response to proprietary Microsoft Office formats, Sun Microsystems released the the Open Document Format standard for office documents to the public domain. After formal development as a standard by the Organization for the Advancement of Structured Information Standards (OASIS), ODF was ultimately standardized under the auspices of the ISO with a unanimous vote from participating member countries.[3] Several governments around the world, including the Netherlands, Malaysia and Japan, have started to adopt ODF as a required standard for documents, not wanting to have their communications with citizens beholden to proprietary formats and software from a monopolist firm.

Standards which are treated as public goods can serve as engines for innovation, as these "means of coproduction" are placed in the commons, with no encumbrances. Under these conditions, the barriers to entry to the service system are minimal, allowing for large scale service systems comprising many firms and other actors.

Widely adopted standards, however, may fall prey to the issue of lock-in. In a perverse twist of fate, a public standard's very success may contribute to the retardation of technological innovation, if the switching and coordination costs to a new version of the standard are prohibitive. By no means is this meant to indicate that public standards are undesirable; this is offered as a caution and a qualification of the discussion of public standards.

Club Good

Standards may be considered club goods under either of two conditions:

1. *Sponsorship Club*: No new firms are allowed to join the group of firms sponsoring a standard.

2. *Licensing Club*: No new firms are allowed to join the group of firms licensed to adopt a standard.

Under the Sponsorship Club condition, the sponsoring firms have an unseemly competitive advantage, as they can shape standards to fit their particular skills and knowledge base. The Licensing Club condition gives rise to a closed network of firms which cooperate as a cartel to create a service system.

An early example with interesting parallels, albeit not of a service system, is that of the "appellation contrôlée" in France: the government enforced standards to limit competition by excluding vintners outside specific wine-growing regions from being able to use the label (the standard) for that region (Kindleberger 1983).

A more modern case with qualities of both conditions is that of Motorola's attempts to enter the cellular telephony market in Japan, as related in Tyson (1992). In 1984, when Motorola first attempted to enter

---

3 Microsoft has attempted to standardize its document format, OOXML, but was defeated in the most recent round of ISO voting, with numerous concerns cited, ranging from the inadequacy of Microsoft's patent pledge, undocumented features of OOXML and dependencies on proprietary Microsoft products. As of this writing, OOXML has undergone significant revisions, and is due for a second round of voting to seek approval as an ISO standard.

the Japanese market, technical standards for telecommunications were to be established by the Telecommunications Deliberation Council, which was appointed by, and attached to, the Ministry of Posts and Telecommunications (MPT). Certification and testing tasks were to be handled by an association of Japanese telecommunications equipment manufacturers. Neither group had any representation from foreign firms. This is an example of the Sponsorship Club condition, as no new firms, specifically foreign firms, were allowed to join the group sponsoring telecommunications standards in Japan. It is also indicative of the Licensing Club condition, as it seems apparent that the politics of these structures of governance would implicitly exclude non-Japanese firms from adopting the standards.

After telecommunications talks with the US government, MPT appointed experts from five American companies, including Motorola and AT&T, to the Telecommunications Deliberation Council's board of advisers. The result was that in March 1986, the council recommended that any of three protocols, including those of NTT and Motorola, could be adopted for cellular services. However, MPT decided to split Japan into geographical regions, with NTT allowed to operate in every region. One additional company would be allowed to compete with NTT in each region, with a non-NTT protocol if it chose to do so. This provides a specific example of the Licensing Club condition, as new companies were excluded from entering specific markets in Japan, while NTT was granted access across the country. NTT's protocol standard gained competitive advantage from this arrangement, as non-NTT protocols would not work across Japan, limiting their roaming capabilities to the regions in which they found deployment. Under pressure from the US government, and from the Ministry of International Trade and Industry (MITI) in Japan, Motorola ultimately managed to make its protocol available across Japan.

Standards may be treated as club goods when the objective of the cartel sponsoring the standard is protectionism; this is particularly true when governments are involved, as in the examples outlined above. The result is a highly localized service system, restricted to the firms capable of participating in it.

Quasi-Public Good

Standards which emerge in a de facto fashion, and are not submitted to a standards organization, but which nonetheless remain freely licensed, may be considered quasi-public goods.

The early history of Adobe's PDF file format follows this pattern. Adobe published complete technical specifications for PDF with every new version of the format. The intent appears to have been to grow the service system around PDF, increasing adoption and innovation in the PDF service system outside Adobe, but simultaneously positioning Adobe as the premium brand for PDF-related products. Various forms of PDF are now ISO standards, with Adobe continuing to function as a key technical contributor. Jim King, one of Adobe's representatives to the ISO, says of the new PDF 1.7 standard: 'The current objective is to move PDF 1.7 to ISO management unchanged'.[4] In spite of being a public standard, it would appear that Adobe remains the principal maintainer of the PDF standard.

Freely licensing a proprietary standard can reduce sponsorship costs, and spread risk. As with public standards, this can have the effect of broadening the scope of the service system, and spreading innovation outside the firm setting a standard.

Other emerging models of standardization are those maintained under open source licenses. These

---

4   On his blog, at Hhttp://blogs.adobe.com/insidepdf/2007/12/comments_on_comments.htmlH, last retrieved 16th December 2007.

could, perhaps, be treated as public goods; they can be regarded as quasi-public goods as they often emerge in a de facto fashion, and lack the standing accorded by a standards body.

For instance, Xiph.org, 'a non-profit corporation dedicated to protecting the foundations of Internet multimedia from control by private interests',[5] was created in response to monopolist behaviour by the Fraunhofer Society,[6] which holds several key patents related to the MP3 standard. Xiph.org maintains a number of unencumbered multimedia standards which are widely implemented in open source software, including the Ogg Vorbis audio format and the Theora video compression format. Although initially developed by Xiph.org, these standards have been submitted to the IETF for maintenance.

The standards developed by Xiph.org exemplify what Benkler (2002) calls "commons-based peer production": a mode of production distinct from property- and contract-based models of firms and markets. As Benkler puts it, "[i]ts central characteristic is that groups of individuals successfully collaborate on large-scale projects following a diverse cluster of motivational drives and social signals, rather than either market prices or managerial commands."[7]

Commons-based peer production offers a new model of looking at the way standards evolve – from the bottom up, rather than from the top down. The benefits are similar to those offered by public standards, as they are typically provided under open source licenses. These kinds of standards are starting to have some effects, but it remains to be seen how they may transform service systems over time.

Conclusion

I have presented a classification of standards, with a macro-level view of the structure of service systems engendered by different modes of governance and ownership of standards. I do not propose these classifications as absolutes, but rather as a framework for analysis. As the case studies mentioned here demonstrate, there is a continuum of possibilities in each quadrant, each with its attendant complexities.

The analysis of service systems spanning firms often disregards the complex social, political, legal and economic forces making up the environment in which service systems operate, as these are difficult to model. I believe that the classification of standards that I've offered here can serve as a beginning towards integrating these issues into modeling for service systems, by using patterns in governance and ownership of standards as a proxy indicator to these more complex issues.

---

5   See Hhttp://www.xiph.orgH

6   Scientists at the Fraunhofer Society developed the MP3 format, and the Fraunhofer Society continues to hold key related patents. In September 1998, the Fraunhofer Society issued a letter announcing plans to charge licensing fees for the MP3 format.

7   From the abstract on his website at Hhttp://www.benkler.org/CoasesPenguin.htmlH, last retrieved 25th January 2008.

References

Antonelli, C. 1994. Localized technological change and the evolution of standards as economic institutions. Information Economics and Policy 6, 195-216.

Arthur, W. B. 1989. Competing Technologies, Increasing Returns, and Lock-In by Historical Events. Economic Journal 99 (394) 116-131.

Benkler, Y. 2002. Coase's Penguin, or Linux and the Nature of the Firm. 112 Yale Law Journal 369.

Besen, S.M., Farrell, J. 1994. Choosing How to Compete: Strategies and Tactics in Standardization. Journal of Economic Perspectives 8 (2), 117-131.

Bunduchi, R., Williams, R., and Graham, I. 2004. Between public and private – the nature of today's standards. Presented at the "Standards, Democracy and Public Interest" workshop. Available at http://www.york.ac.uk/res/e-society/projects/24/Bunduchistandardisationworkshop2004.pdf, last retrieved 17th December 2007.

Comes vs. Microsoft. 1998. Plaintiff's exhibit 2991. Available at http://antitrust.slated.org/www.iowaconsumercase.org/011607/2000/PX02991.pdf, last retrieved 18th December 2007.

David, P. A., Shurmer, M. 1996. Formal standards-setting for global telecommunications and information services. Telecommunications Policy 20 (10), 789-815.

Farrell, J., Saloner, G. 1985. Standardization, Compatibility and Innovation. Rand Journal of Economics 16, 70-83.

Kindleberger, C. P. 1983. Standards as Public, Collective and Private Goods. Kyklos 36 (3), 377-396.

Spohrer, J., Maglio, P., Bailey, J. & Gruhl, D. 2007. "Steps Toward a Science of Service Systems." IEEE Computer. Volume 40, Issue 1, p. 71-77.

Tyson, L. D. 1992. Who's Bashing Whom? Trade Conflict in High-Technology Industries. Institute for International Economics.

Weitzel, T. 2004. Economics of Standards in Information Networks. Physica-Verlag.