THE CENTER FOR THE STUDY
OF INDUSTRIAL ORGANIZATION
AT NORTHWESTERN UNIVERSITY

Working Paper #0056

Coordination Costs and Standard Setting: Lessons from 56K Modems*

By

Shane Greenstein
Northwestern University

and

Marc Rysman
Boston University

December, 2004.

* The authors thank Angelique Augereau, Joe Farrell, Tim Feddersen, Alicia Shems, Victor Stango, and many seminar participants for useful remarks on our studies of the 56K modem market. We thank Bill McCarthy, Simoa Campus, Ken Kretschmer, Michael Seedman, and Richard Stuart for sharing their observations about events in this market. Rysman acknowledges the support of NSF grant SES-0112527. All errors are ours alone.

Abstract

The authors offer a detailed analysis of the coordination costs behind the standardization of 56K modems. They focus primarily on market events and standard-setting activities during early deployment. They argue that the canonical model for a standards war is misleading in the case of 56K. They present alternative questions than the model's and examine different views on how market events during deployment influenced negotiations within the International Telecommunications Union and vice versa.

INTRODUCTION

We offer a detailed analysis of the coordination costs behind the standardization of 56K modems. Although the canonical model of a standards war could be applied to the case of 56K modems, we argue here that the model is misleading and instead offer up alternative questions for understanding how market events during deployment influenced negotiations and vice versa.

There are three phases to a canonical model of a standards war: First, an economic opportunity arises from a technical upgrade. Second, competition develops between different implementations of that upgrade. Third, resolution of the conflict occurs when one of the implementations wins in a competitive market or a publicly spirited standard-setting organization (SSO) becomes involved in resolving the conflict (For a review, see e.g., Stango, 2004, or Farrell, 1996). There are extensive cases studies describing a variety of ways for winning a competitive war between fixed specifications. There are also a variety of reasons why an SSO chooses to make a specification a focal point[1] for further development (see, e.g., Chapter 8 of Shapiro and Varian, 1999).

On the surface, parallels to the canonical model can be seen in the 56K modem standards war. It did involve a fight between two seemingly symmetric network technologies, each of which provided a possible specification for improving modem speeds beyond 33K. Two large camps of firms formed around each specification, even though service providers and users would have benefited from a single standard from the outset. Eventually, an SSO, the International Telecommunications Union (ITU), intervened with a new standard specification that gained widespread popularity and settled the war. This intervention was useful in that the market appeared to grow rapidly afterwards.

---

[1] A focal point is a specific option or characteristic that all the major players choose even when there are several other feasible and plausible options.

Despite these parallels, we argue that the canonical model is misleading for 56K modems. We support this argument with a detailed study of the standardization process. For the case of the 56K, outsiders have access to adequate, though not excessive, documentation of key events, such as interviews and industry reports in trade magazines, as well as statistical information about deployment prior to the standard's emergence. We exploit this detail by using an eclectic mix of methodologies, weaving together "case study" evidence, interviews with industry participants, interpretations offered by second-hand sources, and novel statistics.

Our methodology and data leads us to differentiate the 56K standards war from the canonical model. We highlight four contrasts. First, in a canonical model, each party thinks it can win the standards war. With 56K modems, neither camp of firms thought it could win the war on its own. In actuality, neither one did. Second, in the canonical model the designs sponsored by alternative camps are fixed. With 56K modems an alternative specification became the standard. Third, in the canonical model design and competition occur in sequence. In contrast in 56K modems, design, negotiation and the market process occurred concurrently and over time rather than in some simple ordering. Finally, the canonical model treats standards as arbitrary focal points and either does not look at their origins or has a superficial description of their origins. With the case of 56K modems, creating a focal point at the ITU was extremely costly. These fundamental differences in perspective and behavior from the canonical model lead us to pose alternative questions than the model's and, as a result, examine different views on how market events during deployment influenced negotiations with the ITU and vice versa.

We begin by focusing on understanding the factors that shape the costs of coordinating on a new standard—specifically on economic factors that shaped deployment prior to February 1998 when the V.90 standard emerged. The costs of coordination were primarily borne during the early deployment of the 56K modem, a period when users could ostensibly choose between two competing specifications, X2 and Flex. An important feature of the modem market was that consumers only signed with an Internet service provider (ISP) within their local calling area.

Hence, competition occurred in distinct local markets, and decision making was fragmented. As a result, we can do statistical analysis normally not available in other examples of technology deployment. Borrowing from our companion paper, Augereau, Greenstein, and Rysman (2004, hereafter AGR), we show that ISPs tended to split across X2 and Flex—not only nationally but also within local markets. While the network features of the product created incentives to coordinate on a single standard, local competition created great pressure to differentiate across the technologies.

We next trace the relationship between early deployment and negotiations within the ITU, for which there are several competing interpretations. We interpret this process as the the cost of creating a focal point and pay special attention to the of role intellectual property (IP). To be sure, we could also focus on why the ITU's intervention was beneficial, but as there is little dispute that the benefits were large, that insight is not particularly novel. More interesting, we highlight two common and sharply contrasting views about the relationship between deployment and negotiations. One view emphasizes the way in which market events strongly shape negotiations. The other view argues that decisions were based on engineering choices, not on business incentives. We argue for a middle ground between these two views.

Events of this case illustrate how some aspects of firm participation inside the SSO varied with market circumstances and IP holdings, while other aspects did not. The situation compelled participation and managerial attention of all interested parties, but each came to the SSO with asymmetric negotiating positions. We argue that had positions been different then behavior would also have been different, namely, behavior would have been less urgent or more urgent, and more inclined towards compromise or less inclined.

Our study adds to the comparatively small number of close economic studies of standards wars. (See Stango (2004) for a review of the literature on such wars.) As with other studies in this vein, we identify conundrums for the canon by analyzing important aspects of these events that either fit or do not fit canonical models. Shapiro and Varian (1999, Chapter 8) include a brief

summary of announcement by firms in different camps of the 56K modem war as of the end of 1997. We also offer evidence on facets of behavior where previous research is incomplete. We analyze how deployment activity shaped the incentives of parties in negotiations and how the negotiations in the ITU shaped behavior and outcomes. Understanding the parties' asymmetric positions and their relationship to deployment is crucial, we argue, for understanding the behavior and outcomes in this particular standards war, as well as in other standards wars.

We now provide a short literature review of related studies. In the following section, we provide an outline of the industry and setting. We then pose alternative questions and analyses than those to which the canonical model points. In answering these questions and conundrums, we examine different views on how market event shaped negotiations and suggest that each view is incomplete. We then offer an alternative analysis of the case of the 56K standards war.

Our study follows in the spirit of several rich analyses of the role of standards during the diffusion of new communications technology, such as Besen and Johnson's (1986) study of FM radio and color television and Farrell and Shapiro's (1992) rich study of the standards war leading to the specification for HDTV in the United States. Our setting differs because standard setting takes place in an SSO, not under the auspices of a regulator that can mandate standards, such as the Federal Communication Commission (FCC). Standard setting in an SSO requires a different framework, one that understands the factors shaping the negotiation between firms.

Our emphasis also bears resemblance Von Burg's (2001) study of the multiple implementations of the Ethernet, and Dranove and Gandal's (2003) study of the DVD/DiVX war. There are key differences in our study from the previous ones. In both previous studies, market events determined the choice between alternative specifications, each of which had its commercial sponsors. In Von burg's study of the Ethernet, three specifications competed in the marketplace and an SSO endorsed all three, whereas in our study we examine how an alternative standard, the V.90, arose at the ITU to replace the two competing specifications, X2 and Flex. In Dranove and Gandal's study, there were two technically different formats competing, as

compared to the two similar formats competing in our study; and one of those specifications quickly failed in the marketplace. Also, in the DVD/DiVX war, firms tried to bypass the SSO, whereas with X2 and Flex, firms believed that working with the SSO was an inevitable eventuality. Thus, our study of the ways companies worked with SSOs as they competed with each other and the relationship between SSOs and companies is based in different market circumstances. As a result, we highlight a different set of relationships between deployment and negotiations at the SSO. This leads to a very different set of insights about the costs of coordination.

B. INDUSTRY AND SETTING[2]

The broad outline of events is not in dispute. Before 1997, the fastest available modem speed was 33K. In early 1997, competing consortiums introduced two types of 56K modems almost simultaneously, X2 and Flex. Although their technical proficiency was identical in that they had the same performance characteristics, they were incompatible, because if a consumer chose a different modem than his or her ISP used, then the consumer was reduced to speeds of 33K or worse. These products exhibited network effects in the sense that when more consumers picked a modem, more ISPs would be attracted to it and the ensuing competition would lead to cheaper, better, and more reliable service for the consumer. Nevertheless, sales in the first year went much slower than the two sides had hoped.

In February 1998, ongoing negotiations between the industry participants at the ITU led to the ratification of a new standard, the V.90. It was incompatible with both of the previous technologies without a proper upgrade of equipment. The V.90 gained almost immediate widespread acceptance, and sales of modems to both ISPs and consumers grew rapidly.

---

[2] A more in-depth discussion of these issues can be found in Rickard's (1997a, 1997b, 1998) studies.

We now explain the details behind the broad outline of events. A modem allows a computer to send and receive data over a telephone line. The speed at which a modem can down- and upload data is measured in bits per second (bps), so a 33.6K modem can send and receive 33.6 kilobits (33,600 bits) of data every second. In the early days of the Internet, modem users typically dialed a telephone number that connected them directly to the computer with which they wanted to exchange data. Modem users could only connect to computers that also maintained modems. Numerous *bulletin boards* sprang up devoted to a wide variety of issues, where readers could post questions and comments. Most exchanges were in "character mode," which used very little memory, so modem speed was not an important issue.

Two changes occurred in the mid-1990s. The first was the rise of ISPs, which allowed users to dial a single number and connect to any computer on the Internet. This meant that only computers associated with ISPs had to maintain modem banks to receive phone calls. Although ISPs charged a fee, consumers often gained because they could access the entire Internet through a local telephone call.[3] Many bulletin board moderators transformed into ISPs as they already had the basic technology (banks of modems) to do so. This led to a very unconcentrated industry. In 1997, about 93% of the U.S. population had access to a commercial ISP by a local phone call (Downes and Greenstein, 1999). An important feature of concentrating modem usage at ISPs was that ISPs often found it worthwhile to invest in digital connections to the local telephone company switch, which meant that ISPs had fast, high-volume connections to the Internet.

A second change in the mid-1990s was the rise of the World Wide Web. The Web provided a protocol for transferring data over the Internet, which allowed for the widespread use of graphics and digital photographs. This change greatly enhanced both the demand for Internet access and the importance of consumer connection speed.

---

[3] The ISPs also offered e-mail accounts and access to the World Wide Web.

These two changes made 56K a potentially valuable technology. Up until early 1997, 33.6K modems were the fastest available for use with analog telephone lines. Rockwell Semiconductor was practically a monopolist (over 80% market share) in the production of modem chipsets, or the internal hardware of a modem. They licensed their technology to over 100 resellers that produced modems under different names. The most successful of these was U.S. Robotics, with about a 40% market share in retail modem sales.

The adoption of digital circuitry between ISPs and the telephone companies allowed for the elimination of one analog-to-digital transformation, which allowed for theoretical modem speeds of up to 56K. U.S. Robotics recognized this possibility first and began work on their X2 modem.[4] Worried that they would be closed from this new market, Rockwell quickly began work on their own 56K modem. After joining with Motorola and Lucent in this endeavor, their product was called K56Flex, or Flex. Due to setbacks at U.S. Robotics and a remarkable production run at Rockwell, both brought their product to market at essentially the same time, February 1997. Some product reviews suggest there were problems with Flex up until July. It is clear from contemporary reports that within 6 months the two technologies worked equally well, though there could be variability between them depending on local connection characteristics.

The cost of the new modems depended on the purchaser. Modems for consumers were initially priced at around $200, as compared to $100 for 33K modems. For ISPs, the conversion depended on their technology. Since the 1980s, the entire telephone network was being gradually upgraded to a digital system. If an ISP was in an area that had been fully upgraded, it could offer 56K by simply buying a few consumer-grade 56K modems. If an ISP's connection to the telephone network had not been upgraded, it would have to invest in T1 lines or ISDN lines, which represent high-quality digital connections to the Internet.

---

[4] Much of the market was at 28K, which used the same basic technology as 33K, and 56 = 28 × *2:* Hence the name *X2*.

Because racks of consumer modems had high maintenance and administrative costs, they were an inefficient way to offer 56K to more than a few customers. As a result, ISPs tended to invest in a Remote Access Server, a large server that came equipped with high-quality modems and required T1 lines or ISDN lines. For instance, in March 1997, U.S. Robotics sold the Total Control Network Hub that connected forty-eight ports to two T1 lines for $44,126, or $919.29 per port.[5]

The price per port could be driven down to around $500 for larger servers. Digital lines such as T1 lines had installation costs around $2000. Monthly charges for digital lines were around $50 per port, as opposed to $20 or $30 for analog lines. Note that many ISPs had already invested in Remote Access Servers and T1 or ISDN lines, as they were also an efficient way to handle 33K modems. The ISPs could simply upgrade their server. Doing so cost $50 to $100 per port and was sometimes offered for free as the standards battle intensified. The ability to upgrade depended on the server—U.S. Robotics servers could be upgraded only to X2, most other servers could be upgraded only to Flex. The result was that upgrade costs were much higher for some ISPs than for others.

The Development of the V.90 Standard

Throughout this time period, there were deliberations over standard setting at the Telecommunications Industry Association (TIA) and the ITU. The TIA is an organization of private firms in the United States, and it has representation at the ITU. The ITU is an organization of the United Nations, which sets standards for telecommunication issues under its ITU-T branch. Typically, negotiations on a standard start at the TIA and then are moved to the

[5] Each connecting consumer requires one port. Because consumers do not all connect at once, ISPs typically required one port for every three or four consumers. The number of ports that a typical ISP maintained at a given point-of-presence ranged from fifty to many thousands.

ITU. Negotiations may simultaneously continue at the TIA, as they did to some extent in this example.

The ITU-T has both government and "sector" members. Sector members are typically private firms. Currently, ITU-T has 189 member states and more than 650 sector members, 128 from the United States. The Department of State, the Department of Commerce and the FCC represent the U.S. Government. A sector membership costs between $20,000 and $50,000 annually and, for U.S. companies, requires approval by the Department of State. All members may participate in any working group, such as Study Group 16, which handled the 56K modems. The negotiation is based on submissions, typically proposals for the potential standard, along with documentation of technical characteristics and possibly performance data. The ITU requires a consensus vote to approve a standard.

The ITU was holding meetings with industry participants as early as November 1996 and claimed that it would announce a standard for 56K modems about two years after the introduction of the modem. It is important to keep in mind several points when evaluating the progress of the market during ITU negotiations. First, it is not clear how credible the ITU's scheduling claims were. Two years would be very quick relative to previous ITU decisions. Farrell (1996) reports that similar organizations delivered standards in five years, on average. Second, the ITU had no enforcement power in this case; it served only to create a focal point.[6] In theory, if one technology could emerge as the market standard, the ITU's decision might not matter. Therefore, it was crucial that all the major players chose to support and participate in creating the ITU's standard even when other specifications (their own) were available.

Our evidence below suggests that market participants did not believe it was a realistic for one of the pre-existing specifications to win in the market. Nevertheless, even two years was

[6] With some technologies, the ITU can compel member governments to use approved technologies in government contracts (but even this relies on the United Nations' enforcement power). But in this industry, the ITU has no enforcement power.

considered a long time in this industry, so that may explain why it appears that the technology sponsors seemed to compete as if they were trying to win a standards war, as opposed to waiting for the ITU decision. Certainly, if the ITU decision dragged on for years, as it had with some other standards, then competing vigorously was the only sensible strategy.

As it turned out, 56K modem sales to ISPs went very slowly relative to what the market could have supported.[7] Barely 50% of ISP' adopted 56K by October 1997, with almost none of the large ISPs (AOL, AT&T, UUNET, MSN, GTE, Bell-South, EarthLink) adopting. Although there is some evidence that X2 sales were greater than Flex sales, most evidence suggests that sales to consumers were relatively low (We present more evidence of this below). Rockwell and U.S. Robotics felt that the source of these problems was the standards battle.

With strong industry support, the ITU announced the V.90 standard, an amalgam of X2 and Flex, in February 1998. At the time, this was regarded as the fastest the ITU had ever reached a decision (ITU Press and Public Information Service 1998). Although the V.90 was incompatible with either of the previous two standards, sales were strong and there was widespread adoption by both ISPs and consumers.

In summary, the events of this case appear to have all the elements of a canonical standards war. There was an economic opportunity arising from a technical upgrade of modems, and all parties believed this opportunity would be valuable for users and vendors. There was a conflict between different implementations of that upgrade, but these implementations did not appear to be technically or functionally different from each other. A publicly spirited SSO became involved and promulgated a specification for a new specification as standard, apparently to the benefit of all parties and users. Nevertheless, as we argue in the subsequent section, several

[7] A descriptive article on the ITU web site contains quotes from industry experts such as: "The market was drying up. … people had stopped buying 56K modems;" and "A split was there for a short time" (ITU Press and Public Information Service 1998).

questions and conundrums arise that the canonical model does not address. These issues are important for understanding how market events affected negotiations and vice versa.

C. QUESTIONS AND CONUNDRUMS

In this section, we use the events surrounding the deployment of the 56K standard to illustrate broad principles about standardization processes. Our analysis stresses why in this instance a canonical model of the standards war is misleading or at least underspecified. We explore different approaches for characterizing standardization processes and stress the role of deployment. We develop quantitative and qualitative evidence about the interaction between deployment and the standardization process at the ITU. Much of this is based on interviews with market participants. Specifically, we discuss the following nine conundrums and questions:

1. Did ISPs have incentives to coordinate?
2. What incentives to coordinate did the modem makers have?
3. Why are focal points with 56K so costly?
4. How do intellectual property conflicts shape the costs of negotiation?
5. How does the voting structure and rules at the SSO shape the costs of coordination?
6. Why do SSOs not encourage the use of side payments?
7. Does standardization lead to technical improvement?
8. How do participants in standard-setting processes use all the available information?
9. Are SSOs substitutes for each other?

Our analysis of deployment shows why the product's network features created incentives to coordinate on a single standard, but local competition created great pressure to differentiate across the technologies. In addition, we stress that it is not possible to understand the behavior of market participants without understanding their asymmetric market positions and the negotiation process. The interaction of these asymmetries and negotiations receives the most attention in our study, especially as we identify and characterize different common viewpoints. We ultimately

argue that had positions been different, then behavior would also have been different, that is, less urgent or more urgent, and more inclined towards compromise or less inclined.

Readers should keep in mind that our analysis is necessarily speculative, and the methodology must rely on our interpretation of a relatively small number of interviews and articles in the trade press. Most lessons are not "proven" in the sense of statistical analysis or mathematical proof. We also identify places where questions are open because we cannot "test" between differing claims and interpretations for what occurred in the 56K market. With that caveat in mind, we turn to the results from our case study of the 56K modem market.

1. Did Internet Service Providers have incentives to coordinate?

The ISPs that adopted 56K modems before the V.90 was available made a choice between one of two existing technologies. Similar to the standard models of network effects, they had an incentive to coordinate on the same technologies as their rivals, which would raise the possibility that they were using the technology that ultimately would become the market standard. However, ISPs had a countervailing incentive. They could adopt the technology that was less popular to take advantage of larger margins available in the admittedly smaller market.

Our companion paper, AGR, explores this issue in detail.[8] Here, however, we provide some simple statistics suggesting that ISPs preferred differentiation to coordination. In other words, we answer: No, ISPs did not have incentives to coordinate with local competitors. Building on directories of ISPs, we construct a data set on adoption decisions in October 1997, after the products were widely available but before it was clear the ITU would soon reach a decision. For 2233 ISPs, we observe their adoption decision (X2, Flex, both, or neither) as well as a list of telephone numbers that could be used to connect. Merging with a database on local

[8] In this section, we analyze deployment of 56K modem technology as of October 1997 and summarize the more extensive statistical work of AGR. Our primary purpose for showing this data is to emphasize the geographic dispersion of deployment and decision making by ISPs in the United States, which were factors in raising coordination costs.

telephone calling areas allows us to determine which consumers could call which ISPs. As consumers almost always sign up with an ISP in their local calling area, we take local calling areas as independent markets.

Several issues arose in construction of the data. First, we observe less than half of the ISPs in existence, though the ones we miss tend to be small and probably would not have adopted in any event. Second, we observe only a single decision for each firm, not what their decision was in each location. Nevertheless, our understanding is that most firms actually did make a single decision for all of their locations simultaneously. Third, some telephone switches may be part of multiple local calling areas. In these circumstances, we arbitrarily assign switches to a single local calling area. Detailed empirical models in AGR suggest that assignments do not affect the results.[9]

In Table 1, we show the adoption rates in October. By this time, only about half of the ISPs had deployed. Moreover, the vast majority of non-deploying ISPs were large, so the percentage of customers served by 56K was much lower than a half. About 8% of adopters actually adopted both technologies.

Our method creates 2,298 local calling areas. Local calling areas have relatively few firms in each one. The average number of ISPs in a calling area is fifteen with a standard deviation of 20.8. However, there are 738 calling areas with only one ISP and the median number is only three. In Table 2 we show average adoption rates by local calling area. Again, there are only a few adopters in each calling area. The average number of adopters in October 1997 is about six ISPs per calling area. Flex leads X2 when tallied by ISP (as in Table1), while X2 leads Flex when tallied by locale (as in Table 2).

To discuss local interactions, our approach here is to compare the national adoption rate with the adoption rate in each local calling area. If the rates are close to the same, it suggests that

[9] Data came from the Directory, *Boardwatch*. See Augereau, Greenstein and Rysman (2004) for a more detailed discussion of the data and a more detailed statistical analysis.

ISPs were differentiating from each other. If local markets are characterized by agglomeration on one standard or the other, it suggests network effects were important.

We look only at ISPs that adopt X2 or Flex and ignore ISPs that adopt neither or both. We look only at the 1,595 markets in which there are at least two such ISPs. Among such firms, 57.7% adopted X2. We are interested in calculating the number of markets in which adoption approximated this rate of 57.7% and term these markets *highly differentiated*. As a point of comparison, we compute what we would have expected if ISPs had made their decisions independently, with a 57.7% chance of adopting X2 and a 42.3% chance of adopting Flex.

In Table 3, we report the percentage of markets for which the adoption rate falls within a given window, where the window roughly brackets the average national adoption rate. For instance, we see in the first row that in 17% of 1,595 markets, the portion of firms adopting X2 fell between 55% and 60%. There are 13,613 separate firm-market combinations. If each one of these had adopted X2 with the probability 57.7%, we would have expected only 11% of markets to fall within this 55-60% window. The results in rows 2 and 3 tell a similar story for larger windows.

The results in Table 3 show that the number of differentiated markets is much higher than would be expected if the firms were choosing independently. In other words, contrary to what one would expect, there is no geographic clustering at a local level. In AGR, we establish the statistical significance of this result and account for numerous possible complications, such as that ISPs make only a single choice across markets, that some switches are in multiple local calling plans, that there is an impact from firm characteristics and demographic variables, and that there is possible endogeneity of ISP decision making.

When we brought up our hypothesis that ISPs competitively differentiated from each in interviews, we received mixed responses, with some subjects finding it believable while others found it implausible. We were struck that the interview subjects with a closer relationship to the

smaller ISPs found it plausible, as we believe our result is mostly driven by the smallest ISPs. No subjects provided a convincing alternative explanation for these results.

2. What incentives to coordinate did the modem makers have?

There appear to have been ample incentives to coordinate, but for different reasons than one might have expected from studying canonical models of standard setting. It is crucial to understand what issues participants considered open and what issues they considered settled. This case illustrates how participants can be both certain about some aspects of a standard and uncertain about others.

In this instance, everyone had similar expectations about participation: Market participants acted with the belief that an ITU standard eventually would emerge. The open question was when and with what features; and nobody forecast with certainty which specific proposal would emerge. Similarly, that the ITU announced the V.90 in February 1998 was widely regarded as fast by historical norms. Given that this situation was confrontational and many others at the ITU were not, this speed was viewed as sooner than the most optimistic forecast from when the process started two years earlier. Yet, no one ever doubted that such an announcement would arrive eventually.

This raises the related question about what participants expected prior to the ITU standard. Participants acted with the belief that there could be nothing more than a *temporary* de facto standard arising from the market success of one specification or the other. In other words, participants could not forecast how long the market process would continue and how it would proceed, but nobody acted as if this was the *only* possible mode for standard setting. Nor did the market process alone, or in conjunction with the TIA, provide an opportunity for standard setting equivalent to that in the ITU process.

In this light, we can guess why both parties found it in their interest to cooperate with the ITU process even though—after a short period of competition—the X2 standard seems to have had an advantage over Flex in sales and deployment. First, we consider the camp formed around the Flex specification, where the interpretation appears straightforward. The ISPs with server equipment that aligned them with Flex were suffering in the market, and the Rockwell group risked losing them as customers. Hence, the Rockwell group had a clear incentive to agree to a standard that put it on better technical footing.

More surprising, U.S. Robotics never considered ignoring an ITU standard even though it believed it was winning the standards war. The economic incentive for this stance is not transparent in retrospect. Why agree to an ITU standard and allow the Rockwell group to begin marketing substitutable products? Why abandon de facto standardization on X2 through market processes if that provides a lead and adequate profitability?

We can catalogue several related reasons. The first reason was grounded in the history of the market. The Flex group had the most established participants in the industry; Lucent, and particularly Rockwell, were dominant in the previous technology. Despite having the more dominant X2, U.S. Robotics believed that it could not standardize the worldwide market without Rockwell's participation, at least not in a reasonable time. Similarly, Rockwell and Lucent could not act unilaterally and push through their standard without consulting U.S. Robotics. The second reason strengthening the first is that U.S. Robotics believed its advantage in the pre-standard market could be maintained in the post-standard market. For instance, U.S. Robotics established a shelf-space advantage in consumer modems, which it felt had lasting power. Together, these points led U.S. Robotics to believe that the "market-growing" features of an ITU standard outweighed the competitive impact of a public standard.[10] A third reason is one of status. Because

[10] Another explanation for coordination between the U.S. Robotics and Rockwell groups is that they were participating in some sort of repeated game. Note that many features of this market are not conducive to collusion. U.S. Robotics had not produced chipsets in the past and so this was at best the beginning of a

Rockwell was historically dominant and U.S. Robotics was regarded as an upstart, agreement between the two represented a symbolic victory for U.S.R because it attained status as a major equipment manufacturer. The ITU standard-setting process ratified this status.

These observations motivate an interesting counterfactual question about how the market process shapes the ITU standard. What would have happened if Flex had been dominant in the pre-standard market? Would market participants have treated the ITU standard as inevitable in that case? Given that Rockwell would have been dominant in both the 56K technology and previous technologies, it would seem that it would be in a position to impose a proprietary standard. Our conjecture is that the Rockwell group still would have encouraged an ITU standard, but the open question is whether the standard's specification would have looked different. For example, would Rockwell's negotiators have taken a different stance in the face of IP held by others?

Such counterfactual questions are hard to resolve, by definition. It is especially difficult because the eventual standard was a combination of different specifications, a *compromise* among many. Would the combinations have differed if the market positions had been different? There are generally two views on this hypothetical question, both of which we discuss in further detail below. One conjecture is that the standards process has its own momentum and largely ignores the market position, because other issues, such as resolving conflicts over IP or the technical merits of a proposal, are paramount to the speed of the outcome and the type of specification that results. The other view is that the market position informs the urgency of all parties and contributes to a firm's willingness to compromise in specific ways. Had the market position differed, so too would have behavior at the ITU, which might have affected the eventual speed of decision making and the chosen design.

---

repeated game. Also, as new standards appear only once in a few years, there would be a long delay before the "punishment phase." Also, the next technology (broadband) was expected to be extremely different from 56K modems.

3. Why are focal points with 56K so costly?

In the canonical analysis of standards wars, focal points have a role in settling the standards battle. As options that grab the attention of all the major players, they provide a coordinating device when all parties need one. As the standard emerges, it must combine a bundle of components that must all interoperate. A standard is a public good, providing non-rivalrous information about designs to any manufacturer, resulting in a set of goods that collectively work better together than they would have in the absence of the public good.

In the canonical model of a standards war, it does not matter how focal points arise. They are typically modeled as the outcome of a "sunspot" or a "public coin-flipping." The crucial feature of a focal point is its steadfastness after it emerges. Steadfastness arises from one of several sources: strong and transparent economic incentives from key sponsors; a mandate from a government agency; the presence of difficult-to-change investments by many interested parties; and historical precedent that cannot be erased. In the standards canon, it is not essential whether arriving at that point was costly or not, only that it is difficult to change once there.

On the surface, the deployment of 56K modems fits the canon, because it illustrates why a focal point here had such benefits. Use of a focal point avoids the type of geographic fragmentation that occurs when firms are diffusing competing technological specifications. It also fits the canon in the sense that the ITU had precedent on its side and a promise to follow a predictable process in the future. It had provided industry standards for successive generations of this technology and, as we previously stated, industry participants believed that the ITU would do so again using much the same decision-making process. In addition, other buyers in other countries looked to the ITU standards before purchasing equipment, so the ITU standard potentially had a gate-keeping function as well.

But the ITU is a much more costly mechanism for negotiating a focal point than the low-cost mechanisms typically found in the theoretical models, such as sun-spots or public coin-flipping. In addition to the membership costs previously detailed, participation requires sending delegations to meetings that take place throughout the United States and Canada, and (for other standards) throughout the world. Meetings require submissions with potentially expensive documentation of technical claims. The actual negotiations themselves have their own cost. All participants recalled the pain affiliated with the brokering associated with 56K. All sides involved lawyers, engineers, and marketing executives at many firms. Nobody called this easy.

An obvious reason why this process is so costly is that negotiating an agreement has nontrivial explicit costs. An additional reason is that designing a new technology requires an investment of research and development. A third reason may be some inefficiencies in the ITU system relative to some optimal SSO, but we doubt this is important. Indeed, it can be costly to choose between alternative approaches to a technical problem even when the disagreement is entirely within a single firm. Note that a benefit and a potential reason for the costliness is that once an agreement is reached, market players are less likely to revisit the standard-setting process, which raises the likelihood of implementation of any given standard.

This last observation takes on more saliency in light of our next few remarks about negotiations over IP. One of the major negotiating costs in the V.90 involved negotiating through all the parties' IP claims.

4. How do intellectual property conflicts shape the cost of negotiation?

The most naïve models of standards wars are portrayed as solely a fight between producer and user surplus. That is, consumers lose when two proprietary implementations for a technical opportunity vie to gain the producer surplus and thereby delay deployment. In this scenario the SSO's only role is to represent the potential for foregone surplus for users and to make vendors act less selfishly. For the case of 56K, the SSO's primary purpose was different.

The ITU serves as a forum for negotiations between parties who choose to participate. This set normally includes the conflicting parties as well as others. If users show up to represent their interests in the negotiations, then they have a voice too, but there is nothing about the negotiations process that guarantees user interests will be central, or even present. Nor is there any compelling law mandating a specific outcome from negotiations. Firm activity is voluntary.

Why do firms use this forum to negotiate? While there were many potential issues to negotiate, the most worrisome in the case of 56K was that a proposed specification might infringe upon IP held by several firms. Resolving IP issues was the primary activity performed during the negotiations. No other factor was as crucial for achieving agreement on the specification of the V.90. Accordingly, protection of IP appears to be the most prominent feature motivating participation.

To a professional manager in communication equipment markets or a consultant familiar with standardization cases, the importance of resolving IP issues is not surprising; however, it is surprising how little attention this topic receives in the canonical framework. We suggest that although there are some well-understood legal issues, there are fewer economic frameworks for analyzing the role for IP at SSOs. More generally, there is no framework for how IP shapes negotiating costs.

One view of how IP shapes negotiation costs is that patents are simply bargaining chips useful for achieving a desirable outcome from the SSO (such as delaying the adoption of the standard). For instance, if one firm holds a patent necessary for solving the technological issue in question, that firm is in a position to negotiate or delay to their advantage.

Of particular importance to our sources was the use of patents to influence standing in the post-standard market. Formally, all firms would have to pay licensing fees to use the patents of other firms covering the standard. But it was widely understood that firms that held patents over the standard would cross-license their patents to each other, thereby ensuring free use of the

standard to patent holders. This feature meant that firms prioritized the inclusion of their patents in the final standard.[11]

The second view emphasizes the procedural and cultural momentum that shaped the negotiations. According to this view, business decisions are based on engineering choices, not on the economic incentives of participating organizations. The principle goal is to walk out with the best technical standard according to the evaluators' engineering norms without regard for the impact on private interests directly.

Under this view, negotiation within an SSO is very different from simple bilateral negotiation between parties. For example, the debate over IP was not solely a legal debate, as it might have been if IP lawyers negotiated a bilateral agreement outside the purview of the SSO. Instead, because the debate occurred inside an SSO such as the ITU, it became subject to pre-existing decision-making rules for including or excluding features of a standard. That is, participants closely scrutinized the claims about the functional contribution of a technology covered by a patent and vigorously debated over the technical merits of proposals. The resolution of these disputes was partially tempered by engineering norms of the participants at the ITU subgroups.

Resolving disputes requires appreciation of the minute level of engineering detail and legal nuance embedded in a patent. It is not possible to resolve issues by mechanical means or nondiscretionary decision-making norms. These observations point toward the importance of *formal* and *informal* rules at SSOs for resolving conflicting business interests or conflicting technical claims. As a practical matter, SSOs cannot resolve such matters without a myriad combination—or clash—of views from firm participants, administrative staff, technical talent, and legal expertise.

---

[11] For example, "Companies want a piece of their technology in the standard so that others will have to pay a licensing fee for the use of the technology," said an executive at 3-Com (ITU Press and Public Information Service, 1998).

We take a middle ground between these views—especially as design and negotiation occurred concurrently for the 56K. On the one hand, the role of IP as a negotiating tool was correct because we saw that participants would have opposed a standard that did not include their IP. That IP was important in assuring property-holders' position in the post-standard market was clearly on the minds of many of the people involved. On the other had, there is also more than just a grain of truth to the belief that agreement was dictated by the "best technology" rather than by strategic concerns. It is partly reflected in everyone believing a standard would eventually emerge from the ITU and in the degree of control held by engineers associated with the ITU.

In the case of 56K it is clear (in retrospect) that all firms approached negotiations over IP issues with a sense of urgency about reaching an outcome and a sense of cooperation, or, at a minimum, non-obstructionism to a point. Participants perceived that an ITU standard would help virtually all parties, particularly if done sooner rather than later. As was previously noted, multiple factors, including the market positions of the firms, contributed to those perceptions and, hence, these choices. To be sure, the outcome was ultimately constrained by many of the important technical details that shaped the precise specification, which inevitably resulted in costly negotiations. Without a sense of urgency and cooperation, however, the negotiations would have been even more costly, and would almost certainly have reached resolution at a later date.

5. How do the voting structure and rules at the SSO shape the costs of coordination?

Voting structure

Assigning authority for dispute resolution is an important facet of negotiation costs; for example, SSOs in general can resolve disputes via consensus voting or majority voting. We find that market participants have thoughtful and sophisticated assessments of how particular SSOs resolve disputes. Such assessments include views about where an SSO vests authority to resolve disputes and what biases arise as a result of these assignments.

The ITU uses a consensus voting structure and requires nondiscriminatory licensing practices. This structure is important for resolving IP disputes. The open question is whether the specification of a standard is affected by these negotiation rules or whether the outcome would be the same under any set of rules for resolving disputes—both in the case of 56K and in general.

There are two contrasting views about consensus voting, consistent with the two camps we previously identified. One view— consistent with the first camp—stresses the strategic behavior of participants. Firms want their IP in any given standard, and they try to have the standard modified to include their patents. A consensus voting process gives them great leverage to do so. This process might not create the best technology available, but it does create one that all participants will approve. That is, patents may be included just to help the working group achieve a consensus in favor of the proposed standard.

The alternative view—consistent with the second camp—is that technical merit plays an important role in determining inclusion. Through discussion, it is possible to exclude "unimportant" technologies that degrade the functioning of the standard. It is through such a process of review and open debate that a superior hybrid technology emerges. In this view, consensus voting ensures that all participants are heard and ensures that the ITU considers all known options.

Majority voting can have very different implications. In a process based on majority voting, there is much less scope for firms to ensure the consideration of their technology, for better or for worse. We cannot make a blanket statement about the efficiency of majority voting over consensus voting. One of our contacts works with both the IEEE (i.e., Institute of Electrical and Electronics Engineers) and the ITU. The IEEE is based on majority voting, and he reports[12] that outcomes are easily manipulated. When a vote arises that is important for a particular firm that firm will send a large number of people (e.g., twenty) to the meeting. Most of these

[12] AU: Again, possibly insert information here regarding the interview.

attendees do not know what is going on in the meeting, but a group leader signals to them how to vote. One may wonder at the efficiency implications of such a system.

The canonical approach to analyzing a standards war treats the choices as fixed. There is no general framework for thinking about a negotiated specification at an SSO. Hence, the canon does not provide much guidance beyond the conventional wisdom, namely, that consensus procedures lead to better technologies whereas majority voting leads to quicker agreements. Verifying this convention requires evidence about a wide cross-section of cases well beyond the case of 56K and the scope of this article[13]

Rules

A contrast of views pervades the debate about the comparative relevance of the ITU's requirement that participants agree to license their related patents at a "fair and reasonable rate." Some believe this rule works as intended, whereas others focus on how this rule raises coordination costs. In particular, the ITU requires that any participant holding a patent that may affect a proposed standard must disclose the patent. The participant must also agree to license that patent at a "fair and reasonable rate" and do so in a manner that is nondiscriminatory. This does not imply that licensing is cheap, nor does it mean that patented technology will become widely available at some price. If firms vary from some consensus view of what constitutes a reasonable price they can be sanctioned in other SSO actions, or, at worse, taken to court for violation of a participant's rules.

Lemley (2002) provides an excellent discussion of the various legal issues that arise from this type of requirement and the interaction of SSOs and IP more generally. Lemley stresses the importance of handling IP for the success of an SSO, and one of his central policy recommendations is that SSOs develop clear statements that are similar to the one at the ITU.

[13] Indeed, the case of 56K even seems to mildly defy this wisdom, as it was widely regarded as both beneficial and comparatively fast.

The ITU requirement is there to ensure that the ITU is not unknowlingly making proprietary technologies into international standards and that a standard can be implemented easily after the ITU has endorsed it. The goal of the ITU requirement is that any firm can make use of the standard whether or not that firm participated in the standards process.

One may question whether this rule accomplishes its stated goal. If the ITU requirement operated as intended, licensing patents associated with a standard would be straightforward. However, if that were the case, firms would not be willing to expend so many resources ensuring that they can cross-license relevant patents after the standard is promulgated.

Assuming that it is difficult to make a standard without infringing on someone's IP, at least in part, we conjecture that there are two possible outcomes for any negotiating session. One is "unaggressive," that all firms deliberately avoid staking claims over their own IP, volunteer their IP without fuss, and compromise specifications emerge quickly, even when they come close to violating someone's patents. The other norm is "aggressive," that all firms attempt to include their patented technologies in an eventual compromise specification, claim broad importance for them, and achieve a cross-licensing deal to their benefit.

We conjecture that the first norm, unaggressive behavior, cannot survive in the presence of at least one firm acting according to the second norm, aggressive behavior. That is, if one firm tries to include a patented technology and make broad claims about it, then it is in the interest of all firms to do the same. In anticipation of that outcome, it is in every firm's incentive to try to get any advantage they can from making their patented claims earliest.

The ITU rule can be interpreted as an attempt to promote the first norm, where all volunteer the patents freely and without fuss, thereby lowering negotiating costs for everyone. If the second behavioral norm holds, however, the negotiation costs are likely to be high whether or not the rule is present. That is, negotiation costs are high in situations where there are many conflicting claims over IP. In such a case, it is unclear whether the rule about licensing alters behavior or even helps.

In the 56K standard negotiations, participants placed an emphasis on getting their IP included in the standard. On the surface, this appears to be aggressive behavior. For reasons we next explain, we conjecture that this would have arisen under virtually any set of consensus rules and licensing norms. And it made negotiating costs high.

6. Why do SSOs not encourage use of side payments?

In any basic economic model of negotiations, the objective of negotiations is to identify the set of common solutions that yield net benefits to all parties. It is a common property of such models that all parties can use side payments to enlarge the set of possible outcomes that leave all parties better off.

The negotiations at SSOs, in contrast, typically do not include side payments, and the negotiations at the ITU for 56K modems followed the SSO convention. Why SSOs follow this convention is puzzling, since such a habit drives up costs.

First, we examine *why* costs are raised by the absence of side payments. Consider one naïve model of the negotiating process—the joint-surplus maximizing model—which, if side payments were present, would correctly describe negotiating behavior. This model requires side-payments for an agreement to arise in any setting where participants have very asymmetric assets. In such a model, participants in a standard-setting process always choose the technology that maximizes joint participant surplus. The SSO could simply use side payments to compensate participants who would lose relative to some alternative technology. Firms with inferior technology could be paid to vote with the best technology.

Second, we examine the puzzle of why SSOs do not use side payments, and find that the conundrum is more complex when we highlight the relationship between negotiations and deployment. If side-payments solutions were observed often, then it would not be so important for firms to place their IP in the standard. In practice, it seems that the major form of payment for

a vote is to include the voter's IP in the standard, which brings the benefit of allowing the firm to participate in the post-standard market. This is obviously a crude method of payment and its use is puzzling in comparison to side payments, which are much more efficient.

The following observation highlights the relevance of no-side payments. Agreement can be difficult when a firm has relevant IP but does not plan on participating in the post-standard market. In these cases, the IP holder expects licensing payments, which makes the rest of the participants wary of ratifying a particular standard. Our interview subjects noted that a key to the quick agreement on the V.90 was that all the participants who had relevant IP also were producers in the post-standard market. All market players anticipated participating in market processes after the standard was announced and were willing to cross-license their patents, allowing for production without licensing fees.

We conjecture that the absence of side-payments here arises for many of the same reasons contracting breaks down between private parties in the face of uncertainty. When the economic value of agreement depends on the resolution of some uncertainty in the future—such as the level of demand—the contract must specify how that future state will be measured and how payoffs between parties relate to that measure. Such state-contingent contracts between bilateral settings are particularly hard to forge when there are different views about the likely value of future events or when discussions about contracts reveal too much about a party's competitive position and strategic plans for the future. It is also hard to enforce such contracts if events cannot be measured in a verifiable manner beyond opportunistic reinterpretation. We conjecture that in a multilateral setting, such as standard-setting negotiations at an SSO, such factors greatly interfere with the emergence of written state-contingent contracts.

The absence of written contracts specifying how parties will benefit or lose in the event of certain outcomes does not eliminate the need for some sort of mechanism for paying off parties for resolving their differences. In the absence of a written agreement, we conjecture that parties favor economic payoffs that are contingent on deployment and market success, where each

party's market success is a trade secret, by default, and not subjected to reporting biases or other legal disputes about enforcement.

Consistent with our remarks above, there are two views about the relevance of these issues for the case of 56K. One view highlights the technical constraints placed on the outcome and, accordingly, diminishes the importance of side payment considerations. Another view, and the one to which we are sympathetic, highlights the sense of urgency and cooperation with which parties approached the negotiations as they deployed infrastructure into the market place. In that light, firms only reaped the benefits from agreement by accelerating the deployment of 56K and making additional sales. In that sense, lack of side payments heightened incentives to achieve agreement and thus start the selling.

7. Does standardization lead to technical improvement?

A standards war determined in the market typically leads to one proprietary technology becoming the standard or to no standardization at all. This simple observation underlies a seeming advantage for SSOs, namely, that they have a greater set of options than a market process. The 56K modem case illustrates the issue concretely. The ITU could (1) endorse one party's specification as standard without change; (2) endorse no specification from any party; (3) endorse a specification that combines elements of standards presently proposed; and (4) endorse a specification that combines elements of present proposals, but add additional elements to make the resulting compromise palatable to all relevant parties. On this basis one might naively conclude that because, unlike markets, SSOs have options 3 and 4 available, they are superior to markets. That is, an SSO may take the best of several proprietary technologies and create a technology superior to any individual firm or consortium would have created on its own.

Such a view is naïve because it ignores the negotiation process for reaching a focal point. In this case, even if all parties desire a standard, the consensus system at the ITU essentially

excludes options 1 and 2. That is, these first two options were extremely unlikely even given both sides' interest in achieving a standard. Hence, determining standards in an SSO rarely involves a pure expansion of options. Instead, it biases the outcome toward a different type of choice. Is it a better or worse choice? Once again, the canonical framework for a standards war does not consider the trade-off, so we have little prior literature to guide our understanding.

How should one think about the potential costs and advantages of combining technologies? There are two key costs: One involves the short-run costs for designing a standard for the issues under consideration. The second and more subtle cost is of designing a standard in anticipation of what is likely to occur in the near future, as new technical opportunities arise for upgrades. Events in 56K illustrate each of these.

First, there are the costs of simply writing a standard. We were initially surprised that 56K modems did not undergo an enormous improvement at the ITU. While there is some limited evidence that both technologies for 56K modems were improving after their introduction, we came across no declarations in the public press that the V.90 was a noticeable technical improvement over X2 and Flex. Our evidence is weak in that we have no evidence that it was not better, but we are struck by the lack of public discussion of any improvements in the V.90. Clearly, this lesson applies only to 56K modems and does not extrapolate to other technologies.

The second lesson is more transparently illustrated by events here. The V.90 was not the last standard for 56K modems to come from the ITU. There were further upgrades with the V.91 and V.92, which clearly were superior to their predecessor by objective engineering norms—and were widely acknowledged as such. Hence, even if one was unsure about the improvement embedded in the first, there seems little dispute that the first agreement created a unified base specification for building further improvement.

This gives rise to counterfactual questions about what would happen in the absence of agreement or in the presence of a longer delay or a different type of agreement. Would such upgrades have occurred as quickly if a proprietary technology had been the choice for the V.90?

Similarly, in the absence of an ITU standard, would de facto market standards advance more quickly, less quickly or at comparable rates? If standards are negotiated by consensus among firms, is it more efficient to have the same partners negotiate with each other? We conjecture that familiarity lowers negotiation costs because participants are familiar with each other's business concerns, IP holdings, and market positions, as well as other factors that shape the costs of negotiations. As noted, the canon does not provide a framework for considering these open questions, both in the case of 56K modems and in general.

8. How do participants in a standard-setting process use all available information?

Models of negotiations tend to emphasize that disputes arise from the asymmetric positions of the parties and the private information strategically kept from each other. While these behaviors might have been relevant to some parts of the negotiation in the case of 56K, the issues associated with making decisions in the face of market uncertainty and conjectures about the future direction of technology were much more pressing. Participants based their decisions and actions on the best available information, but, despite that, sometimes consensus forecasts about the future turn out to be wrong. Said another way, it is easy to model negotiations as if no uncertainty is present, but doing so is naïve and potentially a misleading way to understand the biases inherent to using SSOs to resolve standards wars. It is easy to look back on events with perfect hindsight or with information about how market trends worked out; but this runs the risk of being historically inaccurate.

For 56K modems, part of the impetus for reaching an agreement so quickly stemmed from the belief that 56K modems would be quickly eclipsed by broadband technologies such as digital subscriber lines and cable modems. That is, many participants believed the technical value of upgrading dial-up modems, and the market opportunity for deploying 56K modems as a business would be short-lived. A lengthy ITU process would risk missing the height of the market

opportunity. Of course, within a few years it was obvious that this consensus forecast about the speed of diffusion for the replacement technology was wildly overoptimistic.[14]

In light of the dot-com bust and other overoptimistic forecasts about the rise of the Internet, one may accept a forecasting mistake such as this. This preconception about broadband seems to have been held by every market observer. Yet, as of mid-2004, the technologies are only now beginning to displace the 56K modem in personal computer communications. As Gandal, Gantman, and Genesove (2004) point out, that still understates the staying power of 56K. ITU standards for 56K modems are still the dominant interface for many technologies such as fax machines and cellular telephones.

More to the point, this case illustrates how forums, such as the ITU, can allow misconceptions to shape outcomes in ways that might not occur in market processes. Markets would arrive at an outcome on the basis of firms' strategies, whether or not they were independently determined, or there was a consensus about the future. In contrast, SSO's magnify the error that arises from a wrong consensus.

This observation complicates comparisons of SSOs to markets. This case illustrates precisely why it is difficult to make blanket assertions. All participants thought the window for the 56K market would be short and, therefore, negotiated with a sense of urgency. This urgency was important in coming to resolution in the face of so many costly negotiating obstacles. In this sense, the mistaken forecast about the near future contributed to reaching resolution, something that might not have occurred if no SSO existed.

We now turn to another example about the role for these forums in settling disagreements about uncertainty. Specifically, even in 2004, we repeatedly encountered the observation that market processes in 1997 were difficult to document, that market information was inherently ambiguous. Even in retrospect some factors are held in dispute. Some participants continue to

[14] This was a source of great amusement for some of the participants we interviewed.

issue charges about vaporware (mostly about Flex) and express skepticism about publicly stated commitments. While each firm could track its own sales of modems, only one trade magazine, *Boardwatch*, published something resembling a survey of use among service providers. Different associations provided their members with different viewpoints about actions.[15] In summary, decision making necessarily took place amongst interpretative confusion built upon factual ambiguity.

In this light, one view of SSOs is as forums offering an opportunity for firms to compare their views, share information, and reduce ambiguity. This information aggregation can be about more than just the technical merits of various approaches to a given problem. It can be about nature of demand and the reconciliation of alternative visions about the path along which the market place will develop.

Related, and more understandably, there is disagreement and inherent ambiguity about the consequences of paths not taken. We have found former participants expressing different opinions about what an interim agreement at the TIA might have looked like in the absence of compromise at the ITU. Moreover, we previously highlighted how fragmented the market experience was across the United States, so it is no surprise that, even in retrospect, participants also provide distinct forecasts about whether sales were strong or weak prior to the agreement at the ITU. They also provide different views about whether they would have continued to be strong or weak if the emergence of the standard had been delayed.[16] We speculate that some of these differences are consistent with previously stated positions, and some are simply to save face. To our ears, they will never be resolved.

On the surface, a lack of resolution for such matters is not, per se, of much interest to anyone—with exception of a market historian or a participant with a stake in how history gets

---

[15] This can be seen, for example, in the wide array of sources quoted by Shapiro and Varian (1999).
[16] For example, contrast the following press release in the ITU Press and Public Information Service's 1998 Plenipotentiary Conference (see www.itu.int/newsarchive/press/PP98/PressRel-Features/Features3.html).

told. But it is interesting for this study because it highlights a trade-off between market processes and negotiated forums. In de facto market standardization processes, such unresolved disagreements are not relevant except in so far as they shape firm strategies that affect market outcomes. In negotiations, however, such disagreements can play a role in shaping consensus outcomes. Hence, in the face of market uncertainty, we perceive a role for such forums in aggregating fragmented information among multiple parties, and we also perceive the possibility that such forums can allow misconceptions to shape outcomes in ways that would not occur in market process.

9. Are SSOs substitutes for each other?

Do SSOs compete with one another for jurisdiction? One might view SSOs as arbitrators that compete to have disagreements brought under their purview. In that sense, SSOs choose their structure to attract the most "disputes." For instance, Besen and Farrell (1991) reports that the ITU was losing importance relative to regional private SSOs, such as the IEEE, and it responded by dropping the requirement that countries vote before a standard can be approved. Since countries vote only once every four years, bypassing this requirement allowed the ITU to promulgate standards more quickly.

In that light, we can reinterpret some of the events over the 56K modem war. We reinterpret the question about why the Rockwell and U.S. Robotics groups chose to bring their dispute to the ITU. Earlier we asked why they came to the ITU instead of allowing market processes to carry on. In this section we ask why they chose the ITU instead of the IEEE or some other SSO.

We believe this question arises in the canonical model because the canon has an incomplete view of the negotiations process. To illustrate, we have a few potential answers for why the ITU served as SSO and no other forum did. First, as was previously noted, there was

precedent. The ITU was the source of all previous modem standards and so had both expertise and infrastructure in its favor.[17] In addition, there were structural advantages at the ITU for modems. The ITU has an international jurisdiction; and an ITU standard meant that producers could immediately begin producing for all areas of the world. Although, because of U.S. influence on technology, the IEEE has a de facto jurisdiction greater than the United States, our sources say that the internationalism of the ITU was perceived as an advantage.

The ITU also was better able to negotiate the regulatory requirements. An FCC cap on the modulation within phone wires limited the new modems to 56K. In fact, speeds greater than 56K could have been achievable in some foreign countries, but those countries were willing to agree to this standard to achieve an international standard. Presumably, coordinating these issues was easier when done through the ITU, which has a long-standing relationship with both the FCC and international telecommunication regulators, than through the IEEE.

Finally, the status of these institutions in business culture played a role in why the ITU was chosen. Rockwell had a history in defense contracting and was considered an establishment firm. U.S. Robotics was closely associated with ISPs and was considered an upstart. The ITU is the most established SSO in the world. One source claimed the ITU's "establishment credentials" made it an acceptable venue for Rockwell to negotiate with this new competitor. We find it difficult to translate these ideas about credentials into modern economic language, but found them provocative nonetheless. To say the least, this notion is not part of the canonical model of forum shopping during standards wars.

These reasons for using the ITU versus another SSO slightly alter our earlier interpretation of the coordinating advantages from using a negotiated forum. That is, not only will using an SSO help coordinate actors with different interests or who face different

[17] This of course raises the question of why modems ever were brought to the ITU in the first place many years earlier, but we leave that aside.

geographically independent competitive situations, but it will also help coordinate geographically distinct markets around the globe.

A theoretic model in which SSOs choose their voting rules or other such characteristics and compete for market share in the standards market would be exceptionally interesting (see Lerner and Tirole, 2004 for a start), but our research points out important constraints on such models. There exist important asymmetries between existing SSOs in their ability to coordinate otherwise fragmented market actors. Moreover, since there are multiple sources of fragmentation in need of potentially different types of coordination devices, no single forum will be superior for all situations. We conjecture that different forums will possess different comparative advantages, and these advantages cannot be shaped without constraint, nor are these advantages free of an SSO's history and long-standing formal and informal norms for resolving disputes.

D. CONCLUSION

We provide detailed analysis of a standards war and the costs of coordinating a solution to it. On the surface, this case has the three key elements found in a canonical standards war: an economic opportunity arising from a technical upgrade, a conflict between different implementations of that upgrade, and a resolution to the conflict, this time through the involvement of a publicly spirited SSO. Taking advantage of the detailed information available, we focus on the earliest period of deployment and analyze the interaction of market participants with the behavior of the SSO. Our main point is that this canonical model is misleading or incomplete with regards to the costs of coordination.

Incompleteness arose in several general areas. There is a large difference between a situation in which a regulatory agency intervenes and one in which firms voluntarily negotiate with an SSO. Yet, most previous cases of standards wars involve the FCC, a government agency

that can mandate standards. Because regulatory concerns are paramount in understanding the activities of the FCC, the literature on such standards wars provide a set of insights that simply do not carry over to one in which an SSO is involved. The costs of negotiating in an SSO are shaped by a very different set of determinants.

In this case the ITU had no power to mandate a standard. The ITU can issue a specification, which can then act as a focal point. This specification is negotiated and need not have direct correspondence with any specification already for sale. For understanding this outcome it was more essential to understand that the ITU has its own idiosyncratic set of rules and precedents. While different than the concerns of regulators, these rules and sets of procedures give momentum to events and push them in directions that might overlap with—or be orthogonal to—the concerns of users or to those with economic interests. Moreover, these activities involve individuals with long-standing professional relationships with each other and with the SSO, factors that also shape the negotiations and outcomes.

The canon is also incomplete in its analysis of the subtle ways in which the costs of coordination vary with firm behavior and market circumstances. Participation is voluntary on some levels and not others. One can see this nuance in three ways. First, all firms in this marketplace were members of this organization. It was inevitable that they would confront each other's claims over IP and marketing goals. Moreover, it was necessary to have an ITU standard to meet international markets. So, no matter how the market progressed, it was necessary for each firm to consider its negotiating position and come to these meetings with a position, whether it was strategic or not. This is not a mandated standard in the sense of a regulatory body mandating involvement of all interested parties and compelling adoption through legal means. Yet, there is a sense in which the situation compelled participation and managerial attention of all interested parties, and the focal point compelled use. We know of no model in the canon that properly captures how economic incentives led to this outcome.

Second, all firms took for granted that an ITU standard was inevitable, though many were uncertain about what it would look like and when it would emerge. The market position of firms then shapes the negotiating position of firms. For many firms, such a standard was valuable for their marketing purposes, and their marketing opportunity had a short window. Those perceptions of the marketing opportunity informed participatory behavior, making some parties less obstructionist than they might have been under different market circumstances. It also made others take a more urgent stance and pressed them to compromise sooner rather than later. Had market positions been different then negotiations can also be different, that is, in the sense of less urgent or more urgent, and more inclined towards compromise or less inclined.

Moreover, market-oriented events help crystallize forecasts. They also show where the market opportunity will move and thus help all parties be more foresighted about which IP are relevant for cross-licensing purposes and which are not, and which factors are relevant for the post-standard market opportunity—a key factor in reaching a compromise. We find it useful to describe this behavior as asymmetric negotiating positions brought about by asymmetric market positions. Again, we know of no model in the canon that captures these features.

Third, once the standards process gets started, the inevitability of the focal point becomes a potential factor in market events. There is a strong possibility that a standards war that ends with another specification simply adds more uncertainty to the marketplace. The uncertainties encompass such significant outcomes, such as the speed of announcement, nuances of bargaining position, inevitability of a final specification. Even without this process, there were concerns among service providers that their investments would be orphaned. With this process reaching a likely outcome, these investments became contingent on the outcome. For example, it is striking that market participants knew the history of this ITU committee and did not forecast that the process would resolve itself quickly. Yet, once it became more apparent that the ITU committee might defy its own history, then it was in all the parties' interest to wait just a few months more.

Yet, once again, no model in the canon places emphasis on how the management of the negotiating process at the SSO feeds back into market events.

From the perspective of economic canon, our close study of the details of events here suggest that the model of the standards war needs modification in several important respects. We conclude that the canon needs to address several open questions: What circumstances lead all firms to be compelled to participate in a voluntary standard-setting process and when do circumstances not do so? What factors shape negotiating positions, which can range from being obstructionist to urging compromise? Under what circumstances can the standard-making process produce a feedback from the process into market events, either slowing it down by sowing uncertainty or speeding it up by ending concerns about orphaning? Such questions are essential for analyzing the costs of coordinating in their proper completeness, and for understanding the extent of public benefits that might arise from a delay in emergence of a standard.

From the perspective of policy towards SSOs, our study details important costs in the process for 56K modems. There are explicit costs, such as membership and negotiation costs, and implicit costs, such as a procedure that leads to a suboptimal technology or an inefficient handling of IP rights. However, this analysis should not be seen as a criticism of the ITU or SSOs in general, and particularly not in this instance. Indeed, for the ITU to provide a resolution to a difficult standards problem within eighteen months seems a remarkable accomplishment. Compared to the alternatives of regulation or pure market processes, SSOs may often be a superior coordination mechanism. Moving from a situation where knowledge and technology is dispersed among independent firms to one in which the market is coordinated on a single standard has inevitable costs. Our paper merely details what might be thought of as the "true costs" of coordinating through an SSO in what surely was one of the better circumstances. One can only imagine these costs in circumstances where the outcomes were not as beneficial to so many parties.

We offer these questions with a few caveats in mind. Our conclusions and observations depended on getting accurate information from participants with the good graces to speak with researchers. We have focused the study primarily on the period prior to the issuance of the V.90 standard. It is clear that events did not suddenly stop after this. The market grew and lasted longer than many participants expected. The ITU also upgraded the 56K modem standard several more times. A full appreciation of these later events might generate different insights about what really turned out to matter for later outcomes. Also, and not unrelated, we have largely eschewed welfare analysis in favor of identifying and characterizing the nuances of firm behavior. We identified trade-offs between different types of rules in an SSO and between different types of firm strategies in their negotiating position, but we did not fully develop these observations. A fully specified model would be required to analyze all welfare trade-offs, and we do not attempt to make such an assessment here.

References.

Augereau, A., S. Greenstein and M. Rysman. 2004. Coordination vs. Differentiation in a Standards War: 56K Modems, Mimeo, Boston University.

Besen, S. and J. Farrell. 1991. The Role of the ITU in Standardization: Pre-eminence, Impotence or Rubber Stamp? *Telecommunications Policy* 15(4), pp. 311–21.

Besen, S. and L. Johnson. 1986. *Compatibility Standards, Competition and Innovation in the Broadcasting Industry.* Santa Monica, CA: Rand Corporation.

Downes, T. and S. Greenstein. 1999. Do Commercial ISP's Provide Universal Service? In *Competition, Regulation and Convergence: Current Trends in Telecommunications Policy Research,* eds. S. Gillett and I. Vogelsang, 195–212. Mahwah, N.J.: Lawrence Erlbaum Associates.

Dranove, D and N. Gandal. 2003. The DVD vs. DIVX Standard War: Empirical Evidence of Network Effects and Preannouncement Effects, *Journal of Economics and Management Science* 12 (3): 363–86.

Ellison, G. and E. Glaeser. 1997. Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach, *Journal of Political Economy* 105 (5) 889–927.

Farrell, J. 1996. Choosing Rules for Formal Standardization, Mimeo, University of California, Berkeley, CA.

——— and C. Shapiro. 1992. Standard Setting in High-Definition Television, *Brookings Papers on Economic Activity. MicroEconomics*, 1-77.

Gandal, N., N. Gantman, and D. Genesove. 2004. Intellectual Property, Standardization Committees and Market Competition, Mimeo, Tel Aviv University.

ITU Press and Public Information Service, 1998, From Competition to Cooperation: The Road to E-Commerce, ITU Plenipotentiary Conference, October 12 – November 6, www.itu.int/newsarchive/press/PP98/PressRel-Features/Features3.html (accessed 5/5/2004)

Lemley, M. 2002. Intellectual Property Rights and Standard-Setting Organizations, *California Law Review,* 90, 1889.

Rickard, J. 1997a. 56K Modems: The Battle Continues, *Boardwatch,* March.

———. 1997b. U.S. Robotics Launches the New Battle56Kbps Modems, *Boardwatch*, January.

———. 1998. The 56K Modem Battle, *Boardwatch,* March.

Rysman, M. and S. Greenstein, Forthcoming. "Testing for Agglomeration and Dispersion," *Economics Letters.*

Shapiro, C. and H. Varian. 1999. *Information Rules: A Strategic Guide to the Network Economy*, Cambridge, MA: Harvard Business School Press.

Stango, V., 2004, "The Economics of Standard's Wars," *Review of Network Economics*, 3 (1), pp 1-19.

Von Burg, U. 2001. *The Triumph of Ethernet, Technological Communities and the Battle for the LAN Standard*, Stanford University Press.