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Standards Mark the Course of Economic Progress [1]

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Abstract

The transformation from fixed communications systems such as railroads and telephony to adaptive communications systems such as the Internet is evidence of a paradigm shift. This paradigm shift is made possible using new innovations (programmable computers) and new forms of credit creation. Using J. A. Schumpeter's economic analysis as a basis, this paper explores how technical standards form the linkage between innovation and credit creation. A five succession taxonomy is developed which identifies the paradigm shifts in technology, technical standards, credit creation and innovation in five eras. In the current era, the ability of the Internet to electronically transfer brand names, trademarks and proprietary interfaces, using a new succession of standards called adaptability standards, represents an emerging form of credit creation.

Standards are Fundamental

Poets often give words to basic truths. "A vast similitude interlocks all," wrote Walt Whitman. Technical standards [2] are developed in each and every human society to enable communications, quantify ownership and facilitate the course of trade. The vast similitude of symbols, numbers, alphabets, currency, weights, measurement systems, navigational elements and communications systems may be termed technical standards. The complexity of these standards is an indication of each tribe or society's sophistication and technological attainment.

Adam Smith identified that the economic power of trade (exchange) gives occasion to the division of labor, and the division of labor provides the greatest improvement in productivity (Smith 1937). Standards for symbols, currency, measurement, manufacturing, and communications provide the definitions used to enable an exchange. Using these definitions, the division of labor is expanded, resulting in increased productivity and economic growth. Technical standards provide the basis from which change, development and economic transformation occur.

Standards Link History, Technology, Innovation and Credit Creation

J. A. Schumpeter developed the concept that all economic cycles are generated by invention and innovation (Schumpeter 1964). He also noted that the subject matter of economics is essentially a unique process in historic time (Schumpeter 1954).

P. David (1987) proposed, for the purpose of formal economic modeling, a three level taxonomy of technical standards related to behavioral standards. He described standards for reference and definition (symbols and measurement), standards for minimal admissible attributes (similarity), and standards for interface compatibility (compatibility).

Expanding on David's three levels, Table 1 identifies five historic eras by their unique innovation, technology, standards and credit creation. Each era is wrought by the paradigm shifts that occurs as invention begets new technology which enhances human communications through the emergence of new successions of technical standards. Along with each paradigm shift of technology a new form of credit creation emerges.

	Historic Era				
	Hunter Gatherer	**Agrarian**	**Industrial**	**Information Systems Fixed**	**Adaptive**
Innovation[3]	Drawing and carving	Trade routes	Mechanized transport	Electronic (e.g., telephony)	Internet
Technology	Language	Measuring and navigation	Powered machines	Linear processes (e.g., mail)	Adaptive processes (e.g., computers)
Technical Standards	Symbols	Measurement	Similarity	Compatibility	Adaptability
Credit Creation	Trading	Property ownership	Invention ownership (patents)	System ownership (e.g., utility co.)	Concept ownership (e.g., brands, trademarks)

Table 1. Historic Paradigm Shifts

Standards are a Marker of Economic Impact

Standards are the means to codify technology for a society. Prior to the development of common agreements defining a technology, a technology is in the development phase before deployment and before significant economic impact. Multiple standards are created and over time are winnowed down in an evolutionary process to the most technically desirable and culturally acceptable in each era. As technology is applied in new ways, each succession of standards continues to develop and expand, even as new succession develop. Prior to the creation of technical standards, technical information, for example rudimentary tool making, was only passed on through instruction and example. When a society reaches the point where tool information can be passed along via technical standards, the efficiency of that society as a producer is dramatically improved. Technical standards in all their forms provide the definitions used to deploy useful technical information.

The successions of standards continue to evolve beyond the initial era when they emerged. In the following each succession of standards will be discussed in terms of the innovation and technology that begat the needs for a new succession of standards and how this new combination of innovation, technology and standards seems to require new forms of credit creation. Each confluence of changes is seen as a paradigm shift that dramatically changed the human race.

The paradigm shift introduced by a new class of technology requires new ways to balance two conflicting objectives: one, incentives for invention and innovation enabling private gain, and two, public good provided by the diffusion of new products, services and processes enabling lower prices, greater usage and new capabilities (Shurmer 1995). Each succession of standards is defined in economic terms by a change in the self-reinforcing effects (Arthur 1988). The expanding self-reinforcing effects in turn cause a change in the balance between private gain and public good.

Symbol Standards

Symbols form the first succession of standards shown in Table 1. Commonly accepted symbols represent the first human created standards and make possible the earliest form of communications between humans. Of course, the first symbols used for communications were based only on common assumptions and not codified The concept of common symbols emerges in pre-history as symbols denoting individuals and animals. Such symbols are shown in early cave paintings (Burke and Ornstein 1997, p. 27). The marks used for counting in pre-history indicate an emerging number system and imply the existence of initial technical symbol standards. The use of symbols occurs as an early indication of intelligence as the members of a hunter-gatherer society develop intellectually (Burke and Ornstein 1997, p. 30). "Nomadic herdsmen developed the spoken language of number,..." (Smeltzer 1958, page 30).

Measurement Standards

The second succession of standards in Table 1 is that of measurement standards. Measurement standards define physical properties. In the agrarian era symbol standards (number systems) were employed with new measurement standards to codify units of weight and measure (measurement standards) (Smeltzer, page 30). By 3000 BCE the definitions of such measurement standards were kept by a primary authority, such as the king or temple (Skinner 1958). A pharaoh's forearm became the length of a cubit, a king's foot, the length of a foot measure. The Magna Charta which King John of England sealed June 15, 1215 at Runnimede included the "measurements" pledge which defined standards for the measurement of wine, ale, corn, cloth and weight (Klein 1974). Centuries later, in 1799, after a long evolution of different unit and reference standards in each kingdom, the various local measurement standards began coalescing into the metric system (History of Technology and Invention, 1968).

Measurement standards were a significant factor in the development of early civilization. Taxation provides a more reliable form of government income than tribute. Measurement standards provided the weights and measures used for taxation (by barter) and therefore assisted in the rise of the first great city states of Babylon and Egypt (Skinner 1958). By 1700 BCE[4], economic measurement standards, i.e., currency enabled more complex exchange, and expanded trade. Currency standards make possible virtual measurements and require the acceptance of society (usually sponsored by a government) for their broad use.

While measurement standards are more useful to society when more people use the same measurement standard, the use of measurement standards minimizes estimating and tends to reduce the clever, but perhaps not very honest, seller's advantage. Because the use of measurement standards offers long term advantage to society but little short term advantage to early merchant entrepreneurs, measurement standards may be seen to have small self-reinforcing effects. Governments promote common measurement standards for multiple reasons, including equitable taxation. Of course, government-controlled measurement standards minimize innovation of alternative measurement standards. The wide use of common measurement standards provides the greatest value to society; innovations in measurement standards usually offer little more than convenience.

Similarity Standards

Similarity standards form the third succession of standards in Table 1.[5] Similarity standards define the common physical properties of two or more entities, usually to define some similarity. While measurement standards (e.g., liter) define the units to measure the carrying capacity of a barrel, similarity standards define how similar in construction one barrel is to the next. Making each barrel similar can offer economic advantages (self-reinforcing effects) in manufacturing as well as distribution, selling and use.

Similarity specifications emerged during the industrial revolution. Similarity standards codify the results of repetitive processes designed to minimize production costs and increase learning effects (Arthur 1988). Initially, similarity standards were not seen as desirable. Different railroad engineers identified different requirements and therefore designed different train rail spacings. And the railroad owners, the entrepreneurs of the emerging 19th century industrial age, preferred to support only what they owned. Together these engineers and entrepreneurs created railroad systems of many different gauges (Puffert 1991).

By the 19th century, the growing use of mechanized processes instigated the powerful concept of interchangeability. The economic value of interchangeable parts was first identified for the rapid repair of guns after a battle. [6] In the early 1800's, interchangeability was possible only among the guns from one manufacturer. Interchangeability was privately controlled and competition was limited. Examples of private products with interchangeable parts that precluded competition: guns, train track gauges, fire hydrant flanges, rotating gear design, and custom nuts and bolts.

Manufacturers were not initially motivated to develop or follow similarity standards, because only the proprietary self-reinforcing effects of maintaining similarity were obvious to the manufacturers. Proprietary products from a single manufacturer with interchangeable parts were a form of barrier to competition, while the use of interchangeable parts added value to the manufacturer's product and served to increase the manufacturer’s profits. However, during this same period, society began to realize the importance of standard train track gauges or bolt and nut threads [7] or fire hydrant flanges (Hemenway 1975). Sometimes the government stepped in to require similarity standards, as example, for train track gauges in England and America (Puffert 1991) or the USA War Industries Board during World War I which dramatically reduced the number of different styles of consumer goods (Hemenway 1975). But a new means of credit creation based upon patents on inventions also developed to encourage more common usage of similar equipment from different manufacturers. Patents emerged at the beginning of the industrial revolution[8] to allow proprietary products (private gain) to be converted to common specifications and possibly similarity standards. As the markets for manufactured products grew, so also did the manufacturers understanding of the self-reinforcing effects related to similar products and common agreements which evolved to become similarity standards. Similarity standards offer advantages to the manufacturer in production efficiencies, to the distribution chain in handling and promotion, and to the end user in understanding, operation and maintenance. Manufacturers with an economic assist from patents and a growing knowledge of the advantages of similarity standards have, over the past 150 years, increasingly supported their use (Business Week 1995).

Now even products that have little need for interchangeability have similarity requirements (public and private) for safety, usage, environment, shipping, etc. Examples include: the standards for emergency exit signs, motor vehicle speed limits, the definition and marking of specific plastics for recycling, or the transportation of hazardous goods. As these examples suggest, similarity standards, when they represent the minimum admissible attributes relating to public safety and use, are often referenced in government regulations. But the form of government involvement in similarity standards is quite different than for measurement standards due to the positive self-reinforcing effects associated with similarity standards. Once manufacturers realize the production and marketing advantages of similarity standards, less government promotion/protection of such standards is necessary to protect the public good.

Compatibility Standards

Compatibility standards, the fourth succession of standards in Table 1, define a local or remote relationship between two or more independent entities for the purpose of interworking (physical connection) or information communications (virtual connection). Compatibility standards or specifications define an interface between two dissimilar devices. An interface offers compatibility rather than interchangeability. Imagine two similar plugs and two similar sockets. Assuming that each plug mates with each socket, the two plugs are interchangeable and the two sockets are interchangeable. Each plug is compatible with each socket, but a plug and a socket are not interchangeable.

The concept of technical compatibility specifications developed in the late 19th century, to support flowing services which provide water, sewage removal, gas, oil, electricity, telephone and telegraph. These services are very important for the expanding cities. Like early railroads, each early utility system for water and sewage used different arrangements for pipe and coupling. Standardized pipe sizes and coupling emerged as larger utility companies acquired smaller ones in the 19th and 20th century (Bruce 1958). More complex fluid transportation systems for gas and oil required common definition of the physical properties to be transported, e.g., crude oil grades. Electrical and communications utility systems also developed common specifications as larger companies acquired smaller. Public communications systems require more complex definitions of each interface than fluid transport systems. But all flowing service definitions initially started out as trade practices, later became written private specifications, and only with the advent of deregulation of public communications utilities became compatibility standards.

Data communications, which was not initially perceived as a public service, appears to be where the first public communications compatibility standards developed.[9] Data communications was developed in the later part of the 20th century by AT&T and IBM and deployed in large organizations initially for airline reservations and accounting systems.

The Internet, fundamentally a data communications network, only recently (1990s) was identified as an important public service. Prior to the Internet IBM pioneered large data communications systems and developed many proprietary compatibility specifications (e.g., token ring local area networks, LANs), but these private specifications have been obsoleted by the market's desire for public data communications compatibility (e.g., Ethernet LANs). The success of Ethernet LANs and the failure of the IBM token ring LAN may be partially explained by the public's desire for public standards rather than proprietary specifications.

Once public compatibility standards to useful systems are available, entrepreneurs are quick to take up the challenge, and public compatibility standards become essential parts of day-to-day life, e.g., AC plugs and outlets, Edison light bulb sockets, telephone jacks, electronic mail, the World-Wide-Web (WWW). The amazing and ever-changing array of devices and software that attach to these compatible interfaces gives evidence of the extremely powerful self-reinforcing effects that may be associated with public compatibility standards.

Systems and equipment that utilize compatibility standards evidence greater self-reinforcing effects than equipment based on similarity standards. This occurs due to the addition of coordination effects[10] to the self-reinforcing effects already associated with similarity standards. The greater self-reinforcing effects in turn motivate entrepreneurs to be the first to bring to market new systems and equipment that embody their own compatibility specifications. One example is the rapid rise of the Netscape browser for access to the World-Wide-Web and the following rapid rise of the Microsoft Internet Explorer browser. In these examples, compatibility with the desired service (WWW) is primary and the software seen to best provide compatibility is rapidly accepted due to the sum of the self-reinforcing effects.

Cellular communications systems offer a different example of self-reinforcement. In the US, there is no single technology supported for third generation cellular communications. Different US entrepreneurs have created different cellular technologies, because the need for common, nation-wide cellular communications was not recognized in the US and multi-mode cellular phones were practical. Yet European companies with an earlier need for common, multi-country cellular communications, have created a European position supporting GSM cellular communications. In public communications markets, the European tradition of respect for standardization appears more efficient (less variation needs to be supported) and more successful (greater percentage of potential users) than the US desire for market determination. [11] However, in private interface markets (where at least one side of the compatible interface is privately controlled), the US process of market determination may be more successful, e.g., Microsoft personal computer operating systems or the earlier success of IBM data communications systems.

These examples also illuminate the effect of compatible interfaces on "lock-in" (Arthur 1988). Lock-in occurs when the self reinforcing effects increase demand for a specific product or service and make it difficult for innovative alternatives to be considered. Lock-in is very desirable for the manufacturer who achieves it, but is at best a mixed blessing for the public. Lock-in may be achieved by control of a necessary technical element, by political or market means. There are only two current ways to achieve lock-in of a technical nature. Patents may cause technical lock-in, which is an acceptable result of a successful patent. And technical lock-in may be achieved using a proprietary compatible interface, which may be less desirable to society, as examples from Microsoft (operating system application programming interfaces)or IBM (Systems Network Architecture, SNA) suggest.

If the equipment/software providing an interface is programmable and user changeable, such as Internet browsers or personal computer electronic mail programs, then multiple solutions may be supported, each contending in its market for some advantage which would increase demand and possibly achieve lock-in. User changeability or selection via a converter are necessary conditions to avoid lock-in via compatible interfaces, but not sufficient. A means or mechanism to identify and select among alternative compatible interfaces is also required to prevent lock-in.

Adaptability

Adaptability standards define an adaptive mechanism to select among different compatibility standards or specifications for the purpose of communications. This ability to identify and select can preclude any technical lock-in of programmable systems. Adaptability standards evidence "adaptability effects," a new form of self-reinforcement based on the user's desire for forward and backward compatibility across an interface as well as the implementer's desire for both proprietary and public compatibility. Adaptability standards can support compatible operation with existing programmable technologies as well as compatible operation with new technologies, and can prevent the technical compatibility problems that the introduction of a new capability via an existing interface often causes. Personal computer users are often painfully aware of this form of compatibility problem. The emerging adaptive standards succession (Table 1) is exemplified by the Internet; it is enabled by programmable computers for all the functions that support communications. High speed programmable computers provide the means to implement basic communications yet adapt to utilize new communications programs and allow proprietary communications technology. Once communications functions are programmable and changeable, they can be adapted, in real-time, to support any new communications invention (within the constraints of the resources available) and still allow backward compatible operation. What is necessary in communications systems is a simple protocol that shuttles back and forth between the communicating ends to negotiate which specific protocol(s), data sets and options will be used for compatible operation. Such a "protocol of protocols" is termed an etiquette. Current examples of etiquette standards used to negotiate with remote systems include ITU V.8 used by telephone modems to negotiate remote compatible operation with the far-end 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 for over thirty years. In the IETF, RFC 3261, Session Initiation Protocol (SIP) is used to negotiate multimedia communications. The ITU Digital Subscriber Line (DSL) standards use an etiquette (G.994.1) to support forward and backward compatibility. Etiquettes may also be applied to the local interfaces between software processes in a local system to support local compatibility.

Etiquettes create new ways to implement, control, and add value to communications systems. The negotiation defined by an etiquette standard can support all types of compatibility, and can also transport proprietary enhancements using a standardized way of passing proprietary information. In the etiquette, a character string (or similar) is used to identify proprietary ownership. In Group 3 facsimile, the standardized way to support proprietary enhancements is called ITU T.30 Non-Standard Facilities (NSF). Each NSF, transmitted between facsimile machines, is identified by a proprietary character sequence. Following this, any information may be exchanged because the communicating ends have uniquely identified each other. In SIP, a reverse domain name is used to provide the unique identity. Each of these unique identifiers is "owned" by the organization that implements it and there is legal precedent to suggest that such ownership would be legally recognized. These information sequences become the identification that communicating systems use to verify design ownership - a "branded ID."[12] By using a branded ID, the communications equipment manufacturer maintains legal control over any proprietary features offered. The use of a branded ID to control proprietary enhancements represents a new form of intellectual property that may be transferred over any digital communications system.

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 G3 facsimile to its corporate customers using the NSF. Then, years later, higher speed operation similar to what Ricoh pioneered was included in the G3 facsimile etiquette standard. This ability to offer desirable proprietary features while maintaining compatibility with the G3 facsimile standard contributed to Ricoh's position as the largest corporate facsimile supplier for many years.

Many existing programmable communications systems already support multiple communications protocols with a mechanism in the protocols to discover which communications protocol is being received. However, such systems cannot achieve complete forward compatibility. For complete forward compatibility, the discovery function must be independent of the protocol. This is required to guarantee that changes to the protocol do not impact the etiquette and the reverse. Keeping revisions fully compatible in very complex software/hardware systems is currently impossible without using the independent discovery concept of an etiquette, 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 are independent of the protocols, they can negotiate among different communications protocols (including different revisions) to utilize the version that is most compatible.

Etiquette standards are not limited to allowing private technical inventions such as higher data rates or lower error rates. Etiquettes using a branded ID can also increase profits by offering specific capabilities to particular market segments. For example, the banking industry may negotiate better encryption, the radiologist market may negotiate higher resolution, the wireless market may negotiate better error control. Market segmentation via the etiquette can also be applied to the distribution channel, allowing individual equipment dealers and distributors to automatically poll their specific customers' equipment for usage billing (e.g., copier market), problem analysis, and maintenance support (automatic ordering of replacement parts). In these automatic polling cases, the etiquette may include a branded ID as well as a distributor and customer ID added by the machine dealer to uniquely identify their customers.

The concept of etiquette standards is just emerging. Exactly how etiquette standards will balance the desire for public good with the need to promote private gain is yet to be fully determined. But the desirability of future compatible operation and the private economic opportunities made possible by etiquette standards are not likely to go unnoticed. Once the concept of etiquettes is understood technically, economically and politically, the adaptability effects of etiquette standards can add to the self-reinforcing effects.

Etiquettes and the Internet

The Internet is built from a compact series of similarity and compatibility standards (Transmission Control Protocol, Internet Protocol, User Datagram Protocol, etc.) used to enable end-to-end communications between various programmable computers. This model is perfect for the use of etiquettes. Using etiquettes, separate systems can operate in different ways yet find compatible modes of operation. Two separate voice-over-the-Internet devices (Internet telephones) may, for example, attempt to negotiate a common voice digitizer (converts between voice and bits) using a common etiquette. If the two devices do not share a common voice digitizer, then one or both devices could go to a “voice digitizer downloading web site” (e.g., a batch interworking system) where a common voice digitizer could be downloaded. Or they could go to a “voice digitizer conversion web site” (e.g., a real-time conversion system) and each Internet telephone could pass its coded voice stream to the web site for real-time conversion to the voice digitizer used by the opposite Internet telephone.

Using the example above, the “voice digitizer downloading web site” could provide the desired voice digitizer software for purchase charged to a credit card. Or the “voice digitizer conversion web site” could perform the actual conversion process for a usage or time based fee charged to a credit card. Etiquette standards may make the next evolution of the Internet, where the network provides the processing and application services, more manageable and profitable.

Standards and Credit Creation

J. A. Schumpeter (1964) explains that the entrepreneur is the key player in the on-going economic development of society and that credit creation may be seen as the monetary complement of the entrepreneur’s innovation. The taxonomy offered in Table 1 links specific technical inventions and innovations to a succession of standards. In turn, each succession of standards relates to a new form of credit creation which makes possible new rewards to the entrepreneur. Since symbols emerge in pre-history, no attempt is made here to discuss the economic rewards of this succession. The remaining four different ways to offer the entrepreneur economic rewards based upon his or her efforts are discussed below. In the future, additional forms of credit creation may be identified.

Property ownership

Once the concept of property ownership was created/understood in the agrarian period, it was possible to barter or sell for profit. Profit, the dominant way to reward the entrepreneur, emerged as a fundamental part of the first bartered transaction.

Invention ownership

Profit is still the dominant mechanism providing the entrepreneur a reward for innovation. But it is not the only mechanism. Innovation may also include invention. The inventor, one specific type of entrepreneur, can find economic rewards through the use of patents which confer on the inventor exclusivity of ownership of his/her invention for a period of time.

Patents augment the profit motive by supporting proprietary products (private gain) yet motivating the inventor to share the invention with others, for greater public good. Competition between the inventor and the licensees of the invention forces increased efficiencies in manufacturing and distribution, thereby reducing costs and prices (public good). Of course, such competition is only possible when the fees paid by the licensees are reasonable. If the cost of licensing is too great, it prevents the licensee’s products from being competitive with similar products from the inventor’s company. Recognizing this effect, most standards development organizations now require identified patent holders to agree that patents related to a standard under development will be licensed on "reasonable, fair and non-discriminatory terms."

History shows that public standards (particularly measurement and similarity standards) have impeded private invention and innovation (Farrell 1985). Conversely, private invention and innovation have impeded public standards. Differing railroad track gauges prior to government intervention is one example of the latter. During the 20th century, companies which sponsor and acquire inventions have recognized the advantages of common similarity standards for increasing efficiency and expanding markets. Such improvements are now widely understood to be more important to company profits than proprietary implementations. However, common compatibility standards are not yet viewed in such an enlightened manner. Many companies wish to create their own private compatibility specifications (which they often term "standards"), not be bound to public compatibility standards. They hope that their market success will lead to market dominance and they will control the compatibility specifications chosen by the market, using their patents or market position. Intel (microprocessor interfaces) and Microsoft (application programming interfaces), and IBM (system network architecture) before them, offer examples of the immense value of private compatibility specifications when the market considers them de facto compatibility "standards."

System Ownership

Compatibility standards are a fundamental part of the issue of system ownership. The emergence of large interconnected systems begins with the creation of utility systems. Utility companies, initially a very small portion of the economy, in about 100 years became the largest single economic group in the USA.[13] This is evidence of an economic paradigm shift.

Public utilities are those industries which are required to render service at reasonable and nondiscriminatory prices to all who apply for it, i.e., they are necessary for the public good. The private ownership of utility systems has not always been seen to be in the public's best interest as they were considered "natural monopolies."[14] Natural monopolies have five defining characteristics:

1. Provide a necessary product or service.
2. Has a dominant position over similar products or services.
3. Controls the supply of the product or service.
4. The product or service may be increased with little relationship to cost.
5. Unique and specific arrangements[15] are necessary to use the product or service.

The problem of how to have these desirable systems yet avoid the gouging possible when such systems are privately owned gave rise to the concept of utilities: owned, controlled or regulated by a government.

Of course, public utilities also limit the inventor's or innovator's opportunity for private gain. The innovator 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. With only one potential customer there is little room for negotiation. This loss of the innovator's advantage appears to be one reason for the reduced pace of innovation in public telephone and telegraph companies (PT&Ts).

In the past, communications utilities[16] in the form of PT&Ts have dominated communications technology invention and treated their own inventions as public property (Bauer 1934). However PT&Ts, possibly due to the lack of competition, have implemented slowly-evolving communication systems that lagged behind technology's capabilities and society's needs. Because of this, PT&Ts have been privatized in many countries. The privatization of PT&Ts appears to bring with it the advantage of competition: innovation. However, the new private owners of these public communications systems consider the existing patents their own property to be used for their private gain. The passage of large patent portfolios from public communications utilities (even privately owned) to private companies (without public regulation) neglects the effect of patented communications technology included in existing compatibility standards.

There are significant differences between patents controlling similarity and patents controlling compatibility. Advances in technology may quickly reduce or bypass the effect of patents controlling similarity. Patents controlling a desired standard for public compatibility cannot be bypassed so easily. A patent on a superior vacuum tube radio design (similarity) is obsoleted by transistor radios; and the replacement of each radio is an individual decision. However a patent controlling standardized AM radio broadcast transmission (compatibility) is valuable until the AM radio broadcast is no longer desired or the patent expires; and the replacement of all AM broadcasting transmitters and radios is far from an individual decision.

Patented communications standards may be seen as creating a natural monopoly if the public communications system is considered necessary, is privately owned and controlled, and the patented technology is required for compatibility. Patents are designed to confer a unique advantage on the private inventor for a period of time. Patents were not intended to support natural monopolies such as utility systems. However, in fixed information systems (Table 1), patents necessary for compatibility with privately owned, but publicly used systems may reinforce the unique arrangement aspect of a natural monopoly. Patents used in public communications standards then become a license for the patent holder to extract revenue from potential competitors who must use the patented technology, thereby weakening competition. This reduction in competition has a likelihood of reducing the public good, while increasing the private gain.

Where patented technology of the utility company is already included in public compatibility standards, the future value of the patented technology is assured. Currently when such a patent portfolio is transferred to a private company, the private company receives a windfall (increased private gain from the future patent royalties). In effect, it is a transfer of value previously held in the public domain to private enterprise. PT&Ts world-wide are being privatized. The future value of their patent portfolios applicable to existing compatibility standards is a current issue which should be considered in the transfer from public to private ownership of the PT&T systems.

Concept Ownership

The newest succession of standards, adaptability, is emerging and with it a new form of credit creation has appeared - concept ownership. In some respects, concept ownership is already well established, although accounting practices to value concept ownership are still developing. Trademarks, brands and copyright have for sometime provided commercial rights to concepts. Etiquette standards provide a mechanism to enable proprietary concepts to be controlled (via the branded ID) and electronically communicated over public communications systems.

Commercial organizations always desire new ways to profit from the innovator's advantage. The commercial use of etiquettes appears to further such advantage. Etiquettes, by transporting proprietary information, support a new means to achieve monetary gain based on invention or innovation, while supporting the compatibility so necessary for public communications. The branded ID in effect becomes a new form of intellectual property, offering new ways to support private invention and yet accommodate public good in communicating systems. Patents remain a reasonable means for the inventor to achieve monetary gain based directly on the invention itself, rather than on interface compatibility.

Standards and Governments

Too often, public standards are equated with some government action. This perception is false. The lower successions of standards, symbols and measurement standards, required government involvement to achieve widespread utilization. At the next succession, the willingness to use public similarity standards was increased by the creation of patents (government sponsored incentive) to support both public usage and private gain. With patents as economic incentive, the self-reinforcing effects of interchangeability allow market forces to dominate. Government involvement in similarity standards has only continued for restraint of trade enforcement, the use of standards for international trade, and for issues of public safety. The pattern continues with compatibility standards. Once the government has required compatible interfaces to public utilities (e.g., FCC Part 68), the self-reinforcing effects made possible by compatibility standards again allow the market forces to take over. Then government involvement in compatibility standards can focus on public policy issues such as pornography, security and privacy.

The concept of adaptability standards is very new and not widely understood. Government intervention may be required to initiate the acceptance of adaptability standards as occurred with measurement, similarity and compatibility standards before. However the forms of government intervention implemented previously, including patents and regulated utilities, introduced innovative forms of credit creation. Possibly requiring market dominant organizations to implement adaptability standards, which support new forms of credit creation, could be of greater public good than, as example, a breakup of Microsoft or large PT&Ts.

Standards Development and Market Model

Technology drives the technical development process. The model in Figure 1, below, pictorially associates standards development with the development sphere. Product or service developments, innovation or invention, are brought to market and the self-reinforcement effects are shown as feedback loops. This model is the same for each era shown in Table 1. The paradigm shift that occurs at the beginning of each era is the result of the increased self-reinforcement of the new innovation made possible by the new technology and succession of standards and caused by a new form of credit creation.

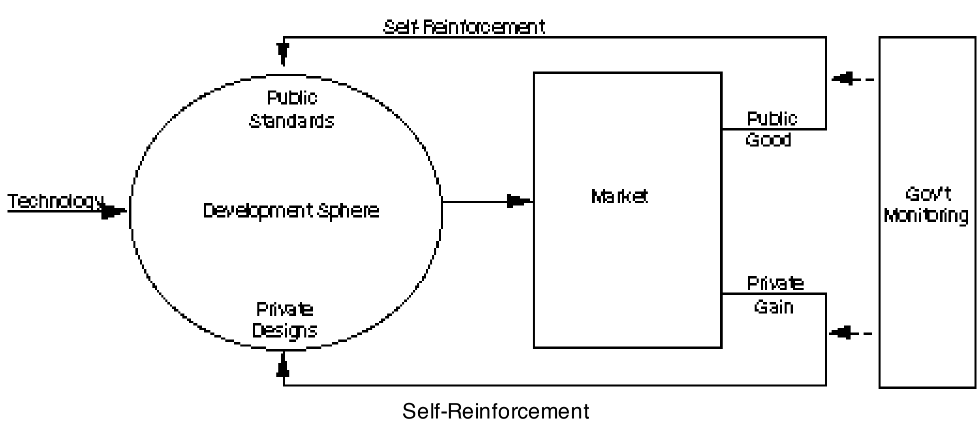

Figure 1. Standards Development and Market Model

If private companies envision an advantage they will develop and deploy private specifications, just as the 19th century railroad barons did. Self-reinforcement can promote both private designs and public standardization. Self-reinforcement is based on the understanding that greater use of a technical development promotes yet further use. In addition, the success of a private specification will promote interest in developing yet other private specifications, just as the success of public standards will promote interest in developing yet other public standards. This is why governments often strive to promote specific public standards.

The feedback relationship between public good and public standards or private gain and private designs should not be considered fixed. In limited cases private gain is best served by public standards, e.g., when a patent provides private control of a public standard. And public good is often initially best served by a private design, e.g., when a new innovation is introduced. If the innovation then achieves market dominance, a public standard becomes important for public good.

The development sphere (public and private technical development) ranges from single company private designs (specifications) to world-wide public standards, and every imaginable government development, consortium and forum in between. Commercial organizations will attempt the standardization procedure, if any, that appears to offer the least risk and greatest rewards (in that order) as standardization is often not considered an intrinsic part of the development process. Wiser governments will monitor the markets response and, when necessary, attempt to maximize public good while maintaining ample private incentive. The long term trend seems clear, government intervention in this model is needed less and less as each paradigm shift increases the opportunities for entrepreneurs to achieve private gain with less compromise of the public good.

Conclusions

Schumpeter's waves of innovation flow from new industries built upon new technologies. As Schumpeter explained (1954), new credit creation occurs to support the development of the new industry. Adding the concepts of economic self-reinforcement from Arthur (1988) and the expanding on the taxonomy of standards from David (1987), technical standards can be seen as an intrinsic part of the linkage between technology, credit creation and innovation. By supporting the balance of private gain with public good, each succession of technical standards brings with it a new form of credit creation that provides new funds for the development of the emerging technologies. In the current era, adaptability standards support a new form of credit creation, concept ownership, by enabling the transport of branded IDs with proprietary enhancements. Specific etiquettes, when implemented by communications product and service developers and their distribution partners, allow for future change, development and transformation while minimizing disruptions caused by incompatibility.

Understanding that standards mark the course of economic progress leads to a deeper knowledge of both. Standards, a vast similitude, have emerged as a multi-disciplinary field of considerable excitement. "This vast similitude spans them, and always has spanned, and shall forever span them, and compactly hold them" (Whitman).

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Footnotes

[1] This paper is a revised version of a paper presented at the International J.A. Schumpeter Society Economics Conference, June 28 - July 1, 2000, Manchester, England. Return to text

[2]A technical standard codifies for a society the constraints upon one or more implementations. Return to text

[3] The paradigm shifting innovations enhancing human communications are shown. Return to text

[4] The code of Hammurabi (circa 1700 BCE) makes frequent reference to minas, shekels and talents which were used as units of both weight and monetary exchange (Brooks 1976). Return to text

[5] "The rise of the machine industry, which we associate with the so-called Industrial Revolution (1760 - 1830), was made possible, technically, by the existence of a vast number of standards..." *Industrial Standardization*, National Industrial Conference Board, Inc., New York, 1929. Return to text

[6] The industrial revolution has many fathers. E. Whitney is generally credited with introducing the “American system” of production with interchangeable parts in 1798 (Fleck 1958). In fact, Thomas Jefferson paid a visit to the French gunsmith Le Blanc in 1785 and reported on similar methods (Gilbert 1958, p. 437). Return to text

[7] In 1841 Sir Joseph Whitworth proposed a standard for screw threads in a paper to the Institution of Civil Engineers in England . He also was a major proponent of the early technology of accurate measurement which is required to verify conformance to standards or specifications (Gilbert 1958, p. 433). Return to text

[8] Patents are authorized in the US Constitution Art. 1 Sec.8. The first US patent bill was enacted in 1790. The US Patent Office was created in 1836. Return to text

[9] An early public digital interface was the RS-232 serial interface first standardized by the Electronic Industries Association, May, 1960. The RS-232 interface was often used to connect IBM computing equipment to AT&T data communications systems. Return to text

[10] Communications services evidence coordinating effects: one type of self-reinforcing effect based on the user advantages gained when more users have the same service (Arthur 1988). Return to text

[11] Nokia of Finland is now a larger provider of cellular telephones than Motorola, the largest US cellular telephone provider. Return to text

[12] Identifying information sequences in use today include brands, trademarks, copyright statements, Internet domain names, and ASCAP (American Society of Composers, Authors and Publishers) requirements. Using a branded ID to control ownership is supported by legal precedent. Return to text

[13] By 1933, public utilities (including transportation) represented 40% of the total assets, and the largest single group, of US corporations with assets over $50 million (Barnes 1947). Return to text

[14] Richard Ely (Ely 1887) coined the phrase "natural monopoly." He refers to the earlier work of T.H. Farrer, *The State in its Relation to Trade*, 1883, for a description of the five characteristics of natural monopolies. Return to text

[15] The unique and specific arrangements are the forerunners of compatibility specifications. Return to text

[16] This paper focuses on "fluid" utility systems, as distinct from transportation or other industries that have been regulated, because they evidence more significant "unique and specific arrangements" (compatibility

standards and specifications). Return to text

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