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INDUSTRY STRUCTURES AND STANDARDIZATION

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Joseph Farrell - GTE Labs

Farrell discussed the economic issues in standardization drawing primarily from the work done by Garth Saloner(MIT) and himself. He stated that the subject of standardization is a new one for economists and at present it is gaining in importance. He said that economists take a technically naive view of standardization in terms of compatibility. i.e. they usually think of something being compatible or not. He then gave examples of things that are or have been standardized namely - screw threads, sound reproduction(speed), railroad gauges, telephone transmission, computer architecture, and disk drives. Farrell divided the reasons for standardization into three classes. First, direct network externalities(e.g. telephone system), second, complementary input(e.g. PC software), and third, transferable skills(e.g. typewriter keyboard). He said that the reason for standardization is contrary to the normal story in economics, which says that everything gets more expensive, more difficult etc, 'on the margin'. However, in standardization the picture is completely opposite - there is an increase in returns due to fundamental economies of scale. Dealing with the question of whether we should standardize or not, he said that the most obvious reason why standardization might be a bad idea, is that of variety tradeoff - the result is that there will be a conflict between the benefits of standardization and the benefits of variety. Another issue is that of product enhancement via standardization. This is true in the case of a smaller competitor who benefits from standardization (the smaller competitor's customer will benefit more by standardization from the larger competitor than the other way around). He also mentioned head-on competition which is brought about by the absence of standardization where the 'winner-takes-all'. In this situation standardization may neither reduce nor increase competition, but replace one form of competition with another. Lastly, he said, related to the question of whether to standardize is the issue of coordination, where problems arise because the market does not fix on one particular standard.

Farrell then discussed the issue of "switching standards", which he said was of great interest to economists studying standardization. In the area of telecommunications and computers, rapid technological development could in some instances be stifled by standards. The reasons for standardization retarding innovation he grouped into two categories: a) coordination and communication problems, b) installed-base problems. Under the coordination and communication issue, Farrell discussed the choices made by various agents deciding whether to stay with an old standard or switch to a new one. He stated that choices are made in sequence and payoffs depend on who eventually switches. In this context he suggested a theorem that states - "if (i) preferences are

identical, (ii) that is public knowledge, then the unique perfect equilibrium is efficient". He said that in this simple case there is no excess inertia; standardization does not inefficiently retard innovation. This result he said, surprised them. However, if there is a conflict (people's preferences are not identical) you don't necessarily get the efficient result. In fact, if there is a conflict "early movers have power". A further modification to the theorem is, what happens to people's preferences if there is uncertainty? In this situation there is an inefficient outcome which cannot be resolved simply by communication. What happens is that everybody holds back not knowing whether they will be followed. Installed-base problems on the other hand are related Farrell said, to the timing of a switch. Adoption of a new standard occurs gradually and payoffs also flow in over time. He said that the early adopters of new technology bear a disproportionate cost of transient incompatibility. If however the new technology is adopted, the installed-base can lead to excess momentum.

In closing, Farrell discussed the timing of initial adoption of standards. i.e. current benefits of standardization versus the benefits of waiting and gathering more information. He pointed out that while early standardization may lock us in (excess inertia), the individual choice to "go with the current crowd" has costs in future flexibility. Therefore, there is reason to expect that decentralized standard formation will lead to premature standardization. There are also some reasons he said, to expect the opposite.

Marvin Sirbu - Carnegie-Mellon University

Sirbu began by discussing the definition of standards. He said that a standard could vary between formal standards set by international organizations such as the CCITT and de facto standards such as the IBM PC. However, he stressed that standardization is really a process and not a document of specifications - a set of behaviors of vendors agreeing to manufacture products that work with each. A standard can be developed in an informal manner or it can follow a very formal process. Sirbu focussed his attention on the compatibility issues related to standards. In addition he said, standards are used for variety reduction (thereby improving efficiencies in for example inventory policies), improving the quality of performance (e.g. pollution standards), and information (e.g. color coding on resistors). He then briefly discussed the various benefits and disadvantages of standards.

BENEFITS - 1) More selection among suppliers(advantage for buyer)
2) Lower production costs
3) Reduced translation costs
4) Increased market size

5) Reduced inventory costs
6) Lower entry costs
7) Lower investment risk

DISADVANTAGES - 1) More selection among suppliers(disadvantage for supplier)
2) Inhibits innovation
3) Lose economies of specialization

Sirbu spoke about information technology standards in the light of the compatibility issue. He said that the first difficulty is that specifications in this area are very complex. Also, he stated that the technology and/or markets are not properly understood at the early stage when people attempt to,establish standards; it takes a long time for people to get sufficiently educated to enable them make useful comparisons. As a result, people come to the standards process with very different perceptions - perceptions of the problem to be resolved and the nature of the technology. Further, since the new technology is being developed it is a kind of 'moving target' for which it is difficult to establish a standard. Unlike software (where standards may not be very stable), in the case of hardware it is much more difficult to change a standard once it is established.

Talking about the wide variety of people responsible for establishing formal standards in the information industry, Sirbu listed the following groups:

- International Telecommunications Union(ITU), now associated with the UN. The CCITT is one arm of the ITU.
- International Standards Organization (ISO)
- National standards bodies (e.g. American National Standards Institute, British Standards Institute)
- Trade associations (e.g. Electronic Industry Association)
- Professional organizations(e.g. IFIP, IEEE)

He also added that the type of membership and voting procedure influenced the standards set by each of the above groups.

The process of developing a standard begins with the concept stage and is followed by service specifications (Is a communication standard going to be optimized for interactive communication or bulk file transfer). Based on the service specifications a document is written which is the formal technical standard (protocol). All of the detailed syntax is part of the protocol document and the document usually contains a variety of options. At this point the users or government bodies study the various options, limit their number and specify parameters that may have been left unspecified thus producing what Sirou called a 'reference guide'. The reference guides are used by vendors to guide product manufacture. The ultimate verification of the standard is ascertained by the successful conformance testing of products manufactured by the vendors. Sirbu pointed out that increasingly standards have been developed

before market use begins.

Sirbu presented a four cell model (see figure 1), according to buyer and manufacturer decision coordination. The model describes two products that work together from the point-of-view of the type of buyer(related or unrelated), and the type of manufacturer(centralized of decentralized). He then pointed out that the products in the lower row(unrelated buyers) almost always have standards unlike the upper row(related buyers). In order to show the above theory at work in practice, Sirbu considered the example of modems(see figure 2). Modems were used because they have the same group of manufacturers, the same kind of companies involved in buying the product, and the only difference is that in some cases modems are bought by related buyers while in others by unrelated buyers. He pointed out that modems have two types of standards - the de facto standard set by AT&T and the more formal standard developed by CCITT. These standards exist for the various modems in markets described in figure 2. At times the AT&T and CCITT standards are the same, in other cases it is completely different(see figure 3). Having noted where there were standards (de facto or formal), he went on to examine the market for each product to see whether it was standardized (i.e. where vendors in the market sell 90% of their product compatible with the standard). The results of the analysis are given in figure 4, and its success indicates that the model is a useful way of describing situations in which standards will be developed.

In closing, Sirbu referred to Oliver Williamson's book 'Markets & Hierarchy' and briefly discussed the bargaining problem faced by two firms, regarding a mutually beneficial investment("standards and small numbers bargaining"). The problem, he said, is heightened if the investment is specific - to manufacture products for the other company. Uncertainty makes contingent contracting difficult and the contract will have a high risk premium written into it. He concluded that standards therefore reduce asset specificity.

SPEAKER'S COMMENTS AND RESPONSES TO QUESTIONS

A question was raised as to whether users themselves have at any stage demanded a standard. Farrell responded saying that the US government has been quite interested in standards in the past and more recently the Defense Department. He said that users have often got to "shout to get standards". They have either got to get organized or have to get a hold of a large user like the government, in order to force the establishing of standards. Sirbu pointed out that from the vendor's standpoint, whether he wants to standardize of not will be based on his relative market size and market desires. At present, he said, there are situations where standards are being developed in advance of products.

Responding to a question about whether standards encourage or discourage new entrants to a market, Sirou mentioned that it clearly does encourage new entrants. As an example he cited Hewlett Packard's development of an instrument bus standard in 1972. The recommended standard was accepted in 1974 by the IEEE and improved in 1975. By 1977, he said, there were 300 different products compatible with the IEEE 488 interface bus introduced to the market by 100 manufacturing concerns. Farrell said that another supporting argument is that when there are network externalities it is better to have more people using a system (similar to supply side economies of scale).

Farrell responding to a question about the economic implications of standardization, mentioned that because of demand side economies of scale the failure to standardize causes monopolies.

A query was raised as to whether the cost of translation was higher in the long-run than standardization and Sirou said that the translation cost varies from one setting to another. Farrell added that just because the cost of translation becomes lower it does not mean that the incentive for standards will also be reduced.

Buyer and Manufacturer Decision Coordination

	Centralized Manufacture		Decentralized Manufacture
	Peer to Peer	Interface	Interface
Related Buyers	Short Haul Modems Line Drivers Intra-corporate electronic mail streamer backup tape	(IBM) computers and disk drives CPU and Operating system software	Modems and terminals PBX and CPU (USA) LAN Dolby noise reduction Operating systems and application software
Unrelated Buyers	Dial-up modems Telecopiers Telex ASCII transfer tape	(ATT) CPE and central office VAN interfaces	TV Broadcasting X.25 PBX and CPU (Europe) Open Systems Interconnection

Figure 1

MODEM CLASSES

CLASS I: CENTRALIZED BUYERS

Leased-Line, Multipoint Modems

2400 bps
4800 bps
9600 bps

Short Haul Modems

Up to 19.2 Kbps, asynchronous
Up to 19.2 Kbps, synchronous
Over 19.2 Kbps, synchronous

Line Drivers

Up to 19.2 Kbps
Over 19.2 Kbps

CLASS II: UNRELATED BUYERS

Half-Duplex, Dial-up Modems

1200 bps
2400 bps
4800 bps
9600 bps

Full-Duplex, Dial-up Modems

300 bps
1200 bps
2400 bps
4800 bps
9600 bps

CLASS III: MIXED BUYERS

Leased-Line, Point-to-Point Modems

1200 bps
2400 bps
4800 bps
9600 bps
14.4 Kbps
16.0 Kbps
19.2 Kbps

Figure 2

MODEM STANDARDS

MODEM	AT&T	CCITT	AT&T AND CCITT COMPATIBILITY
300 2W FD	103J/113D	V.21	Incompatible
1200 2W HD	202S	V.23	Different reverse channel and slighty different frequencies, but may interwork
1200 4W FD	202T		
1200 2W FD	212A	V.22	212A is subset of V.22. Different fallback
2400 2W HD	201C	V.26 *bis*	Compatible
2400 4W FD	201C	V.26	Compatible
2400 2W FD	2224	V.22 *bis*/V.26 *ter*	AT&T based on V.22 *bis*. Different fallback
4800 2W HD	208B	V.27 *ter*	Incompatible
4800 4W FD	208A	V.27/V.27 *bis*	Incompatible
4800 2W FD	N/A	V.32	N/A
9600 4W FD	209	V.29	Incompatible
9600 2W FD	N/A	V.32	N/A

Figure 3

STANDARDIZATION BY MODEM CLASS

Category	Number of Cases	Cases with one Dominant Standard in U.S.		Cases in which CCITT Recommendation Exists	
		Number	Percentage	Number	Percentage
SINGLE BUYERS					
Short Haul	3	0	0	0	0
Line Drivers	2	0	0	0	0
Leased Multipoint	3	0	0	0	0
Total	8	0	0	0	0
MULTIPLE BUYERS					
Half-Duplex Dial-Up	4	3	75	3	75
Full-Duplex Dial-Up	5	3 *	60	5	100
Total	9	6	67	8	89
MIXED BUYERS					
Leased Point-To-Point	7	3	43	3	43

* Full-duplex, dial-up modems at 4800 bps and 9600 bps have not yet appeared on the market except for three manufaturers with non-standard products at 4800 bps (Anderson-Jacobson, Nokia and TRT)

Figure 4