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Technical Communications Standards: New Directions in Innovation

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Abstract:

The management of high technology communications companies often view public technical standards, as mechanisms that may reduce their market control and profit margins. This viewpoint has considerable historical precedent, but declining validity today. By reviewing the history of technical standards and identifying its relation to communications technology, this paper identifies new ways to use public standards as a means to enhance, rather than reduce, the inventor's advantage in communications systems.

Public standards have been a commercial coin with two sides: they can be a barrier to private invention or a means inventors use to control markets. Companies recognize that their inventions and innovation, if successful, increases their profits. Leading companies wish to create their own private standards not be bound to public standards. They hope that their market success will lead to market dominance. History does show that public standards in the past have impeded private invention and innovation. Conversely, private invention and innovation when uncontrolled may provide value to the inventor beyond the value gained by the society. Two approaches have been used by society to balance the incentive value of private gain with the need for public good. One, patents are used to allow inventors to add value yet open their inventions to multiple developers. Two, public utilities are used to prevent commercial advantage where there is the potential for a "natural" monopoly.

Patents confer an advantage on the private inventor and public utilities attempt to offer advantage to the public. However both of these approaches create significant problems when applied to communications systems. Patented public standards are one means to create a "natural" monopoly. Patents in public communications standards become a license for the patent holder to extract revenue from potential competitors, thereby reducing competition. Public Telephone and Telegraph companies (public utilities) due to the lack of competition, have implemented slowly-evolving communication systems that are lagging behind society's needs. This paper describes new incentives for invention and innovation that do not enhance "natural" monopolies.

Company Strategy

The Venn diagram below (Figure 1) models the way most commercial high-technology companies develop new products and services. Traditionally, companies have attempted to take/maintain control of their markets, and therefore profits, from two directions - markets and technology.

- Technology strategy: a research and development organization invents new products and processes in advance of competitors; company controls these inventions with patents where possible.
- Market strategy: company control of its market with a proprietary visual design, unique brand identity or focused sales organization.

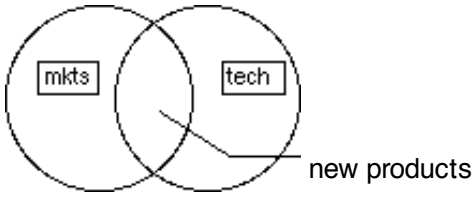

Figure 1. The Product Development Model

Bringing together a new technology and/or a new market creates opportunities for new products or services. New inventions such as the train or the automobile drive many new technologies and also create completely new markets. Less complex new inventions such as the electric can opener can make use of the same market channels and brands as its predecessor - the manual can opener.

However, maintaining proprietary advantage via control of markets or technology has become much more difficult. Technology control is lessened due to independently available powerful product development tools and the increasing need to purchase outside technology for product development. Most technical products have become too complex for a single company to develop completely in a timely manner. Market control is lessened due to more extensive use of independent distribution and more rapid information dissemination which makes competition more likely.

Faced with these difficulties, some high-tech communications companies are including their patented technology in public communications standards as a means to increase their revenues. Including patented technology in a public communications standard requires that all who would communicate using the standard should pay for the patented technology. This can be a very profitable "natural" monopoly in wide spread public communications standards such as modems (e.g., V.34 and V.90) or Internet protocols. Leading communications companies are now very active in the development of public standards. The expanding requirements for public safety and usability standards also increase the importance of standards for product development.

For these reasons, standards are becoming a part of more communications product development plans. The Venn diagram of communications product development below (Figure 2) displays the communications standards strategy: participate in all possible standards consortia and develop intellectual property in public standards to increase revenues and profits.

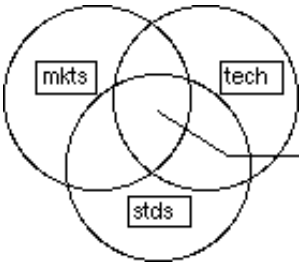

Figure 2. The Communications Product Development Model

Using a standards strategy as an equal part of the company's technology and market strategy is an emerging concept. It is also a difficult concept for the smaller company to accept, as participation in a public standards process can add greatly to the cost of developing new communications technology. And lacking the patented technology in an earlier communications standard reduces the income available to participate in the next communications standard development. Because of these effects, public communications standards development committees are in danger of being dominated by just a few companies. But the same technology that is making standards more important is also creating new ways to profit from invention and innovation.

The Strata of Standards and their Effect on Innovation

The relationship between standards and technology, the fruit of invention and innovation, is tightly coupled. Technical standards, in all their forms public and private, are the means to codify technology for a segment of society. Invention and innovation are also closely linked to the progress of society [1]. Because of these connections, the waves of progress, technology and standards are related.

	Agrarian Wave	Industrial Wave	Information Wave	
			Linear	Adaptive
Strata of Standards	Units/ Reference	Similarity and methodology	Compatibility	Etiquette
New Technology	Weights and measures	Powered machines	Telephony (linear processes)	Computers (adaptive processes)
New Communications	Trade routes	Mechanized transport	Electronic	Wireless
New Value System	Land as Private Property	Patents Control Inventions	Public Utilities	Branded IDs Control Inventions

Table 1. Waves of Change [2].

The same as invention and technology, standards follow an evolutionary path. Multiple standards are created and over time winnowed down to the most desirable and culturally acceptable standards that codify the technical requirements developed during the preceding wave. Future waves build upon the previous technical work, by reference to the standards. Standards developed during one wave thus become the foundation upon which the technologies for the next wave are built. Each of the great waves of society can be identified in a related wave of standards [3].

Unit and Reference Standards

The first wave of civilization, the agrarian wave, begat the need to define units of weight and measure as early as 3500 BC [4]. The definitions of such unit standards were kept by a primary authority, such as the king or temple by 3000 BC [5]. Centuries later, after a long expansion of similar but different unit and reference standards in each geographic area, the various different national and regional unit standards began coalescing into the metric system [6]. Originally the king's forearm became the length of a cubit. The king's

foot, the length of a foot measure. Unless of royal birth, there was little room for innovation with unit standards. In fact, unit standards gain in value to society as a whole when more people use the same standard: a concept economists describe as increasing "externalities". So the gain in the value of unit standards is inversely proportional to the variation (or innovation) allowed.

While unit standards can certainly be shown to inhibit innovation of additional unit standards, unit standards were a significant factor in the development of early civilization. Taxation is a more reliable form of income than tribute. Unit standards provided the weights and measures used for taxation and therefore assisted in the rise of the first great city states of Babylon and Egypt [7].

The early history of unit standards shows that unit standards usually inhibit invention of redundant unit standards but do assist in the development of more complex societies.

Similarity and Methodology Standards

The next strata of standards in Table 1 is similarity standards. Similarity standards define common properties. While unit standards may define the carrying capacity of a barrel, similarity standards define how similar (construction) one barrel is to the next. Making each barrel similar offers significant economic advantage in manufacturing as well as distribution and selling. Similarity standards codify the second great wave of civilization, the industrial revolution [8]. Initially similarity standards were only private standards. The barons of the emerging 18th century industrial age were supportive of "standards" so long as they controlled them. They created rail systems of many different gauges so as to prevent the operation of their competitor's trains on their right-of-way (tracks).

In the early 19th century, the growing use of mechanized process instigated the powerful concept of interchangeability. Interchangeability of parts was originally conceived for the rapid repair of guns after a battle. In the earliest systems interchangeability was possible only among the guns from one manufacturer. In this manner, interchangeability was privately controlled and competition was limited. Examples of private products with interchangable parts that preclude competition: guns, train track spacing, fire plug flanges, custom nuts and bolts. Given the technology of the period, these products with interchangable parts were made using custom jigs developed by each manufacturer. So different manufacturers using different custom jigs and inaccurate measuring systems could not successfully make interchangable parts for the same product.

By the mid 19th century, machine tools and measuring devices had progressed sufficiently that it was practical to create a drawing (specification) and machine parts to match. By using these specifications, multiple companies could manufacturer interchangable parts. These specifications were, in effect, early standards. During the same period, society realized the importance of having all train tracks or all nuts and bolts [9] or fire plug flanges the same and the result was the beginnings of the systems for standardization in use today. Now even products that do not need any form of interchangeability have similarity requirements (public and private) for safety, usage, environment, shipping, etc.

The early history of similarity standards demonstrates that proprietary products with interchangable parts were a form of barrier to market entry, but did serve to increase a company's profits. Converting proprietary products to public similarity standards allows others to compete and the public is better served.

Compatibility Standards

The third strata of standards in Table 1 is compatibility standards. Compatibility standards define a form of interworking. Interworking of dissimilar parts or systems is closely related to the interchangeability of similar parts and systems, but it is distinct. The plug and socket are not similar, but they can interwork (be

locally compatible) [10]. All properly built plugs are also interchangable with each other. Properly written, a similarity standard for the plug could be compatible with a properly written similarity standard for a socket. But when the necessary aspects of both the plug and socket are described in one document - that is a compatibility standard.

Compatibility standards are fundamentally required for any form of communications. Possibly the first technical communications standard was a common number system. Communications systems, which implement compatibility standards, have developed as public systems (telegraph and telephone) as well as private systems (data communications systems). Given the sophistication of electronics and other complex communications technology, it is no longer practical to define compatibility using only separate similarity standards.

Telegraph and telephone companies, initially through invention and innovation and later via regulation as a public utility, maintained control of their standards and markets. Public utilities are often termed "natural" monopolies, because of the difficulty defining all of the standards required to support unbiased competition [11]. In fact, the need for regulation of telegraph and telephone companies was an outgrowth of the need for public compatibility standards. Public utility systems represent another means to ensure that public standards are used for public good, not private gain. However, public utilities severely limit the inventor's chance for private gain. The inventor has no means to compete with a public utility, so the avenue with the most potential for private gain, commercial enterprise, is thwarted. Even the gain from selling an invention to a public utility is very limited since with only one customer there is little room for negotiation. This loss of the inventor's advantage appears to be responsible for the slow pace of innovation in public telephone and telegraph companies.

Public voice communications was recognized to be a public good (e.g., universal service) very early in its development [12]. Public voice communications required a similarity of equipment and systems for compatibility Such compatibility was seen to force a monopoly, so governments decided to control the telephone and telegraph companies via a regulated monopoly (public utility). Data communications evolved through its development and use in large organizations and was not until recently recognized as a public good (e.g., the Internet). IBM pioneered data communications systems and developed many proprietary compatibility specifications (under the system Synchronous Network Architecture) but these, often technically superior private standards, have been obsoleted by the markets desire for public data communications compatibility standards as exemplified by the Internet. The history of private and public compatibility standards for communications identifies the importance of public compatibility standards.

There are two significant paths to public standards - government intervention (via regulations and public utilities) or consensus standardization. Public voice communications systems are evolving away from public control [13] and moving toward commercial control, i.e., publicly available for a fee and privately funded. This trend is partially made possible through the use and acceptance of voluntary (consensus) public standards to define compatibility. The privatization of most major Public Telephone and Telegraph organizations is one indication of the growing acceptance of consensus standardization. Consensus based standardization does not in itself strike a balance between private motivation and public gain. One of the problems with voluntary consensus based public standards is how to accommodate patented invention in such standards. Currently, consensus-based standards organizations use a doctrine requiring that patent holders offer to license their inventions on "reasonable, fair and non-discriminatory" terms. This has the effect of reducing the maximum royalties that an inventor can receive but defining that the invention will be available to multiple developers.

The early history of compatibility standards demonstrates that private compatibility standards were a very significant barrier to competition. Initially public utilities were used as a means to prevent private communications market domination. More recently, consensus based standardization is being used to avoid

creating public utilities yet prevent market domination. However, compatibility standards tend to reduce the means available to a communications systems inventor to gain a commercial advantage.

Etiquettes

The latest wave of change (Table 1), the adaptive information wave, refers to the use of changeable programmable processors for all seven layers of communications [14]. Programmable processors provide the means to implement basic communications yet allow proprietary communications technology. Once all communications functions are programmable and changeable, they can be adapted to support any new invention and still allow prior compatible operation. What is necessary is a simple protocol that shuttles back and forth between the communicating ends and negotiates which specific layer processes will be used for compatible operation. Such a "protocol of protocols" is termed an etiquette.

The advent and wide spread use of digital signal processors (DSP, a specific form of microprocessor) to support the programmable operation of even the physical layer communications function of modulation (previously associated with fixed function circuit design) is the last step to making etiquettes practical. DSPs provide the programmable operation at the first (physical) OSI layer; programmable controllers and host software on ever faster hosts can provide programmable operation of the remaining six layers.

Etiquette standards create new ways to design, control and add value to communications systems. The concepts of etiquettes can also be applied to the local interfaces between software processes in a single system. However, in such local interfaces, the functions of an etiquette are often integrated into the software processes, making the specific functions of an etiquette more difficult to identify.

Examples of etiquettes used to negotiate with remote systems include the International Telecommunications Union (ITU) V.8 used by telephone modems to negotiate compatible operation with the remote modem. This is how older and newer telephone modems (e.g., V.34 and V.90) find a common way to communicate. In Group 3 facsimile, the negotiating protocol ITU T.30 is an etiquette that has also been very successfully extended (e.g., from 4800, to 9600, 14400 and 28800 bit/s) for over thirty years. In the IETF, draft RFC Session Initiation Protocol (SIP) is a new etiquette to negotiate multimedia communications.

Etiquettes between remote systems become desirable when programmable processors and changeable memory (new forms of technology) are available to support all of the OSI layers used for remote communications. With the introduction of such adaptive technology, a new wave of standards is emerging. As DSP become economically viable to support the physical layer of communications, it becomes practical to employ etiquettes to negotiate communications between systems. This negotiation can support all types of compatibility, and can also support proprietary "branded" enhancements.

A proper etiquette is a serial structure containing the etiquette revision level, negotiated parameters (what the etiquette is negotiating, usually which protocol, associated revision level and options), and proprietary enhancements. Etiquettes require a serial structure to ensure that revisions remain fully backward compatible. The proprietary enhancements section of the etiquette would include the legally controlled identifier (branded ID) [15], market segmentation fields, and any proprietary enhancements (or a pointer to them). Adding new protocol identifiers to etiquettes allows the support of additional protocols without affecting the compatible operation of existing protocols. Over time, desirable proprietary enhancements may become standard and may be added to the standardized parameter sets. Ricoh, a Japanese facsimile machine manufacturer, offered proprietary higher speed facsimile to its corporate customers. Then, years later, similar higher speed operation to what they pioneered, was included in the G3 facsimile standard.

Keeping revisions fully backward compatible in very complex protocol stacks or software processes is impossible, because it is not possible to identify or test all the ramifications of a change. Thus changes to

add features or fix "bugs" can result in more "bugs." Since etiquettes can negotiate protocols (including different revisions), it is possible for an etiquette to negotiate the "best" protocol or revision for a specific application. The logic describing what is "best" would need to be previously uploaded to each of the communicating systems.

As companies develop unique communications features, they can add them to the proprietary enhancements field, as Ricoh did with higher speed facsimile. In this manner, companies can add value yet support compatible communications or interfaces. In the proprietary enhancements field, the use of a branded ID (SIP uses a reverse domain name) may provide a legal way to control the proprietary enhancement and therefore may represent a new form of intellectual property.

Such enhancements are not limited to allowing private inventions such as higher data rates or better compression. Etiquettes can also control market segments to increase profits by offering specific capabilities to specific market segments. For example, the banking industry may negotiate better encryption, the radiologist market may negotiate higher resolution or the wireless market may negotiate better error control. Market segmentation via the etiquette can also be applied to the sales channel, allowing individual dealers and distributors to automatically poll their specific customers' equipment for usage billing (copier market), problem analysis, and maintenance support (automatic ordering of replacement parts).

The Product Continuum

Over the history of human achievement, from the agrarian to the information age, the first three strata of standards have developed. As each stratum of standards emerged, there has been a tension between the private gain proprietary standards (properly termed specifications) offered and the public good desired from public standards. Over time and with considerable difficulty, the private gain motivation has been adjusted to meet the long term public good.

Initially all new concepts, ideas and products are in some way unique. Eventually, some of these concepts, ideas, and products become widely accepted; then each implementation of the same concept, idea or product is in many ways uniform. But throughout recorded history, invention and standardization have been at opposite ends of a continuum. Simply, the tension between invention and standardization can be seen in the product continuum. Over the product continuum shown in Figure 3, the interests of standard seekers and standards creators appear as opposite.

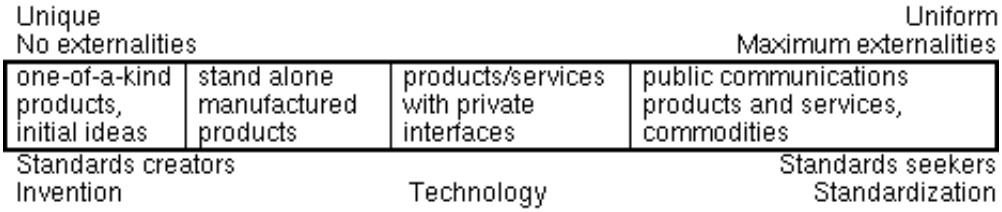

Figure 3. The Product Continuum

Both the standards creators and the standards seekers wish to create some type of a standard: one, by force of market success and the other by committee acclamation. The creation of a new product (invention) is only the first step. To achieve monetary gain, the invention needs to be integrated into a useful product or service and provided to the marketplace. This often requires innovation. In the first three waves of society, if the processes of invention and innovation were sufficiently successful, a range of standards, first private and later public, emerged to codify for society the desired practices. In this way, public good was balanced with private gain using patents and public utilities. When this balance was not possible, government intervention was often required [16].

There are two agreed ways to create formal public standards - government intervention or accredited consensus standardization. This simple fact has never stopped developers from trying a third way - market standards. The concept is straight forward: if the invention is desirable enough and well marketed (e.g., Microsoft Windows), an entire market may accept it as "standard" even though it is privately controlled. This third way redefines a public standard in a way which removes the public's advantage and returns it to the inventor. A number of major companies have built their success by defining the "standard" as what they offer. IBM and Microsoft are recent examples. The Standard Oil Company (owned by Rockefeller) was an earlier example. As these examples suggest, when the concept of public standards is subverted for private gain, government action may eventually become necessary.

Of course, companies must try to maximize their success, or there could be no inventor's advantage. When they are successful enough to reach the envious position of being the market standard, then they have a responsibility to convert their technology into public standards. If they do not accept this responsibility, then often the government attempts to right the issue.

Conclusions

Technology, the fruit of invention, is fundamental to the long term success of any society, and standardization brings these fruits to society. Each stratum of standards codifies a new class of technology for society and requires new ways to balance the short term inventor's advantage with the long term public good.

Compatibility standards are already changing the balance between communications invention and standardization. More and more, public compatibility standards for communications are deemed to be too important to allow any private organization overwhelming proprietary advantage. This in turn has created the need for the public standards committees' "reasonable, fair and non-discriminatory" doctrine of intellectual property rights for work included in a public standard. While certainly a valuable addition to balancing public good with private gain, the "reasonable, fair and non-discriminatory" doctrine has not become a complete solution [17].

The segment of a communications market that is willing to acquire and use proprietary communications systems is in serious decline for fundamental reasons. Commercial organizations that create communications products and services and wish to maximize their profits, need new ways to profit from the inventor's advantage. The growing commercial use of etiquettes appears to offer such new ways to profit.

Etiquettes bridge the ends of the product continuum, joining the interests of the standards creators and standard seekers. This stratum of standards represents a new means to achieve monetary gain based on invention or innovation, while still supporting the compatibility so necessary to society. And patents still remain a means for the inventor to achieve monetary gain directly based on the invention.

The ubiquitous use of programmable processors and changeable memory represents a paradigm shift from structured linear communications systems. This new paradigm can be seen by its emerging effect on the technical standards, communications systems and the value systems of our society. Far sighted communications companies will recognize this new wave and take advantage of etiquettes to responsibly innovate, without reducing world-wide compatibility.

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Footnotes

[1] Joseph A. Schumpeter, Business Cycles, McGraw-Hill, Inc., first edition 1939 He develops the concept that all economic cycles (waves) are generated by innovation. Return to text

[2] The title of a book by Alvin Toffler, 1980 describing the three waves noted. Return to text

[3] Ken Krechmer, Technical Standards: Foundations for the Future, ACM StandardView, March 1996. Return to text

[4] Lal C. Verman, Standardization in India - Ancient and Modern. Shri Ram Institute for Industrial Research, 1965. Return to text

[5] F.G. Skinner, The Origins of Standardization, History of Technology Vol. I Oxford Press, 1958. Return to text

[6] The meter and kilogram were first approved in 1799. The USA is still "moving towards" metric use. History of Technology and Invention Vol. III, Crown Publishers, first printed 1968. Return to text

[7] F.G. Skinner, The Origins of Standardization, History of Technology Vol. I Oxford Press, 1958. Return to text

[8] The industrial revolution has many fathers. E. Whitney is generally credited with introducing the "American system" of production with interchangable parts in 1798. In fact, Thomas Jefferson paid a visit to a French gunsmith Le Blanc in 1785 and saw the same methods. History of Technology, Vol. VI and V Oxford, 1958. Return to text

[9] J. Whitworth proposed in 1841 in a paper to the Institution of Civil Engineers in England a standard specifications for bolts and nuts. He also was a major proponent of the early technology of accurate measurement. History of Technology Vol. IV, 1958. Return to text

[10] The author considers interworking to be synonymous with local compatibility (e.g., train rail and wheel truck) and distinct from remote compatibility. Return to text

[11] Allowing independent access to different parts of the telephone network without reducing performance (unbundling) is a significant problem today. Return to text

[12] History of Engineering and Science in the Bell System 1825-1925, Bell Telephone Laboratories, Inc. 1975. Return to text

[13] Beginning with divestiture in the USA in 1984. Return to text

[14] In communications, a seven layer model of possible communications functions is termed the "OSI Model" and is defined in ITU X.200 or ISO 7498. Return to text

[15] This concept requires legal advice, but simply it is the use of an ASCII string of information to prevent

the use of the proprietary etiquette sequence by other developers. Examples of such information sequences used today include copyright statements, Internet domain names and ASCAP (American Society of Composers, Authors and Publishers) requirements. Return to text

[16] In early 19th Century England several different rail gauges were in use: 4 feet 8.5 inches, 5 feet and 7 feet 0.25 inch. In 1846 the Gauge Act of Parliament specified that any new line would be built with the 4 feet 8.5 inch gauge (which was in the widest use). A History of Technology and Invention Vol. III Crown Publishers, first printed 1968. Return to text

[17] Ken Krechmer, Communications Standards and Patent Rights: Conflict or Coordination, Standards and Technology Annual Report (STAR) from Telecommunications Industry Association (TIA), 1997. Return to text

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