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FEATURE ARTICLE

STANDARDS WARS: SITUATIONS, STRATEGIES AND OUTCOMES

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Abstract: *While standards wars provide the most visible example of conflict in establishing standards, there are many lesser levels of confrontation that arise from the same situations and motivations, and that may be better described as "standards skirmishes." Where such events do not lead quickly to consensus, a variety of behaviors that can be called "escalations" have evolved to signal determination without resulting in the breakdown of the standard setting process and engagement in a full standards war. It is also important to note that not all standards wars are "bad," since standardization at too early a stage may result in lock-in on an inferior technology, and greater long-term harm than the temporary disruption that may result from a "standards competition" that provides a ready standard for deployment in support of the superior technology that prevails. In this article, I examine some of the situations and strategies that illustrate these observations.*

Introduction: Standards wars have become a commonplace in today's world, even to those that do not recognize them as such. Almost anyone would immediately understand the meaning of a standards war if any of the following simple phrases was offered as an example: "VHS vs. Betamax," "Internet Explorer vs. Netscape Navigator," or "PC vs. Macintosh." While each of these examples refers to a battle between the proponents of proprietary products in order to create a "de facto" standard (i.e., a nearly universally adopted technical format, interface or architecture controlled by a single vendor or group of vendors), such conflicts represent only the more extreme and visible examples of a process that plays out in countless consortia and accredited standards development organizations (SDOs) on a constant basis.

As the modern world has become more and more dependent on information and communications technology (ICT), standards have become more essential, and therefore more valuable. With that perception of value has come a greater interest in the exact composition of such standards, since the elements, and even the timing of release, of such standards can have profound competitive effects on stakeholders, both positive and negative.

Not surprisingly, the level of attention and involvement invested by those that are most affected by the development and implementation of standards continues to increase, as does the interest of the same players in influencing the outcome of the standards development process. This focus has led to the development of a range of strategies, each of which is appropriate to particular circumstances.

In this article, I will describe some of the principle motivations for influencing the standards development and implementation process, the strategies that have evolved over time to effect that influence, and the types of outcomes that result from this ongoing process.

Historical background: Standards, broadly construed, such as languages, alphabets and numbering systems have been created since time immemorial. These standards evolved gradually and outside of formal processes, but nonetheless had great value. Over time, it came to be recognized that the control of a standard could convey the right to be compensated for the use of that standard.

An early example of this realization gave rise to a word we still use today – "royalty." A royalty, as first conceived, referred to the share of a precious metal that was retained by the crown when the balance was turned into coinage, and the service that was being compensated was the state's guarantee (not always accurate) of the purity of the metal of which the coin was made, and therefore the intrinsic value of the coin itself.

With the advent of the industrial age, the need for standards expanded dramatically, as better systems of weights and measures became desirable for scientific purposes, expanding trade increased the need for uniformity across borders, new industrial techniques relied on interchangeable parts, and new networks – railroads, telecommunications and power transmission systems – demanded consistent measures in everything from track and wire gauges to time itself, the latter leading to the modern system of time zones.

Each of these new standard systems presented the opportunity for interested parties to win or to lose. To use railways as an example, governmentally enforced standardization of gauges avoided the costly and time consuming process of transferring cargo from the cars of one railway owner to those of the owner of the adjacent line, but also helped to erode the monopoly of each of the owners.

Standardization could also bring commoditization as well as loss of a monopoly. Not surprisingly, such a depreciation occurred first in the area of items such as bolts and nuts, where the cost of standardization was low and the benefit was high. When technology eventually made the production of interchangeable parts feasible, mass production logically followed, creating new situations where standards could be both beneficial and threatening, depending upon the stakeholder.

The automotive industry provides an interesting example of this phenomenon:

Between 1904 and 1908, more than 240 companies entered the fledgling automotive business. In 1910 there was a mini-recession, and many of these entrants went out of business. Parts suppliers realized that it would be much less risky to produce parts that they could sell to more than one manufacturer. Simultaneously, the smaller automobile manufacturers realized that they could enjoy some of the cost savings from economies of scale and competition if they also used standardized parts that were provided by a number of suppliers.¹

The authors go on to note that not all automobile manufacturers perceived standardization of parts as being in their best interest. The most powerful – Ford and General Motors – were large enough to achieve comparable benefits entirely within their own operations. In consequence, industry-wide agreement on interchangeable parts would provide them no significant benefits, while at the same time minimizing the advantages that their economies of scale would otherwise provide to them over their smaller rivals.

This differential in costs and benefits between the "incumbent" (i.e., the dominant payer in a product space) and its competitors continues to breed outright standards wars and lesser skirmishes today. But this is only one of many dynamics in the marketplace, as we shall now explore.

War and peace: The existence of standards wars may, at first blush, seem oxymoronic. After all, the reasons for having a standard (and especially a standard created to permit interoperability between products) at all is to create a marketplace for products that might not otherwise exist. This is achieved by convincing the market that it need not worry over the following issues:

- Will the standard become widely adopted by vendors? If I buy, for example, a telephone, will my friends buy one, too? If multiple vendors and service providers announce that they will provide the interoperable products and infrastructure, then I have reasonable assurance that my telephone will prove to be a wise investment.

¹Shapiro, Carl and Varian, Hal R., *Intro for Managing in a Modular Age*. School of Information Management and Systems (SIMS), University of California, Berkeley (2000), p.1, at <http://www.sims.berkeley.edu/~hal/Papers/modular.pdf>

- Will the standardized product become ubiquitous? Economists focus on the value of the "network effect," which notes that the network becomes of exponentially increasing value to each participant as the network grows. For example, the value of a telephone to its owner increases by the addition of new categories (friends, catalog companies, first responders, etc.) as well as by the number of users.²
- Will the standard remain supported over time? If a standardized product is superseded quickly by a new product generation, the user at minimum may face an upgrade cost (as when telephones converted from rotary to push button, but remained backwardly compatible), and at worst abandonment, or "stranding" (as when video stores ceased stocking Betamax titles).
- Will prices be reasonable and alternatives interesting? With wide adoption competition and economies of manufacturing scale predictably lead to price and feature competition.

Where the messaging is convincing, it becomes possible to sell new products, even to the first customers. At first, it may be necessary to make early sales at a loss, in order to build a sufficiently large network to generate sustaining momentum. Thereafter, however, it should be possible to earn back the investment through falling production costs and increasing sales at higher prices. A current example of this practice is the competition between two competing satellite radio systems, each of which has budgeted substantial, multi-year losses in order to price their initial services attractively.

Notwithstanding the obvious logic of this simple outline, it is not sufficiently sophisticated to predict actual behavior, since there is more than one way to achieve the profitable end-state described above, and the rewards (as well as the risks) for pursuing other strategies.

At one extreme, there is the "winner take all" approach, in which a single vendor (or group of vendors) succeeds not only in establishing the standard, but also (most typically) through patent protection, ensuring that no other vendor may share in the benefits, absent a license and payment of a share of the resulting profit. As a generality, the risks of expensive failure are greatest with this approach, unless the player is already dominant in the same market. When this strategy does succeed, the result is a so-called "de facto" standard. Examples of such standards include the winners in the examples given in the first paragraph of this article: the VHS video format, the Microsoft Internet Explorer (IE) Web browser, and the "WinTel" (i.e., Microsoft/Intel) personal computer system.

At the opposite end of the spectrum is the formal consensus-based standards development process, the output of which is referred to as a "de jure" standard (if developed by an SDO) or simply standards or specifications (if by a consortium). The minimum attributes of this type of standard open participation of all interested parties, and the ability of both non-participants as well as development participants to implement the standard on "reasonable and non-discriminatory" (or "RAND") terms. Increasingly, standards created by both SDOs and consortia are referred to simply as "open standards."³

Although these examples may appear to represent completely different realities, there is in fact ample opportunity for gamesmanship at both ends of the spectrum, and at every gradation in between. The goal of such maneuvering is to have the greatest influence on the resulting standard, while still achieving wide adoption.

Standards skirmishes, escalations, and declarations of war: The attractiveness of controlling a de facto standard is clear, since it conveys upon the individual company, or group of allied companies, the

² To be more precise, economists speak of two types of network effects: "direct network effects" (the type just noted) and "indirect network effects." An example of an indirect network effect is the wide adoption of a new format for audio or video content. Once enough consumers have upgraded their playback equipment to use the next generation of media, it becomes attractive for content owners, retail outlets and rental stores to make content available in the new format.

³ The statement to which this footnote is appended masks the degree of debate over what the precise definition of an "open standard" should be. Due to new developments, such as the embracing of open source by the marketplace, the range of opinions on this definition is becoming broader rather than the opposite.

ability to command large profits either through high margins based on a monopolist vendor advantage, or through indirect means through licensing income (or, ideally, both). The motivations that sometimes lead to a standards war more often inspire more subtle and varied behaviors that might better be characterized as "standards skirmishes," as they do not result in the introduction of competing standards into the marketplace.

Skirmishes: The following are typical of the reasons that stakeholders enter into a skirmish, as compared to a war:

- ***Direct licensing revenue:*** The SDO world, and most consortia, do not prohibit the inclusion of intellectual property rights (IPR) in a standard, even if the result would be that an implementer would be required to pay a royalty or other fee for the privilege of implementing the standard. While many standard setting organizations (SSOs) of each type actively try to avoid this result, others are quite tolerant to the creation of standards that, if implemented, would infringe upon patents owned by members. As a result, there can be active competition among members in such an SSO to steer an evolving standard into infringement of a contestant's patent. In organizations where this result is not considered to be desirable, such conduct still can occur on a more covert basis.
- ***Indirect licensing revenue:*** While virtually all well-run SSOs have IPR policies that require the licensing of "necessarily infringed" patent claims (i.e., those claims in member owned or controlled patents that would be unavoidably infringed by the required portions of a standard), most do not impose the same requirements on "optional" elements of a specification (i.e., elements that are not required for a full implementation, or, in some SSOs, which represent multiple alternatives for satisfying a single required element). The result is the opportunity to steer a standard under development in a direction that does not require either disclosure or a commitment to RAND terms, but may leave implementers either very likely to seek a royalty-bearing license, or with no choice but to do so (imagine a standard for all of the basic parts of a bicycle that does not include descriptions of reflectors, multiple gearing assemblies, and other desirable but non-essential features).
- ***Indirect benefits:*** Many standards are based on specifications that describe existing products, or elements of products, being produced by members and submitted to an SSO. While the member must then license others to manufacture and sell the same products, the submitter may reap an almost endless variety of advantages, such as a head start in selling its own product into a wider market, undercutting the product of a competitor, increasing its own sale of a related (and patented) product, gaining credibility, steering a market in the direction of its own strategic plan, and so on.

Escalations Each of the situations described above can provide the basis for an outright war at the outset, or can result through escalation of confrontations within a standards process before that process has been completed. The latter occurs when factions within a working group become polarized and consensus becomes increasingly difficult to achieve. Given that participation is voluntary, the implied, or open, threat to withdraw and launch a competing standard carries real weight, and the methods of signaling determination have become more elaborate in some SSOs where the imprimatur of the organization is valuable and each faction still hopes to prevail within the system.

This type of behavior has become increasingly common in the IEEE working group that creates new standards within the 802 family of wireless standards. In recent years, the rival factions that have formed within some of these single working groups have created their own extrinsic organizations to marshal support for their favored specification in an increasingly rough and tumble process.

Recently, this type of skirmish resulted in the ultimate failure of the IEEE 802.15.31 task developing an Ultrawideband standard, which failed to achieve consensus and eventually disbanded in defeat. During the lifetime of the task group, 25 separate proposals had been narrowed to just two, but the patent holders of those submissions founded supporting groups – the UWB Forum and the WiMedia Alliance – that ultimately divided the membership. The result is that each of these groups is taking the products based upon their respective incompatible specifications into the marketplace. In short, a customer-

confusing standards war that will slow adoption for all, and may ultimately leave some subset of the marketplace stranded.⁴

Wars. A full-fledged standards war is most likely to occur as a result of either opportunity, prevailing practice within a given market area, or the lack of alternatives for displacing an incumbent. The following are examples of each type of situation:

- **Opportunity:** New markets provide great opportunities, often to a broad range of competitors. When such an opportunity requires agreement upon a standard in order for the rewards to become real, the standards strategy that is likely to be most successful for a given market participant will depend on a variety of factors. For the largest players, an attempt to establish a de facto standard may be most attractive, while the smallest players may believe that the creation of a consensus standard may offer the only viable opportunity to participate on substantially equal terms. In the absence of a single dominant player, the result can be a hodge-podge of individual players striving for dominance as well as several competing consortia, each seeking to establish its own standard as the dominant route to new products. An example of just such a confused situation arose in the case of wireless home networks, where both WiFi (developed by the IEEE), Bluetooth (developed by Nokia) and other specifications all vied to become the dominant standard.
- **Prevailing practice:** The pot of gold that is perceived in some markets niches can be quite different than in others. For example, success in the world of Internet and Web standards is defined by achieving global adoption of fee-free, consensus-based standards. In contrast, success in the consumer electronic space is often defined by winner take all, "take no prisoners" battles to force royalty-bearing, proprietary formats upon one's rivals. The result has been a series of punishing standards wars that have always been grueling for the vendors involved, and that have sometimes resulted in great cost for everyone in the supply chain, from the losing vendor camp, to content owners, distributors, retail store owners, and confused consumers (some number of which ultimately find themselves abandoned).
- **Lack of an alternative:** Despite the difficulty of displacing an incumbent through introduction of a competing standard, this strategy has been attempted on frequent occasions. Just as an attack on an entrenched position is rarely made in broad daylight, a standards-based assault on an incumbent is also most often attempted at a time of perceived weakness on the part of the party that enjoys the monopoly position. That weakness can be the development of a technology that may be better, faster and/or cheaper, or it can be a fortuitous event.

A current example of the latter was the adoption by the Information Technology Division of the Commonwealth of Massachusetts of the OASIS OpenDocument Format (ODF) in September of 2005, but not the Open XML Reference Schema that Microsoft had developed in connection with Microsoft Office, the predominant office productivity software suite. The impact of the decision would be the conversion of the state's c. 50,000 desktops to software that supported ODF, which Microsoft announced Office would not do. The result has been a broad push by companies such as IBM and Sun to promote and support ODF, in order to lessen Microsoft's grip on the desktop.⁵

Settings for standards wars: Economists have studied competitive strategies in standard setting for some time, generating many articles on the topic.⁶ Many detailed analysis focus on a limited number of

⁴ For more on skirmishes and wars in the wireless marketplace, see Updegrove, Andrew, *Case Study: The Unruly Emergence of the Digital Home*. ConsortiumInfo.org, Consortium Standards Bulletin, Vol. V, No. 2 (February 2006).

⁵ For ongoing, detailed coverage of the ODF-XML Reference Schema standards war, see the OpenDocument file of entries at the ConsortiumInfo.org Standards Blog at <http://www.consortiuminfo.org/standardsblog/index.php?topic=20051116124417686>, as well as Updegrove, Andrew, *Massachusetts and OpenDocument: a Brave New World?*. ConsortiumInfo.org, Consortium Standards Bulletin, Vol. IV, No. 9 (September 2005). <http://www.consortiuminfo.org/bulletins/sep05.php#feature>

⁶ For a representative sampling, see the results of this search request at the ConsortiumInfo.org: [Standards Metalibrary](#) (March 26, 2006).

common situations and strategies, such as displacing the incumbent⁷, or the motivations for governments to intervene to achieve specific results.⁸ In fact, the situations and responsive strategies can be quite diverse, as demonstrated by the following examples:

Exhausted market: Marketplaces that are dependent upon standards often become saturated and commoditized. In order to provide new, higher-margin sales, a next generation product is usually designed in order to boost both sales and profit margins. Often, by necessity or design, this will also require that a new standard become established in the marketplace. As earlier noted, this is particularly common in consumer electronics such as audio and video players, where each successive wave of standards-based technology leads not only to the opportunity to sell new devices, but new copies of old content as well. The long line of technologies in music in just the last thirty years includes migrations from analog to digital recording and reproduction, and from vinyl records through various types and intermediate versions of tape, CD and DVD formats. In each case, the move to a new generation of device has required common agreement upon a new standard(s), as well as the opportunity (often seized) to embark on a fresh standards war.

New technology: The advent of a new technology provides an opportunity similar to that provided by a new generation of an existing technology, but often with a greater incentive for cooperation, because the intended customers must be persuaded that they will not be stranded if the standard upon which the new product is based does not become widely adopted. However, this does not necessarily mean that the entire market will converge on a single standard. Often those that wish to exploit the new opportunity clump into two or more camps, each with its own rival solution.

Strategies for standards wars: Single situation, such as "displacing the incumbent," can have quite a few variations in factual setting as well, each of which will lead to a different strategy. Consider the following:

- ***Displacement of the incumbent, where the incumbent has more limited resources than the challenger:*** In the case of Microsoft's displacement of Netscape's Navigator, Microsoft had the economic resources to outspend and outlast its rival, since (unlike Netscape) it had other sources of revenue to underwrite and sustain its attack. Microsoft achieved victory in part not by seeking voluntary allies but by using its market power to require its PC sales partners to include Internet Explorer (IE) and not Navigator on the units that they sold.
- ***Displacement of the incumbent in a growing market:*** The IE – Navigator example demonstrates another significant situational dynamic: the fact that it is easier to displace an incumbent in a rapidly growing market than in a substantially saturated market niche. Despite the fact that Netscape enjoyed a seemingly insurmountable 90% market share among browser users in 1995 and IE had made little, if any, market penetration at that point, Microsoft's market share expanded to 39% by 1997, despite the fact that most discriminating users believed Navigator to still be the superior product. By August of 1999, the market shares of IE and Navigator had inverted, with IE claiming 76% to Navigator's 23%. The very great majority of the systems that were using IE, of course, were new systems that came with IE pre-installed.⁹
- ***Displacement of the incumbent in a mature market, where the incumbent has great resources:*** For decades, Intel has dominated the independent microprocessor manufacturing world, a situation that has become more pronounced as the world moved from minicomputers and mainframes running proprietary operating systems to hardware using the more similar variations of UNIX such as IBM's AIX and Hewlett-Packard's HP-UX. Faced with this situation, vendors tried various standards-based strategies over the years in attempt to regain ground.

⁷ See, for example, Windrum, Paul, *Back from the brink: Microsoft and the strategic use of standards in the Browser Wars*. Research Memorandum 005, Maastricht Economic Research Institute on Innovation and Technology (2000), at <<http://ideas.repec.org/p/dgr/umamer/2000005.html>>

⁸ E.g., Cabral, Luis M.B. and Kretschmer, Tobias, *Standards Battles and Public Policy*. Federal Reserve Bank of Chicago (April 2004), at <http://www.chicagofed.org/news_and_conferences/conferences_and_events/files/cabral.pdf>.

⁹ Windrum, *ibid*, p.1.

One such effort to establish an alternative operating system in the marketplace was an attempt to convince customers that a new type of chip architecture, called "RISC" (for Reduced Instruction Set Computer), was sufficiently superior to Intel chips that switching platforms was desirable. The first effort to be launched was 88open Consortium LTD, launched by Motorola to promote its 8800 RISC chip. Data General, Encore Computers, Harris, and Omron, among other hardware companies, supported the effort. Sun Microsystems announced a similar organization, called SPARC International, to promote its own RISC architecture.

Each organization was intended to provide incentives to independent software vendors (ISVs) to port their software to the new environment, so that customers would have a rich variety of applications to run on SPARC-based systems if they made the switch. A subsequent effort, called PowerOpen, was launched by Motorola, IBM and Apple several years later, with the a similar goal and based upon the PowerPC line of chips that each of the three companies was cross-licensed to fabricate. Despite significant funding and effort, none of these efforts was successful in achieving its stated goals: the 8800 chip line never became widely used, while the PowerPC achieved success on the desktop only in the Apple Macintosh, although it was more successful in embedded systems. The SPARC processor continued to power Sun's own products (and is still used by Fujitsu), but did not become a broader threat to Intel. In all of these cases, Intel's resources, alliances (including Microsoft) and dominant installed base proved too difficult to dislodge.

This set of examples illustrates a number of things: first, that different strategies are appropriate to different fact settings, despite the fact that the categorical goal is the same. Second, as in war, a head-on assault of a powerful opponent in a well-established defensive position is apt to be both expensive in resources and unlikely to succeed, even where the attacker arguably has the superior weaponry.

The "good" standards war: It is tempting to assume that standards wars are inherently wasteful and destructive. Perhaps surprisingly, that opinion is not universally held, and the reasons are several.

The first reason is that standards (and especially very detailed standards) can limit the amount of innovation that spring up around a given product or service concept. As a result, there is an inherent tension between optimizing the desirable aspects of standardization (e.g., interoperability, ease of integration, and so on) and flexibility in implementation. If the balance tips too far in terms of rigidity, technology may stagnate, or the standard may not become adopted. On the other hand, if it is weighted too far in favor of flexibility, the specification may not be seen as being sufficiently useful, and once again it may be ignored in the marketplace. If the standard is ignored, then the only alternative is for a rival standard to be created by another SSO, or for a de facto standard to become recognized by default.

Similarly, while the concept of a standard can be good, a given standard can be "bad," either because it is poorly drafted, expensive to implement, not backwardly compatible or likely to be compatible with future products, and so on.¹⁰ A frequent criticism of the consensus process, when taken too far, is that "lowest common denominator" standards can be released that are too late and too poorly regarded to be taken seriously. If such an outcome becomes apparent to participants in the process in question, then better a standards war than stick with a doomed standard.

Timing and maturity of technology and marketplaces can also dictate whether a standards war is apt to be destructive or, indeed, constructive. This is because once a standard becomes broadly adopted, it is usually difficult and expensive to replace it with a better standard that would allow superior technology to be made available to users – in other words, the user becomes "locked in" to an inferior solution. As a result, when an emerging technology becomes standardized too soon, the result can be a market that has become locked in by a standard that may be "good" technically, but "bad" in the sense that an opportunity to develop and deploy a better technology was lost.

¹⁰ It is obligatory in standards literature to cite the QWERTY keyboard as an example of a too-quickly adopted, "bad" standard, although more recently some authors have questioned whether the "badness" of the layout has been exaggerated. See: Stango, Victor, *The Economics of Standards Wars*. Review of Network Economics, Vol. 3, Issue 1 (March 2004), page 8, at www.rnejournal.com/articles/stango_mar04.pdf.

This result may sound unfortunate rather than dire, but in fact the effects of lock-in on the wrong technology can be profound. Where the investment of infrastructure that surrounds the technology upon which the standard is based is very great, the lock-in can not only last for more than a century, but can have a potentially disastrous global impact – as with the early standardization of the automotive industry on the gasoline engine, rather than the electric or steam powered alternatives that were largely abandoned, but might have resulted in far less global warming, as well as in greater choices of energy sources.¹¹

As a result, some standards "wars" should probably not be called "wars" at all, due to the pejorative implication – "competitions" would be a more appropriate term.

Judgments about when standards wars are beneficial or unjustified can therefore be both situational, as well as subjective. A frequently cited example of differing opinions on the "goodness" or "badness" of a standards war is the divergent approach to standardization of second-generation mobile telephone standards in the United States and in Europe. In Europe, a decision was made to standardize early on a single standard, while in the United States, the Federal Communications Commission (FCC) opted to allow the several competing technologies promoted by market competitors to vie for adoption. Not surprisingly, mobile telephony spread more quickly in Europe than in the U.S., and European mobile phone users could use their phones in every service area while their American counterparts achieved the same degree of coverage only gradually.¹²

Looked at objectively, early standardization is most valuable when the generation of technology in question is likely to be of short duration. As a result, the period of benefit is maximized, and the risk is minimized due to the short period of the locked-in. Conversely, where the period of lock-in can be very long (as in the automotive technology example), the extra disruption of a standards competition may be amply rewarded over time.

Lock-in can endanger innovation in other ways as well. Market needs as well as technology can evolve rapidly, and particularly so when new technologies are reaching the marketplace. For example, multiple medium range wireless standards were promoted to address the same basic needs. As those needs and the strengths and weaknesses of each technology became better understood, some (but not all) of the original standards found their own market niches, and additional standards were developed to fill in where none of the original standards excelled. Today, all of the following wireless standards could easily be found in the same home: WiFi, Bluetooth, Near Field Communications – and more are on the way.¹³

As a result, government intervention to mandate standardization through its regulatory power tends to arise most often in traditional areas of government involvement in everyday life, such as public health and safety, where the need for effective standards, as well as their enforcement, is immediate and ongoing.

Summary: For better or worse, standards skirmishes, escalations and wars are likely to be always with us. Such activity can occur at all levels and at every stage in the standards development process, and can involve both *de facto* as well as *de jure* standards. As with natural selection, a marketplace that enables the "survival of the fittest" of standards can have positive as well as negative effects, but the venue within which the conflict occurs can have a bearing on whether or not the survivor is the fittest. For this reason, a standards wars, while more destructive in the short term, may be more beneficial in the long term than a skirmish within an SSO that may be won or lost through the formation of alliances rather than in recognition of the superior quality of the victorious standard.

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¹¹ For an analysis of gasoline engine lock-in, see Cowan, Robin and Hulten, Staffan, *Escaping Lock-in: the Case of the Electric Vehicle*. Technological Forecasting and Social Change, Vol. 53, Issue 1. pp. 61 – 79 at www.cgl.uwaterloo.ca/~racowan/escape.html >.

¹² Cabral and Kretschmer, *op cit.*, at pp. 9-10.

¹³ See Updegrove, *op cit.*, *Case Study: the Unruly Emergence of the Digital Home*.

