velop a better set of tools to help organizations determine security risks.[73]

Option B: Refine computer crime laws and the *remedies and penalties for criminal abuse.*

Computer crime and the ability to inflict damage on computer-based networks have increased significantly in the past several years, keeping pace with the increased access to and use of these electronic systems. The typical infringer is no longer a youthful "hacker" exploring an electronic environment, but rather an ordinary criminal-quite often an employee—using electronic technology as the tool of his or her trade.[74]

This growth in computer crime does not reflect a dearth of legislation prohibiting such behavior; there are now two Federal computer crime laws, and all but three States have adopted at least one.[75] These developments do reflect, however, a lack of consistency in the law, and a lack of agreement about penalties for infringement and remedies for the victims of computer crimes.[76] In the absence of a consensus about the nature of computer crime, it is not surprising that few cases go to trial, and those who are found guilty rarely receive prison sentences.[77] Therefore, Congress could define a more consistent set of communication/computer crime laws—together with a set of appropriate, comparable penalties—and establish abetter way of handling evidential materials in computer-related cases.[78] To execute such a policy, conflicts between Federal and State laws would have to be resolved.

Option C: Support the development of curricula to be used in schools, libraries, museums, and other public facilities to foster a more positive computer ethic.

The lack of agreement in the legal community about the nature of computer/communication-related crime mirrors a more general confusion about this issue in the community-at-large.[79] The absence of a positive ethic governing the use of computer and communication technologies is likely to have even more serious consequences in the future, when many more people will have access to, and become more accustomed to using, these new technologies. To help create such an ethic, Congress might support the development of a special curriculum to be used in schools, libraries, museums, and other public facilities. Ideally, such a curriculum would be available to children when they first come into contact with information and communication technologies. Since school curricula are developed by the States, the Federal Government's role would have to be indirect, such as providing funding. One challenge in fostering an ethical code of behavior for the use of electronic technologies will be to preserve the youthful inclination to use technology to explore and make discoveries, while simultaneously teaching users to respect the rights of others.[80]

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[73]Present risk analysis approaches are typically based on models that are not the most appropriate or useful for computer and telecommunication issues. Ibid.

[74]J.J. Buck Bloombecker, "The Spread of Computer Crime," *International Computer Law Adviser, vol. 2, No. 8,* May 1988, p. 4.

[75]In March 1989, Representative Wally Herger reintroduced a bill to combat computer viruses, which he first introduced in July 1988. HR 55 would make it a Federal crime to knowingly introduce into a computer network a virus or other computer program that causes loss, expense, or risk. In addition, the bill would also allow affected parties to file civil suits to recover damages. Whereas the earlier version of the bill was included in the Federal Code under the section dealing with malicious mischief, the new version is included under the section on computer crimes, and would thus provide for a stiffer 20-year maximum prison sentence for second offenders. Robert Midford, "Bill Expands Protection From Viruses," *Federal Computer Week,* Mar. 20, 1989, pp. 20, '24.

[76]For a discussion of the problems entailed in specifying difficult concepts such as authorized activities, see Sherizen, op. cit., footnote 20.

[77]Ibid.

[78]John A.N. Lee, Gerald Segal, and Rosalie Steier, "Positive Alternatives: A Report on an ACM Panel on Hacking," *Communications of the ACM,* April *1986,* vol. *29, No. 4,* pp. *297-230.*

[79]Ethical issues surfaced again when the Internet network was broken into, as described above, See also Michael Alexander, "Security Ethics Under National Scrutiny," *Computerworld, Nov.* 4, 1988, pp. 1,6.

[80]For a discussion of this challenge, see Michael Specter, "Hackers' Easy Ride," *The Washington Post,* Nov. 11, 1988, p. A-1.

Chapter 11

Interoperability in the Communication Infrastructure

CONTENTS

Figures

Tables

Chapter 11

Interoperability in the Communication Infrastructure

INTRODUCTION

Communication systems are, by definition, designed to interconnect. Thus interconnection, or interoperability, is a critical dimension of any communication infrastructure.[1] The more interoperable a communication system is, the more connections it can provide and the more accessible it will be to everyone on an equal basis. By creating economies of scale, interoperability can also reduce the costs of producing communication technologies, resulting in lower prices. Because new products and services that conform to known standards will be able to interconnect with existing systems, interoperability can foster product innovation. In addition, because interoperability permits redundancy, it can support the survivability of a system. Finally, interoperable communication systems support the flow of information, a critical feature in an information age.

Interoperability is important not only in a technical sense, but in an administrative sense as well. That is, to be most useful, the infrastructure needs to be transparent to users in terms of the technologies they use and the kinds of services offered, as well as the prices and rules that govern their use.

Interoperability also has a down side. By facilitating access, for example, it can make a communication system more vulnerable to breaches in security. Moreover, vulnerabilities in any one part of a system can easily be transmitted to others (as witnessed recently with the spread of computer viruses). In addition, to the extent that interoperability requires standardization, it will limit diversity of choice.[2] Under some circumstances, standards may also retard innovation by acting as barriers to market entry or by inhibiting manufacturers and vendors from venturing forth with a new, but incompatible, product.[3]

THE PROBLEM

In the past, achieving adequate interoperability within the communication infrastructure was relatively easy. In telephony, AT&T provided both end-to-end service and system interconnection. In mass media and information-processing technologies, the government played an important role, assuring, when necessary, that adequate standardization took place.[4]

However, OTA found that interoperability is likely to become more problematic in the future, from both technical and administrative standpoints. Not only will the need for interoperability become greater, but achieving it is also likely to be harder. Seven factors suggest such an outcome.

Factor 1: The growing importance of information and communication as strategic resources.

Communication systems serve as an infrastructure that supports all social activities. Interoperabil-

[1] For some theoretical, economic discussions of interoperability and communication standards, see Stanley M. Besen and Garth Saloner, "Compatibility Standards and the Market for Telecommunications Services,'' The Rand Corp., February 1988; Stanley M. Besen and Leland L. Johnson, "Compatibility Standards, Competition, and Innovation in the Broadcast Industry," The Rand Corp., November 1986; Sanford V. Berg, "Technical Standards and Technological Change in the Telecommunication Industry," Public Utility Research Center, University of Florida, Gainesville, August 1988; Joseph Farrell and Garth Saloner, "Economic Issues in Standardization," Sloan School of Management, Massachusetts Institute of Technology, WP #1795-86, October 1985; and David Hack, "Telecommunications and Information-Systems Standardization-Is America Ready?" Library of Congress, Congressional Research Service, May 21, 1987. For a thorough characterization of standard-setting organizations and processes from an organizational/behavioralist point of view, see Carl F. Cargill, *Information Technology Standardization Theory, Process and Organizations* (Rockport, MA: Digital Press, 1989).

[2] Eli M. Noam, "The Political Economy of ISDN: European Network Integration vs American System Fragmentation," paper presented to the XIV Annual Telecommunications Policy Research Conference, Airlie, VA, April 1986.

[3] Joseph Farrell and Garth Saloner, "Standardization, Compatibility, and Innovation," *Rand Journal of Economics, vol. 16, No. 1,* Spring 1985, pp. 70-83; and Joseph Farrell and Garth Saloner, "Standardization and Variety," *Economic Letters*, January 1986, pp. 71-74,

[4] For example, both the Department of Defense and the General Services Administration played important roles in the standard-setting Process for COBOL, a computer language that allowed for program compatibility that was approved by the American National Standards Association (ANSI) in 1%8. Berg, op. cit., footnote 1, p. 10.

ity is important, therefore, not only in terms of a system's technical characteristics, but also in terms of whether it can support social activities as well. In every realm of society, interoperability serves as a key factor in determining whether, and by whom, new opportunities afforded by information and communication technologies will be realized (see chs. 5,6,7, and 8). Therefore, in considering its role relative to setting standards for the U.S. communication infrastructure, the government increasingly will have to take into account the overall societal benefits of new technologies. For example, against the danger of retarding innovation by pressing prematurely for standards, the government will have to weigh not only potential losses in efficiency, but also the loss of both domestic and international business opportunities that might result from the lack of standards. In addition, in determining whether to play a more proactive role relative to standards, the government will need to balance the potential loss of diversity and customer choice that standardization brings against the problems of equity that might arise if users have to "purchase" interoperability as a commodity.

Factor 2: The elimination of many of the traditional mechanisms by which interoperability has historically been achieved, and the emergence of new players.

The divestiture of AT&T, the convergence of communication and information technologies, and deregulation have all served to undo many of the mechanisms used in the past to achieve interoperability in the U.S. communication infrastructure. Achieving interoperability was relatively easy because there were few stakeholders, and those who were actively involved generally focused their attention on a circumscribed set of technologies. Today, this is no longer the case.

Before the divestiture of AT&T, for example, telecommunication standards were established by the Bell Telephone System, and they were based, for the most part, on a commonly accepted set of engineering criteria. As Horwitt has described it:

> The market has changed since predivestiture days, when Ma Bell set telecommunication standards and other carrier and equipment vendors had no choice but to follow. Now AT&T is just one more vendor—albeit a formidable one—lobbying for industry-wide adoption of the technological protocols it wants to uses

With respect to long-distance carriers alone, instead of one service provider there are now a number of equipment providers, interexchange carriers, enhanced-service providers, service resellers, and private-line networks, all with a stake in standards issues. Divestiture also created the seven Regional Bell Operating Companies, each with a somewhat different business strategy and a distinct view of network standards.[6] Moreover, in the wake of divestiture, a number of companies have emerged to provide gateway, translator, and network management services.[7] Because their products can serve as substitutes for standards, they, too, have a very basic interest in issues involving interoperability and standards.

In addition, with the convergence of communication and computer technologies and their markets. computing companies have a large stake in communication standards, as do communication companies

[5] Elizabeth Horwitt, "protocols Don't Stand Alone," *Computerworld*, Oct. 20,1986, p. 27.

[6] To facilitate the development of standards among the regional holding companies, the Exchange Carriers Standards Association (ECSA) was established at the time of divestiture. The ECSA T1 Committee on Telecommunications has been accredited by ANSI, and today is chiefly responsible for providing the telecommunication industry with an open public fomm for developing interconnection, interoperability, and performance standards. Its 140 member organizations represent exchange carriers, interexchange carriers and resellers, manufacturers, and vendors, as well as users and general interest participants. For a detailed description see, A.M. Rutkowski, "The Exchange Carriers Standards Association," *Telecommunications*, January 1987, pp. 77-87.

[7] One area that has recently demonstrated tremendous growth is that of system integration. System integrators help organizations to develop communication systems comprised of an enormous variety of hardware, databases, and software, and to link them together in a seamless fashion. According to some analysts, the system integration business is growing at an annual rate of 20 percent, and its revenues are expected to increase from $8 billion in 1987 to $22 billion in 1993. For a discussion, see Mark Breibart, "Systems Integration Surge," *Computerworld Focus on integration*, a supplement to *Computerworld*, Feb. 6, 1989, pp. 29-33; see also, Mary Jo Foley, "Private Sector Systems Integration," *Datamation*, *Dec.* 1, 1987, pp. 77-79. Given the variety and complexity of the technology, it should be noted that the term "system integrator" is, itself, very confusing. As one trade journal analyst notes: "Talk to 40 different suppliers and you will get 40 different definitions, Specialist system integrators define it as a business for coordinating the elements of a customer solution. Vendors define it a dozen different ways, and many claim that they have been doing it all along and can't see what the fuss is about. Service firms define it as a service business. Software firms define it as a software business, Communication companies define it as a network business." Brian Jeffery, "The Drive for Integration," *Computerworld*, Sept. 7, 1988, pp. 15-17.

in computing standards. This was illustrated recently by the protracted battle among communication and information technology companies about how and by whom the next version of UNIX will be developed.[8] In these two arenas, the attitudes towards standards, the values placed on them, and the processes for achieving them have historically been somewhat distinct, raising questions about how these two cultures will reconcile their differences in the future.[9] As the technologies converge, there is also likely to be an increasing number of jurisdictional issues emerging among organizations, such as the International Standards Organization (ISO) and the Consultative Committee for International Telephone and Telegraph (CCITT), which traditionally have been responsible for the development of standards in a particular area.

There are new players in the administrative arena as well. With deregulation taking place at the Federal level, many States have begun to take a more assertive role in regulating communication (see ch. 4). With respect to standards, for example, many States have demonstrated their intent to be active participants in the open network architecture (ONA) process.[10] The States are also likely to have an interest in the development of Integrated Services Digital Networks (ISDN), especially with respect to how services are defined and whether or not they will be regulated. Foreign governments, all with their own objectives, are also becoming critical players in the standards-setting process.

Factor 3: The globalization of the economy and, hence, a greater need for international standards and the extension of standards-setting efforts to the international arena.

With the globalization of the economy, U.S. standards now have to be brought into line with international standards. As Ithiel de Sola Pool has pointed out:

> Until now in the telecommunications field there have generally been two sets of standards, the CCITT standards of the International Telecommunications Union followed in most of the world and the Bell system standards which prevailed in America.[11]

Given the breakdown of geographic boundaries, American vendors now need to take international standards-setting processes and the entire world market into account when considering what standards should be adopted for the United States. Thus, although many American computer vendors and telecommunication carriers were reluctant to adopt the CCITT X.400 standard for electronic mail, they found that they needed to support it if they wanted to compete in the world market.[12] Similarly, although the Federal Communications Commission (FCC) was hesitant about setting standards for high definition television (HDTV), it found that it had to move the U.S. standards-setting process along, given that HDTV standards were being developed and adopted in other countries.[13] Two major sets of standards-for ISDN and open systems interconnection (OSI)—are presently being debated and discussed in international fora.[14]

The need for U.S. vendors to align their standards with those of the rest of the world will become even greater after 1992, when the nations of Europe merge into a unified economic market made up of approximately 620 million people. Fully cognizant of how standards can serve as barriers to trade, the European nations are trying to speed up their efforts to achieve

[8]See, for example, Christine Bonafield, "UNIX Split Gets Wider," *CommunicationsWeek*, Nov. 7, 1988, p. 1.

[9]As Besen and Saloner have pointed out, in the information industry, "standardization issues revolved mainly around the ability of manufacturers of peripheral equipment to connect their products to the Central Processing Units of other manufacturers. Since there were only a few mainframe manufacturers, and they provided integrated systems, and thus were not dependent upon the equipment of peripheral manufacturers, they had little incentive to ensure that interfaces were standardized." Besen and Saloner, op. cit., footnote 1, p. 18.

[10]Eli M. Noam, "Implementating ONA: Federal State Partnership Needed to Connect Network of Networks," *CommunicationsWeek*, May 2, 1988, p. 16.

[11]Ithiel de Sola Pool, "competition and Universal Service," Harry Shooshan (cd.), *Disconnecting Bell, The Impact of the AT&T Divestiture (New* York, NY: Pergamon Press, 1984), p. 119.

[12]Besen and Saloner, op. cit., footnote 1, P. 3.

[13]The FCC has decided that whatever HDTV broadcast standard is ultimately selected it must be compatible with existing TV sets and transmitters. Advanced Television Systems, MM Docket No. 87-268,65 R.R. 2d 295 (1988).

[14]These standards, and the issues to which they give rise, are discussed in detail later in the chapter.

regional standardization by the 1992 deadline.[15] To facilitate this process, the European Community established the European Telecommunications Standards Institute (ETSI) early in 1988. This independent body, financed by all of the postal, telegraph, and telephone authorities (PTTs) and major telecommunication suppliers, assumed responsibility for the standards' work that was previously carried out under the Conference of European Post and Telecommunications Administrations (CEPT). Moreover, in April 1989, 18 European countries signed a memorandum of understanding, which states that, effective immediately, those countries will provide a common range of basic services and a list of optional services that will be made available to common standards as demand develops.[16]

How international standards are resolved will affect not only U.S. trade, but also economic and technological developments in the United States. Without common standards, for example, it is not easy for U.S. users with international networks to transport their own company-standard equipment into *other* countries.[17]

The international process for setting standards also affects and is affected by U.S. regulatory policy, as the history of the debate over the "U" interface clearly illustrates. In ISDN standards, for example, the "S" "T" and "U" interfaces define the possible points at which customer premises equipment can link up with the national, public network (see figure 11-1). By picking the "U" interface, the U.S. Government provided the greatest leeway for competition within the customer-premises equipment market. The governments of Europe, who were less concerned about competition in the customer-premises equipment market, selected the "S" and "T" interfaces. These conflicting choices proved to be a matter of considerable contention in the process of establishing ISDN standards.[18]

Factor 4: The increased politicization of standards-setting issues.

A standard, as described by Sanford Berg, can be:

> . . . a potentially private good whose ownership assignment is handled via technical committees. Just as the radio spectrum is a scarce good whose allocation affects the wealth of firms, assignment of points (or specification of a protocol) can give advantages to one firm.[19]

Once a standard has been set, for example, firms whose products are incompatible may no longer be able to compete. Thus, many firms may try to avoid having a standard adopted, unless their own products are likely to be favored. Users, on the other hand, generally welcome standards. With systems that are open or standardized, users have more market power vis a vis vendors. Not only can they mix and match the components of their communication systems, picking and choosing among different vendors; they can also migrate more easily to a new system, phasing out their older equipment more gradually and without disruption.[20] In addition, when products are standardized, users often benefit from lower prices and lower searching costs (costs entailed in locating and comparing products). However, users will often disagree about the best standard. Having invested heavily in one technology, for example, they may oppose a standard that would require switching to another.

Given these competing interests, and the tremendous potential for gains and losses, it is clear why setting standards has often been a contentious process requiring considerable negotiation and bargaining. As Besen and Saloner have described it:

> . . . standard-setting has moved from the technical concern of a single firm to a factor with important implications for competition. As a result, the processes by which standards are set have come to be subject to detailed scrutiny by both the regulatory authorities and the courts. In a sense, telecommuni-

[15] To encourage standardization in Europe, for example, the European Commission, in February 1988, mandated that governments of all member nations invest in computer equipment conforming to the standards of the International Standards Organization (ISO).

[16] John Williamson, "CEPT Agrees To Speed ISDN," *Telephony,* Apr. 17, 1989, p 15.

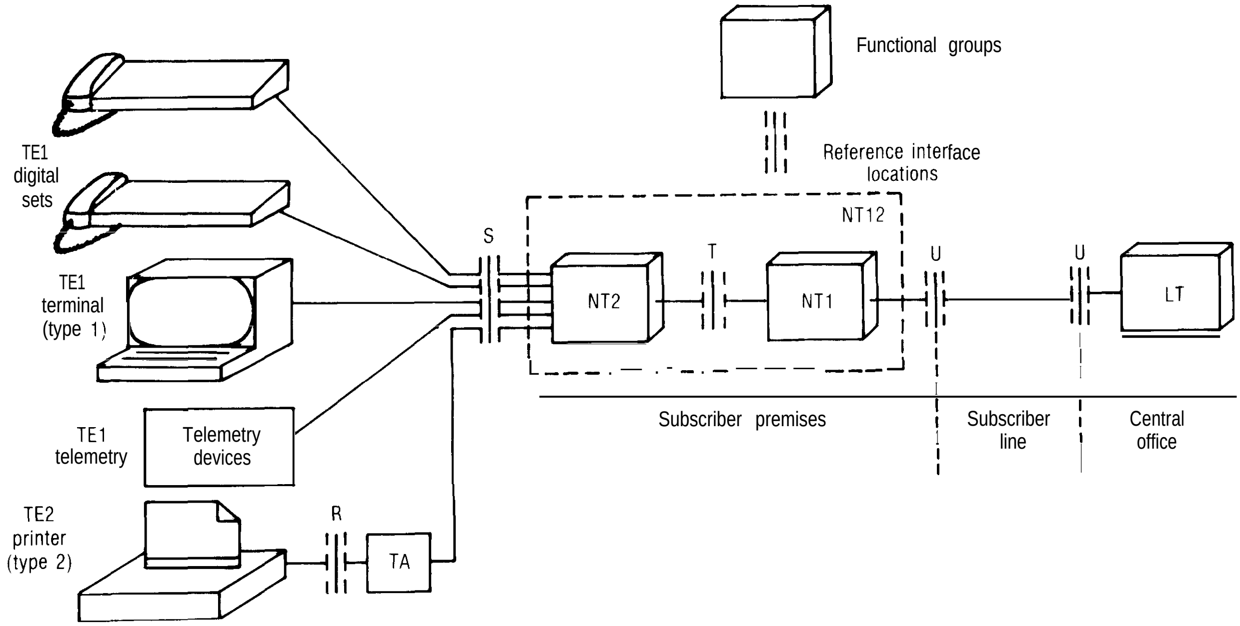
[17] Steve Titch, Margie Semilof, and John Berrigan, "Missing Links," *CommunicationsWeek, CLOSEUP,* Sept. 12, 1988, p. C-7.

[18] See, for a discussion, Ian M. Lifchus, "Standards: Technical Umbrellas for the Information Age," *Telephony,* Apr. 25, 1988; see also, Alan Stewart, "A Users Guide to ISDN Standards," *Telecommunications,* May 1988, pp. 34,35,36, and 37.

[19] Berg, op. cit., footnote 1, p. 9.

[20] Larry DeBoever, "Trek Toward Connection," *Computerworld,* Nov. 16, 1987, pp. S1-S13.

Figure 11-1—ISDN Subscriber Loop Interface



U Interface–Two-wire transmission carrying the 2B + D channel format Implemented by the MT8972 DNIC
T Interface, S Interface — Four-wire Interfaces intended to be physically identical for Star or Passive bus configurations
R Interface–Existing standard interface such as RS-232-C or X 21.
Network Termination 1–Transmission line terminating equipment at subscriber side of network
NT2–Network Termination 2– Intelligent device to convert the single T interface to multiple S interfaces.
Terminal adaptor–Conversion between the ISDN interface (S) and existing interfaces (R) such as RS-232-C or X 21
Terminal equipment (type 1)–intelligent digital devices that can interface directly to the ISDN specified S or R interfaces.
Terminal equipment (type 2)–Existing terminal equipment used with existing Interface standards such as RS-232-C or X 21

SOURCE: Reprinted with permission from Telephony, June 17, 1985, p. 31.

cations standards have become too important to leave their determination to the telephone companies.[21]

The involvement of so many players with conflicting perspectives is likely to make standards-setting processes more visible, more intractable, and, hence, more politicized in the future. Increasingly, issues are emerging not only with respect to what standards should be adopted, but also with respect to how, and by whom, decisions about standards should be made. Recently, for example, there has been a sizable increase in the number and variety of groups getting involved in standards-making issues. Many user groups are now seeking a much more active role, in some instances even bringing their cases directly to international standards-setting groups.[22] The desire for an increased role is not surprising, given that users' network requirements are now so much more sophisticated and mission-critical to their business operations.[23] Vendors and suppliers are also taking note of this

21 Besen and Saloner, op. cit., footnote 1, p. 1.

22 For a discussion, see, for example, Suzanne Wiseman, "ICA Seeks Strong User Role in Standards," *CommunicationsWeek*, June 27, 1988; see also discussion of the role of users in developing the Manufacturing Automation Protocol (MAP) and Technical and Office Protocol (TOP) standards, Stan Kolodziej, "No More Money to Burn: Industry Demands Solutions, MAP Begins to Deliver," *Computerworld, Dec.* 7,1988, pp.31 -34. It should be noted, moreover, that users can also be vendors, a fact that can cloud motivations.

23 Dale Kutnick, "OSI a High-Stakes Game to Play," *Computerworld*, Sept. 12, 1988, p. 19.

new situation, and are sending more of their top-notch people to handle standards issues.[24]

Factor 5: Increased technological complexity and the shift from product-implementation standards to anticipatory-process standards.

The rapid pace of technological change, combined with the convergence of communication and information technologies, has made standards-setting much more complicated. In the past, standards were generally established in response to pre-existing products in order to facilitate their implementation.[25] Today, however, this is no longer typically the case. Standards are now much more future oriented, and the process of setting a standard often anticipates the actual creation of a product. The need for these new kinds of standards, known as anticipatory-process standards,[26] reflects the fact that, today, there is a much greater need for interoperability in the area of information technology, given an environment where the technology is rapidly changing, there are many vendors, and there is a growing value attached to the exchange of information.[27] One example of an anticipatory-process standard is the OSI reference model. It describes how open systems should operate from a generic perspective, as well as the full range of implementation choices that are compatible within this framework.

The shift from product-implementation standards to anticipatory-process standards will create new kinds of problems, and there is little historical, or analytic, guidance for addressing them. For example, the traditional, academic economic literature on standards, which focuses heavily on the development of domestic product standards and the economic factors that drive them, is becoming less and less relevant to, and less able to account for, the process of setting international, anticipatory-process standards, such as those for ISDN and OSI. As Cargill has noted, the outcomes of such processes do not depend on economic variables alone, but on a number of variables, which can range from national goals to personalities and preferences of individual participants. As he has described the intricacies and complexities involved in standards-setting:

> imagine a typical international standards meeting working on a conceptual/process standard for the information technology industry. Assume a small meeting of approximately thirty representatives—say twelve from providers, eight from government, five from impacted users or quasi-governmental bodies, several consultants, and a couple of academics. Then consider the national, regional, and international aspects of the meeting, the needs of the providers to ensure that their processes are not compromised, the governmental issues such as security and national prestige and protection of industry, and the academic sections insistence on a good and technologically sound solution. Finally, factor in the personal characteristics of the delegates, most of whom are highly competent engineers who have been working on this type of technological

24 Stan Kolodziej, "Egos, Infighting and Politics: Standards Progress Bogged Down," *Computerworld, Focus,* Sept. 7, 1988, p. 17. As Cargill has noted,". . . industry-both users and providers alike-is more and more aware that standards are a serious business concern that can cripple or aid efforts to minimize exposure to the vagaries of the market. As this realization has grown, the composition of the standards groups has begun to change. Instead of coming from a regulatory or internal standards background, more and more representatives have a background in technical management. Perfect standards are no longer the goal; instead, the focus is on obtaining a workable and acceptable standard within a time frame that will allow it to be useful." Cargill, op. cit., footnote 1.

25 As Cargill has defined this kind of standard: "A product standard describes a product or service being standardized. The product, which should have a future orientation (although this is not an absolute necessity), defines the standard in that the standard merely exists to serve as a paradigm for the product within the industry. In other words, the standard and the product/service being described are equivalent within the confines of a single discipline/structure, free of external dependencies. The standard assumes that the external interfaces to the product it described are relatively constant and consistent. Although the standard can accept a wide variability of input if the standard specifies the variability, it is more usual for the product standard to be constructed rather tightly. If a standard calls for a series of options, which can be randomly implemented, in terms of numbers, sequences, and fashions, then its purpose is de feated." Ibid.

26 Again, as defined by Cargill, "The process standard focuses on the transmutation of a customer need into a customer solution, examining those things that are input and output *to* a system, but not concerning itself especially with the products that accomplish that transmutation. In other words, it is concerned with the ends, not means. . This concept has substantial implications for the development of standards because it is device independent-rather than specifying a certain product or service to accomplish a need, it merely describes the need, the constraints to achieving the solution, and the output necessary to allow the results of the standardized solution to interplay with solutions from other process standards." Ibid. For a discussion of anticipatory standards see also, Martin B. H. Weiss, "Compatibility Standards and Product Development Strategy: A Retrospective of Data Modern Developments," Carnegie-Mellon University, March 1988.

27 Cage]], op. cit., footnote 1.

problem for years and for whom this arena is a chance to air their theories to their peers.[28]

Factor 6: The growing divergence of vendor/user goals and interests.

The move from product-implementation to anticipatory-process standards has also made it more difficult to reconcile the needs of vendors and users.[29] In the past, the needs of users and Providers generally coalesced, once they had agreed among themselves that a standard was required. The vendor sought to design his product to the standard that best met the user's need. Today, however, providers' and users' needs are much more divergent. Trying to leave their options open in a rapidly changing technological environment, while at the same time providing for some kind of predictability, providers favor the creation of generic standards that, by laying out all technical possibilities, allow them to build to the future capabilities of their systems. Users, on the other hand, have no interest in a broad range of technical possibilities; they want very specific standards that can be designed to meet their particular business needs. They find the process of developing such complex genetic standards much too slow for their purposes. From the users' point of view, participation in this process can be quite expensive since, unlike vendors and suppliers, they are primarily engaged in other economic activities .30

Reflecting this growing gap between vendors* and users' perceptions of standards and the standards-setting process, some users established special consortia to speed up the process. In addition to developing specialized standards protocols based on the OSI model, these groups also sought to use their organizational influence and buying power to encourage vendors to implement products designed for their needs.[31] At the initiative of General Motors, for example, users developed the Manufacturing Automation Protocol (MAP), which is considered to be an essential building block for computer-integrated manufacturing. In addition, the Technical and Office Protocol (TOP) was developed under the auspices of Boeing, while the Government Open Systems Interconnection Profile (GOSIP), a protocol designed to meet the information-processing needs of government agencies, was developed under the auspices of the National Institute for Standards and Technology (NIST). Most recently, a number of electric utility companies, working through the Electric Power Research Institute, have agreed to develop a set of OSI-based communication protocols that will allow them to interconnect their dissimilar systems and networks.[32] Libraries, bankers, and the weather-forecasting industries are also considering the development of special protocols.

Factor 7: The increasing demands on international standards-setting organizations.

The growing complexity of standards issues also puts additional burdens on standards-setting institutions. This is reflected in the extended period of time required for standards to be formally ratified, and the rapid multiplication of standards-setting committees and subcommittees. As one journalist observing international standards meetings has described these sessions:

> The content [of the materials discussed] is technical, voluminous, and difficult. . . . the minutes look like telephone books. . . . Readings come to several hundred pages of technical matter each month.[33]

Under these circumstances, it is estimated that the volume of the CCITT "colored books," which comprise all standards recommendations, is doubling approximately every 4 years.[34] It can take between 4 to 8 years for an international standard to be written. Even after standards have been set in a formalized, international, consensus-based process, users still have to specify the particular uses to which these standards will be applied, and vendors have to implement compatible technologies that meet these standards and specifications. Given the increased demands on standards-setting institutions, some people fear that the process may become so bogged down that many standards will actually become

[28]Ibid.

[29]For a discussion, see ibid.

[30]Ibid.

[31]See for a discussion, Kolodziej, op. cit. footnote 22, pp. 31-33.

[32]Kelly Jackson, "Utilities t. Link Nets Via OSI," *CommunicationsWeek*, Mar. *2711989,* p.1.

[33]Timothy Haight, "Standards-Setting and the Limits of Journalism," *CommunicationsWeek*, Mar. 14, 1988, p. 14.

[34]Denis Gilhooly, "Expanding Scope for CCITT," *CommunicationsWeek,* Jan. 16, 1989

obsolete before they are officially ratified.[35] There is also concern that new standards groups might emerge that would challenge the central role of the existing organizations, creating even greater coordination problems. With these concerns in mind, many have urged that the existing standards-setting institutions be revamped and reformed.[36]

STRATEGIES AND OPTIONS

Interoperability in communication systems can be accomplished in two ways—through a process of standardization, whereby the components of a system are designed to conform to one another; or through the use of translator devices, or "black boxes," designed to connect incompatible parts. Standardization processes themselves are also varied. For example, standards can be established de facto in the marketplace; they can be agreed to on a voluntary basis, by consensus, worked out through negotiation; or they can be mandated by government. In many cases, the process does not end with the setting of standards; before interoperability can be achieved, standards must be further specified and ultimately implemented.[37]

Given these different phases and the multiple routes for achieving interoperability, Congress might select from a broad range of strategies designed to enhance the interoperability of the U.S. communication system. These strategies include:

- supporting research to provide better data and a more analytic rationale for standards-setting decisions;
- allowing for the emergence of market solutions, either in the form of gateway technologies or through the de facto setting of standards;
- indirectly influencing the standards-setting process by providing assistance and guidance to foster the setting of standards;
- influencing the setting of particular standards by providing incentives or imposing sanctions; and
- mandating industry-wide standards.

Research on standards, as well as past experience, clearly illustrate that there is no single optimum way of arriving at interoperability.[38] The level of interoperability to be strived for, and how it should be achieved, will vary in each case, depending on the state of the technology's development, market demand and preferences, the structure of the industry, and the social, political, and economic stakes involved.[39] Thus, although some generalizations can be made about the overall circumstances under which particular government strategies and options are likely to be the most appropriate, these generalizations will need to be tailored to the specifics of each case. For this reason, the discussion below is divided into two parts. The first examines strategies and options for arriving at interoperability from a general perspective (see figure 11-2), and the second looks at three specific cases where interoperability, or the lack of it, has generated significant policy issues. These three cases include a discussion of the standards issues relating to: 1) the establishment of ISDN, 2) the evolution of OSI, and 3) the creation of ONA.

General Discussion of Strategies

Strategy 1: Support research to provide better data and a more analytic rationale for standards-setting decisions.

As discussed in chapters 3 and 4, setting standards often entails trade-offs between efficiency and ease

[35] See, for one discussion, James G. Herman, "Is ISDN Obsolete'?" *Network World*, Aug. 10, 1987. As Herman points out, "The ISDN standards committees are caught in a squeeze between falling requirements for voice and rapidly rising requirements for data. The long-awaited standards may be too little, too late for data and yet be wastefully oversized for voice. It will be interesting to see whether they gain acceptance and fulfill their promise or wither and die from premature obsolescence. "

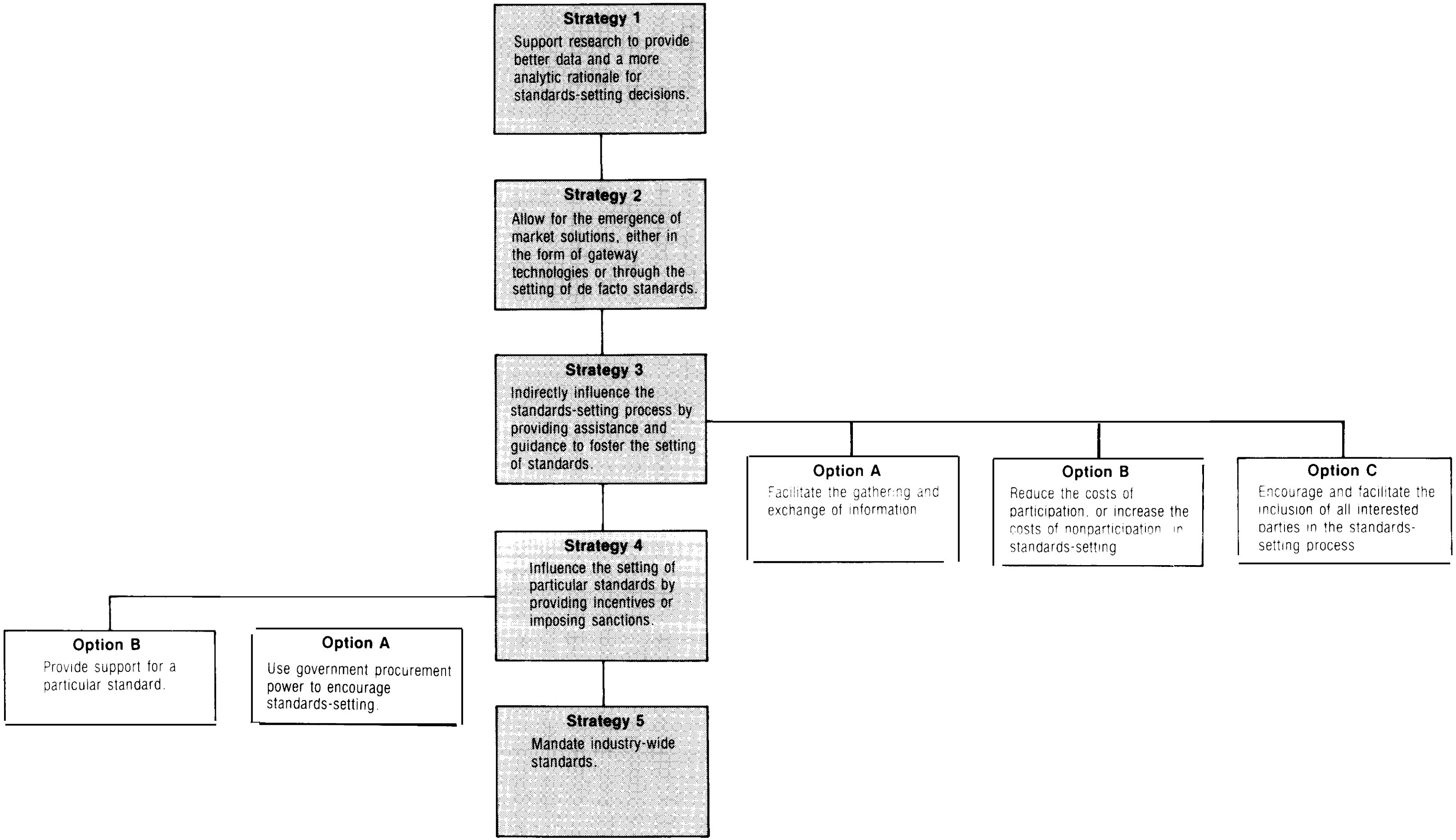
[36] For a discussion see, "Irmer Calls for Reform of CCITT," *Telecommunications*, October 1988, p. 11; and Denis Gilhooly, "CCITT Adopts Plan to Speed Standards Approval Process," *CommunicationsWeek*, Dec. 19, 1988, p. 24.

[37] &.1 Cargill has described a six-phase process of standardization: 1) the pre-conceptualization stage, 2) the formal process, 3) conceptualization, 4) discussion, 5) writing the standards, and 6) implementing the standard. As he notes: "If the proposal for a standard makes it over the first hurdle, and enters the formal process, it must go through three phases of the formal process. *If* it successfully completes all of these steps, it has the potential for being a viable standard—one that is accepted by the IT [information technology] community, and which will and can be used. The final hurdle is the implementation stage. Failure to complete any of these stages will not disqualify it from being a standard-it may only disqualify it from being a standard that is both used and useful." Carl F. Cargill, "A Modest Proposal for Business Based Standards," unpublished paper, p. 6.

[38] Besen and Saloner, op. cit., footnote 1, p. 2.

[39] See, for example, Besen and Johnson, op. cit., footnote 1; Besen and Saloner, op. cit., footnote 1; and Berg, Op. cit., footnote 1.

F gu e 11-2—Congressional Strategies and Options to Address Interoperability/Coordination of the Communication Infrastructure



SO R Tec og Assessment,

of access on the one hand, and innovation and technological change on the other. Understanding these trade-offs requires not only an understanding of the many policy issues that standards raise, but also considerable technical expertise. For policymakers, keeping pace with technological change is becoming increasingly more difficult. As one critical observer of the present situation has described it:

> Many of our institutions—both public and private---do not seem to have evolved along with the technology. Our present public institutions consist of the FCC [Federal Communications Commission], largely operating with a diminished capacity, and pieces of a few other federal agencies, mixed with 50 state commissioners, each with the notion of what the telecommunication network should be. . . . Far more ominous, however, is NARUC's [National Association of Regulatory Utility Commissioners'] decree that on matters of ONA, each state will feel free to go its own way.[40]

One action that Congress might take, therefore, is to further enhance the economic and technical knowledge within government agencies about the new communication and information technologies, and how they may change the Nation's communication infrastructure.

To this end, Congress might fund the National Science Foundation or NIST to conduct further research on the policy and economic implications of standards and standards-setting processes in communication. Such research would be opportune because the academic literature on standards is just beginning to come to grips with the changes wrought by the divestiture of AT&T and the convergence of communication and information technologies.

However, it will be important to ensure that this work is shared among all agencies involved with standards. At present, there appears to be little, if any, formal effort to share such research and experience. In part, this lack of coordination stems from the fact that, in the United States, most standards' activities have taken place in nongovernmental fora, such as Accredited Standards Committees of the American National Standards Institute (ANSI). Ironically, it is said to be in these private sector meetings that many people from different government agencies get together.

However, if too formal a coordination process were established, the sharing of information might provoke some jurisdictional disagreements among agencies. As noted in the discussion of jurisdictional issues (see ch. 13), efforts at coordination are rarely, if ever, neutral with respect to the distribution of power and authority. And those who are bound to lose in the process of coordination are likely to resist any change.

Strategy 2: Allow for the emergence of market solutions, either in the form of gateway technologies or through the setting of de facto standards.

Both research on standards and past experience make it clear that, because of the costs and trade-offs involved, government efforts to bring about interoperability by establishing standards have not always worked in the public interest. On the contrary, when standards have been prematurely set—as in the case of color television—they have often hindered the development of a better technology.[41] Because of these experiences, many recommend that the government intervene in the standards-setting process as little as possible, allowing the marketplace to provide solutions to the problems of interoperability. Such solutions may take the form of either de facto standards or gateway technologies that serve as translators between otherwise incompatible equipment or systems.

Generally speaking, this minimalist approach is the one preferred by many vendors and suppliers, especially those in the information industry. Because the choice of standards can have a major impact on competition, many of them are deeply suspicious of, if not opposed to, the government playing an active role in the standards-setting process. This point of view has been aptly stated by Carl Cargill, senior standards consultant at Digital Equipment Corp. Defending the present system of voluntary, consensus standards against the criticism that it is too slow and inefficient, he contends, for example, that:

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[40] Anthony M. Rutkowski, "Toward a National Information Fabric: organizing fOr Success," *Telecommunications,* September 1987, p. 8.

[41] Nathan Rosenberg, "Reflections on the Future of the Telecommunications Industry, " OTA contractor report, December 1986, p. 10.

> . . . a specialist who does not work for a company that either makes or uses the product will very likely lose sight of why standards exist. . . . the bureaucracies that currently control much of the standardization process in Europe . . . have spawned disasters. Standards planning in the U.S. is where it should be right now—in the hands of the people most directly impacted. This combination of providers and users creates an understanding of what is needed far better than any expert consultant planning agency .42

This minimalist approach is reflected in the FCC's policy strategy for standards over the past several years. The FCC's rationale is exemplified, for example, by its decision on cellular radio, in which it stated:

> We believe it would be inappropriate at this time to embark on a proceeding to select technical standards for future cellular systems. Such a course would be premature given the early stage of development of new cellular and is likely to discourage technical innovation. Instead we seek to foster the development of competing technologies that could then be evaluated in the market.[43]

Economic research and analysis on standards and past experience suggest that this market approach is most likely to result in standardization when all interested parties: 1) prefer the same standard, 2) have something positive to gain from standardization, and 3) have adequate information about the intent of other parties. This optimal situation occurs only rarely.[44] However, even when all of these conditions do not hold true, economists argue that government intervention in the standardization process is likely to have more negative than positive consequences—measured in terms of the criterion of economic efficiency-when: 1) no single technology stands out as being preferable, 2) technologies are undergoing rapid change, and 3) a technology has a variety of different uses. They contend that, under these circumstances, it is often best to allow users to work out their own compatibility problems, either by negotiating among themselves or with the help of companies that will provide them with gateway and integration services.[45]

Standards decisions, however, also need to be weighed against noneconomic criteria. There are times when having "a" standard (even if it is not the optimal one from an economic criterion of efficiency) might be better than having no standard at all. Standards might be required, for example, in order to effectively use defense technologies. It was, in fact, for this reason that the National Research Council (NRC) urged the adoption of UNIX as a standard operating system in its evaluation of the Nationwide Emergency Telecommunications Network.[46] Or, as in the case of HDTV, standards might be sought in order to promote U.S. access to the international market.[47] The government could also press for standards as a way of encouraging the development of what it considers to be an essential, but inchoate, market. It might be argued, for example, that one way of fostering information services for residential and small-business users would be to encourage the development of teletext and videotex standards. Finally, government might become involved in standards-setting processes as a way of structuring competitive markets, as it may be further required to do in the case of implementing the ONA process.

Strategy 3: Indirectly influence the standards-setting process by providing assistance and guidance to foster the setting of standards.

Option A: Facilitate the gathering and exchange of information.

At times, the failure of an industry to set standards is due not to disagreements among parties about the need for standards, or even about the preferred technology that should be adopted, but rather to the fact that the parties involved are unaware of the preferences and intentions of others. As Besen and Saloner have pointed out, vendors might hesitate to take the first step towards the standardization of a

42Carl Cargill, "ANSI Me This: Who Has Control Over Standards?" *Computerworld*, July 4, 1988, p. 17.

43As quoted in Dr. George Calhoun, "The Next Generation of Cellular Radio," *Telecommunications*, June 1988, pp. 41-45.

44See footnote 1. This is not to say, however, that the optimum standard will be set in the marketplace. For, as Besen and Johnson have pointed out, there are some types of market situations in which the wrong technology (based, that is, on the criterion of economic efficiency) might be selected as a standard. Besen and Johnson, op. cit., footnote 1.

45See footnote 1.

46Martin Edmonds, "Defense Interests and United States Policy for Telecommunications," OTA contractor report, June 1988.

47See Norm Alster, "Tv's High-Stakes, High-Tech Battle," *Fortune*, Oct. 24, 1988, pp. 161-170.

product if they are unsure whether other vendors will follow or if they have no way to bargain and negotiate for the exchange of side payments.[48] In cases where the lack of information exchange seems to be the direct cause of the lack of standards, the government may want to intervene to foster an exchange among interested parties.

One way to do this would be through FCC fact-finding proceedings. For example, acting either on its own or in response to industry petitions, the FCC might initiate an inquiry, or Notice to a Proposed Rule Making, to ascertain the views of the public about the need for, or feasibility of, a particular standard. This approach works best when interested parties basically agree on what constitutes the best standard. Where there are strong disagreements, however, this method might actually exacerbate differences, and hence serve to hinder the development of standards.[49] Another problem with this approach is that it does not call for parties to get together to work out their differences. Moreover, because industry comments are presented independently of one another, the data that it generates may not be comparable, making it difficult for the FCC to interpret them.[50]

Alternatively, the FCC might encourage the establishment of an interindustry committee to look into a standards problem and report its findings. This was done in the case of HDTV with the establishment of the Advanced Television Services (ATS) Advisory Committee. Comprised of top executives of television and related industries, this committee was established by the FCC in July 1987 to advise the agency on standards and spectrum allocation. Broadcasters, themselves, set up the Advanced Television Test Center (ATTC) to advise the FCC's ATS Advisory Committee. One advantage of this kind of initiative is that it allows interested parties to work out their differences first and then present the FCC with more uniform information.[51]

Option B: Reduce the costs of participation, or increase the costs of nonparticipation, in standards-setting.

Attempts to set standards might also fail because the effort required to participate in the standards-setting process appears greater to the relevant parties than the perceived benefits. The classic case is that of trying to set up a system of weights and measures; because all parties benefit in the same way from the existence of standards, the costs of trying to develop them may be greater than the perceived benefits.[52] But such a situation might also arise, for example, if the market for a product is small and perhaps undeveloped.[53] When there is no present or perceived future market for a product, industry may have little incentive to spend the time, money, and effort required to develop standards for it. And, in the event that standards are required for a market to develop, the situation might result in a state of inertia, engendering neither standards nor a market. Some say, for example, that this situation accounts for the failures of AM stereo, teletext, and videotex.[54] It may also explain why vendors have been hesitant to implement ISDN standards.

In such cases, the government might try to overcome the inertia by initiating proceedings as described above. As always, the government would have to weigh the cost and potential risks of action against the benefits to be gained by such efforts. It should be noted, however, that the risk of the government forcing a standard prematurely is less when there is inertia and there are no strong advocates of a particular standard.[55]

Option C: Encourage and facilitate the inclusion of all interested parties.

48See footnote 1. Side payments refer to bargains struck between companies to further the standards-setting process.

49Ibid.

50Besen and Johnson, for example, suggest that this lack of comparable data accounts in part for the FCC's hesitancy to set standards for stereo TV. Op. cit., footnote 1, p. 54.

51It should be noted that although the cable industry was represented on the ATS Advisory Committee, the National Cable Television Association declined an invitation to participate in the ATTC.

52As Besen and Saloner note, "paradoxically, when standardization cannot create a competitive advantage, so that achieving a consensus should be easy, the incentive to free ride is greatest. " Op. cit., footnote 1, p. 6.

53Besen and Johnson, op. cit., footnote 1, p. 54.

54Ibid.

55Ibid.

With the growing importance of communication and information-based services, more people have a stake in the outcome of decisions about interoperability in the communication infrastructure. One role that the government might play, therefore, is to assure that all interested parties are included in the debates about standards. The government has already taken some steps in this direction. For example, one reason NIST organized the North American ISDN User's Forum was to assure users a voice in ISDN implementation.[56] Users were also incorporated into the ONA proceedings, as required by FCC rules. Not every group has such leverage, however. Thus, government may have to take further steps to assure that a wide assortment of views are incorporated into the standards process. Small businesses, in particular, have expressed concern that they not be left out. Moreover, as described below, there is clearly a need for greater coordination among State, Federal, and international jurisdictions in working out standards problems.

Strategy 4: Influence the setting of particular standards by providing incentives or imposing sanctions.

In a number of cases, a firm (or fins) may have a strong proprietary interest in particular technologies, and therefore be unwilling to cooperate in establishing an industry standard. Instead, they will try to have their own technology established as a de facto standard in the marketplace. Until recently, for example, this was IBM's style of dealing with standards. Similarly, when users already have an installed base of technology that is built around one particular set of standards they will probably be opposed to switching to anew set. If the government were to promote standardization under such circumstances, it would most likely have to provide sufficient incentives and/or sanctions to induce the parties-at-interest to compromise.

Option A: Use government procurement power to encourage standards-setting.

Because the Federal Government is one of the largest purchasers of both communication and information technologies, it has considerable leverage in these markets. Thus, one way in which the government can encourage standardization is by using its procurement power. By doing so, the Federal Government was able to press IBM to support the computer language, COBOL. More recently, the Department of Defense, responding to NRC recommendations calling for greater standardization of operating protocols, has required that the existing Transport Control Protocol/Internet Protocol (TCP/IP) be replaced by the International Standards Organization's OSI protocol, within 2 years. It should be noted, however, that many equipment vendors disapproved of this decision and formed a lobbying group, the Coalition for Working Systems, to resist the proposal.[57]

Option B: Provide support for a particular standard.

Without mandating a particular standard, the government might make its preferences clear, focusing on one kind of standard over others. Such an approach might be used to restrict or delay the adoption of a particular standard, if the technology is considered to be immature. For example, the FCC used this approach when considering standards for stereo television. The industry was eager for government to establish a standard, which is not surprising given the interdependence of, and hence the need for compatibility between, transmission and receiver systems. However, instead of adopting the standard put forward by an industry committee, the FCC decided to forgo mandatory standards and allow other technologies to evolve. But it did support the industry's choice by protecting their system from interference by others.[58] Given the agreement among stakeholders, this limited support was sufficient for a standard to evolve; when no competing system emerged, the system, with the government's support, became the de facto standard.[59]

Strategy 5: Mandate industry-wide standards.

In recent years, the government has tried, whenever possible, to avoid taking direct control over the standards-setting process and mandating industry-

[56] NIST, "North American ISDN User's Forum, " undated.

[57] Edmonds, op. cit., footnote 46, p. 44.

[58] Besen and Johnson, op. cit., footnote 1, p. 65.

[59] Ibid.

wide standards. This approach is designed to foster the development of new technologies, and it appears to be appropriate in the light of rapidly changing technologies. However, it may be less workable in the future, given the globalization of the communication system and the economy. As other countries establish standards in such key areas as ISDN, OSI, and HDTV, the U.S. Government may, at the very least, have to foster the domestic processes for deciding on standards. If the rest of the world moves forward on standards without the United States, waiting for the domestic market to set de facto standards may be costly in terms of U.S. participation in world trade. Thus, in a few instances, the government may have to play a more active role, even mandating an industry standard in some circumstances. Such a decision, however, would face strong opposition from a number of industry stakeholders, especially those who benefit from existing proprietary technologies.[60]

Strategies *and Options in Three Cases*

Integrated Services Digital Network

The term "integrated services digital network" (ISDN) is a confusing one, referring to both a particular kind of communication network[61] and the set of standards that support it.[62] Understanding the term is further complicated by the fact that it has been used to refer to both narrowband ISDN (N-ISDN)[63] as well as to broadband (B-ISDN),[64] Although this section focuses specifically on the setting of ISDN standards, consideration of the value of ISDN communication networks—narrowband and/or broadband—will serve as an important criterion for determining the appropriateness of any government role in the development of these standards.

As discussed earlier, standards are generally accepted criteria that serve as a basis of comparison. In telecommunication, standardized interfaces consist of specified sets of values, or rules, to which devices and systems must conform if they are to work correctly and consistently. ISDN interfaces serve "to handle electrical signals that contain information and conform to certain values of size, shape, repetition rate, pulse sequence, and noise environment."[65] They are designed to transport voice, data, video, or some combination of these. To do so, ISDN standards need to be established for the: 1) transport mechanisms (transmission), 2) supervisory control signaling (protocols), 3) procedures for interconnecting terminals (connectivity), and 4) the type of intelligence to be passed (services).[66]

ISDN standards have been characterized as "anticipatory" standards-that is, standards that are produced prior to a product's introduction. One purpose of establishing standards in this fashion is to facilitate the evolutionary or orderly development of a technology by allowing for backwards compatibility. Another purpose is to foster multiple development efforts by providing a cohesive structure into which future products can be integrated.[67] In the specific case of ISDN, standards are being developed to support the evolutionary transformation of a voice-based telecommunication network into a gen-

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[60]Reviewing the OTA draft report, some industry stakeholders (for example, AT&T and the American Petroleum Institute) questioned the OTA proposition that government involvement in the standard-setting process can make a significant, and positive, difference under some circumstances, From their perspective, the arguments in favor of this option are unsubstantiated.

[61]As described by the CCITT Study Group XVIII, which is responsible for coordinating ISDN standards, ISDN is "a network evolved from the telephony ISDN that provides end-to-end connectivity to support a wide variety of services, to which users have access by a limited set of standards of multipurpose customer interfaces. For a discussion, see Rolf Wigand, "Integrated Services Digital Networks: Concepts, Policies, and Emerging Issues," *Journal of Communication*, Winter 1988, pp. 29-49.

[62]For a discussion of the confusion caused by this term, see Tom Valovic, "Fourteen Things You Should Know About ISDN," *Telecommunications*, December 1987, pp. 37-42.

[63]The two standard user interfaces for N-ISDN were adopted in 1988 at the Melbourne meeting of the CCITT, after 4 years of discussion. They are the Basic Rate Interface (BRI) and Primary Rate Interface (PRI). The BRI is composed of two channels (each of which transmits at 64 kilobits simultaneously) anda D channel that transmits at 16 kilobits and carries information for signaling and for controlling the B channel. In the United States, the PRI consists of 23 channels (each of which transmits at 64 kilobits) and a D channel that signals at 64 kilobits.

[64]Considerable confusion and disagreement still exist with respect to the actual form that broadband ISDN will take. The term usually refers to very high capacity transmission channels, generally in excess of 100 megabits per second (Mbps).

[65]Alan Stewart, "A User's Guide to ISDN Standards," *Telecommunication.s*, May 1988, PP. 85-90.

[66]Ibid., p. 86.

[67]Hack, op. cit., footnote 1, P. 5.

eral-purpose network, equipped to carry all kinds of electronically transmitted, digital information.[68]

The original impetus for ISDN standardization came from Europe, where the postal, telegraph, and telephone authorities (PTT's) saw it as a means of both upgrading the public network and discouraging the development of private networks, which they feared would be outside of their control.[69] Moreover, by providing interoperability for data communication, ISDN would also make it easier for the European communication industry to compete with IBM, which, through the development of system network architecture (SNA), was preparing to provide interoperable data transport among computers on a proprietary basis.[70] The importance attached to this strategy is clearly revealed in the Nora-Mine Report, which advised the French Government:

> Controlling the network system is thus an essential objective. This requires that its framework be designed to serve the public. But it is also necessary for the state to define access standards; otherwise the manufacturers will, utilizing the available routes but subjecting them to their own protocols . . .
>
> The level of standardization will thus shift the boundary between the manufacturers and the telecommunications organizations; it will be a bitter struggle, since it will develop out of a reciprocal play for influence. But the objective of public control indicates the strategy to follow: increase the pressure in favor of standardization.[71]

Today, European ISDN standards are being developed by the Conference of European Postal Telecommunications Administrations (CEPT),[72] as well as by the European Computer Manufacturing Association's (ECMA) Technical Committee 32 Technical Group 1, and the recently established European Telecommunications Standards Institute. Although there has always been a general European consensus in favor of ISDN, some significant differences persist among country approaches.[73] Concerned that incompatible standards might retard the development of a pan-European telecommunication market, the European Council of Ministers, in November 1987, called for immediate joint action to develop precise interfaces, a common timetable, and a user community large enough to establish new services .74 In addition, between 1987 and 1991, the European Commission plans to spend about $9 million to monitor the telecommunication administrations' ISDN developments and to finance promotional activities in support of ISDN.[75] Notwithstanding all of these joint activities, progress on ISDN to date has been disappointing to the European Commission. As a result, it has had to slow down its push towards developing B-ISDN.[76]

Given the competitive motivations behind much of the European interest in ISDN, it is understandable that the original U.S. response to it was less than enthusiastic.[77] This skeptical attitude was reinforced by the fact that ISDN, built around a uniform set of standards, was seen by many as having an inherent bias in favor of the centralized provision of telecom-

68William Lehr, "ISDN: An Economist's Primer for a New Telecommunications Technology," Stanford University, Technology and Progress Seminar, Feb. 14, 1989, p. 8.

69James G. Herman and Mary A. Johnston, "ISDN When? What Your Firm Can Do in the Interim," *Data Communications*, October 1987, p. 226.

70For a discussion, see Noarn, "The political Economy of ISDN," op. cit., footnote 2, Pp. 28-35.

71S. Nora and A. Mine, *The Computerization of Society*, Report to the President of the French Republic (Cambridge, MA: MIT press, 1980), pp. 74-75, as cited in Noam, ibid.

72For a discussion, see Doug Barry, "EuroPan Standards Gather Pace," *Telecommunications*, January 1989, pp. 64-70. Although the PTTs are pressing forward with their plans for ISDN, some public opposition has emerged over time. In Germany, for example, the Green Party has questioned the value of moving rapidly towards the deployment of information technology, while unions, churches, and other groups have raised questions about the impact of ISDN on jobs. Wigand, op. cit., footnote 61, p. 37.

73One area of difference, for example, is in proposed user interfaces. France plans to implement "telephone user part plus," a specification by CEPT, for user-to-international network links. West Germany is going ahead with "ISDN services user part" through CCITT. Dawn Hayes, "Planning ISDN: Can the Nations Become United?" in "Grand Designs for ISDN," *CommunicationsWeek, CLOSEUP,* May 2, 1988. See also, P. Slaa, *ISDN As a Design Problem: The Case of the Netherlands* (The Hague: The Nederlandse Organisatie voor Technologisch Aspectenonderzoek, March 1988).

74Wigand, op. cit., footnote 61, p. 38.

75Ibid.

76Hayes, op. cit., footnote 73, p. C4.

77For a comparison of early interest, see Wigand, op. cit., footnote 61.

munication services.[78] This perception was bound to work against ISDN, insofar as the United States was just beginning to move away from the integrated Bell System towards divestiture and deregulation at the time when the idea of ISDN was gaining momentum in Europe.

To the extent that discussions about ISDN have occurred in the United States, they have generally taken place in technical rather than in political forums. National ISDN standards are developed, for the most part, by ANSI's TIS1 subcommittee, one of six subcommittees that comprise the larger T1 committee sponsored by the Exchange Carriers Standards Association (ECSA). This is a trade association of U.S. communication carriers and suppliers that was founded after divestiture, and subsequently received accreditation for its T1 Committee from ANSI.[79] Once the T1 S 1 subcommittee agrees on recommendations, it sends them to the T1 Committee. After reaching a consensus, the T1 Committee forwards them to the Department of State, which forwards them to CCITT as representing the official, unified U.S. position.[80]

In keeping with the U.S. tradition of developing voluntary consensus standards, the Federal Government has not been deeply involved in setting ISDN standards. The FCC has intervened, however, in the few cases-such as that of the "U" interface—when it appeared that international ISDN standards developments might have anticompetitive consequences.[81] More recently, NIST has established the North American ISDN User's Forum. This is intended to provide users with a platform for voicing their needs for standards, and to facilitate the development of implementation standards by bringing users and vendors together.[82]

To date, State governments and State regulators have not shown much interest in the issue of ISDN standards. Their involvement, however, may become greater in the future, as ISDN tariffs begin to be filed.[83] The New York State Public Service Commission, for example, recently held a major inquiry on the subject.

The responsibility for reconciling conflicting national ISDN standards on a worldwide basis rests with the CCITT, the standards-setting arm of the International Telecommunications Union. In November 1988, the CCITT plenary session, held in Melbourne, Australia, unanimously accepted the Basic and Primary rate interfaces that had been under discussion since the last plenary session held 4 years before. Discussion groups are now turning their attention to the proposed broadband standards, which are scheduled to be presented to the 1992 plenary session for ratification.[84] One major breakthrough with respect to broadband ISDN was the

78 See Noam, "The Political Economy of ISDN," op. cit., footnote 2, p. 38; see also, Lehr, op. cit., footnote 68.

79 "ISDN," *Data Communications*, December 1987, p. 52. In the United States, most commercial standards are voluntary standards developed through consensus proceedings in nonprofit, nongovernmental organizations. ANSI is the organization in the United States that has the major responsibility for developing national standards. ANSI, itself, does not make standards; it endorses groups of experts and the processes by which standards are arrived at. Among those involved in ANSI proceedings are the Electronic Industries Association, the Institute of Electrical and Electronics Engineers, and NIST. For a discussion, see Hack, op. cit., footnote 1, pp. 8-9.

80 Ibid.

81 Noam, "The Political Economy of ISDN," op. cit., footnote 2, pp. 40-41. It was t. this end, for example, that the FCC, in August 1983, issued a Notice of Inquiry (Docket 83-841). As described by Noam: "Its goals were both to generate comments on the FCC's role in ISDN and to stimulate interest in the policy discussion on ISDN itself. The first report, issued in April 1984, restate[d] the FCC's intention for a limited role. It set, however, several policy principles for ISDN design: a flexible numbering plan that permits user choice of carriers, domestically and internationally; . . . and no limitation of satellite hops in international connections. Secondly, the FCC declared that customer provision of the network termination device (NT1) should be a national option and asked for comments on the definition of the so-called "U" interface point between the customer premises equipment and the network. Thirdly, the FCC described as fundamental that CCITT recommendations must be flexible for national options, and that the American distinction between basic and enhanced services be maintained." The FCC examined ISDN again in its 1986 Report and Order on Computer III, which probed the relationship between ISDN and the FCC's comparably efficient interconnection (CEI) proposals, concluding that any problems that might emerge would be manageable.

82 U.S. Department of Commerce, Press Advisory, "NBS, Industry Form ISDN User's Forum." The Forum consists of two workshops: one for ISDN users and one for ISDN implementors. The User's Workshop is set up to develop requirements for specific business applications for ISDN, whereas the Implementor's Workshop will prepare specification agreements necessary to implement the applications. The activities within the two workshops are being coordinated by the North American ISDN User's Forurn Executive Steering Committee. Contributing to the work of the forum is the 0S1 Implementor's Workshop and the Corporation for Open Systems. Also involved are user organizations (such as General Motors) that have been deeplv involved in the development of MAP (Manufacturing Automation Protocol).

83 Lou Feldner, FCC, personal communication.

84 Keith Newman, "ISDN Standards Ratified," *Computerworld*, Dec. 19, 1988, p. 45.

recent agreement on Synchronous Optical Network (SONET), the international optical-interface standard or, more specifically, the Network to Network Interface (NNI) for B-ISDN.[85]

Although the CCITT has clearly been moving forward in developing ISDN standards, the lengthiness of the process may, in the long run, actually make it more difficult to achieve interoperability and to gain user acceptance for ISDN. For example, many companies—as well as countries-are now building their competitive strategies around the existence of ISDN, and the likelihood of an evolutionary, technological development towards it. To execute these strategies, and to attract future customers, they need to begin now to develop products and test them in trials. These efforts need to be undertaken despite the fact that, in many cases, application specifications and implementation standards are as yet undefined. It would be unfortunate if, as a result, vendors were to develop a number of products that are purported to be designed to ISDN standards, but are actually incompatible with one another.[86] This would dampen users' interest in ISDN, an interest that is still somewhat skeptical at best.[87] A second problem might be that regional standards-setting bodies may begin to supersede CCITT in setting standards, generating centrifugal forces in the international standards-setting arena.[88]

Also stemming the tide towards the development of ISDN standards is the fact that, like any standards-setting, the advantages and disadvantages to be derived will not be distributed evenly among stakeholders. Among the key U.S. beneficiaries of the early adoption of ISDN standards will be AT&T and the regional Bell operating companies (RBOCs). As discussed in chapters 5 and 12. AT&T and the RBOCs will need to continually upgrade, and add intelligence to, their networks if they are to successfully compete with other communication providers for the lucrative business-user and prevent further bypass. To do this, ISDN is essential. Together with signaling system 7 (SS7), ISDN will permit telephone companies to allow customers to tailor their communication circuits on public networks in much the same fashion as they do now on private networks.[89] As one observer has described the relationship between ISDN and the competitive prospects of the RBOC and AT&T:

> . . . from a purely strategic standpoint, it came as no surprise to see both AT&T and the BOCs enthusiastically embrace the concept of ISDN in the aftermath of divestiture, sensing the potential for both real or virtual remonopolization and the need to regain marketing initiatives towards the large corporate user-the lack of which was the short-term price of the complicated trade-offs inherent in divestiture.
>
> Most especially, ISDN became important because it offered a universal scheme whereby significant new functionality for both voice and data (and possibly even higher bandwidth applications such as video) could be offered to corporate customers but be controlled and managed via AT&T and BOC custody of the public networks. This was reinforced by the realization that unless they moved to create these new levels of both network intelligence and control for their customers, they would lose serious competitive advantages as corporate users plunged ahead with their private networking efforts.[90]

While most vendors have publicly declared their intent to move towards ISDN standardization, they have not been uniformly supportive of its development. Many private network vendors, such as those selling T1 multiplexer and PBXs, are fully aware of

[85] This agreement represented an important breakthrough because the SONET standard. which was developed in the T1 committee of the Exchange Carriers Standards Association, was initially opposed by both the Japanese and the Europeans. The compromise specification is based on SONET, but has additional capabilities to allow it to deal with the European 2-MBps digital hierarchy. For a discussion see, Rodney J. Boehm, "SONET: An International Standard," *Telecommunications*, March 1988, pp. 73-76; Rodney J. Boehm, "SONET: A Standard Optical Interface Emerges," *Telephony*, Apr. *4, 1988,* pp. 54-57; and Alistair Henderson, "Into the Synchronous Era," *Telecommunications*, December 1988, pp. 29-33.

[86] See, Byron Belitsos, "Competition Threatens Progress of ISDN in the USA," *Communications International,* October 1986, p. 29; and Sarah Underwood, "ISDN On Trial," *Datamation*, Feb. 1, 1987, pp. 53-56.

[87] See, for example, Clare Lees, "ISDN-User Doubt and Tariff Issues," *Telecommunications*, April 1988, pp. 56-63; John Foley, "ISDN haves Early User Hanging," *CommunicationsWeek*, July 4, 1988, p. 39; and Warren S. Gifford, "ISDN Performance Trade-Offs," *Telecommunications,* April 1988, pp. 65-68.

[88] In recognition of this possibility, CCITT adopted a number of reforms at its November 1988 meeting, which are designed to accelerate the approval procedure. Gilhooly, op. cit, footnote 34.

[89] Stuart Zipper, "Telecom Firms Arm vs. RBOCs in Bid for ISDN, SS7 Public Net Market," *Electronic News*, Oct. 5, 1987.

[90] Tom Valovic, "Public and Private Networks: Who Will Manage and Control Them?" *Telecommunications*, February 1988, pp. 42-45.

the potentially negative impact that ISDN can have on their competitive position vis a vis the regional Bell companies and AT&T[91] With this in mind, they have rushed to sell their products, thereby locking up customers for private digital networks before ISDN and SS7 can become a reality on the public network.[92] Some of the large vendors of switches are employing a mixed strategy-pressing to sell now to private networks, but planning to be the primary suppliers of ISDN switches in the future when a market for ISDN services emerges.[93] While IBM was initially slow to warm up to ISDN, it has recently become a much greater supporter. ISDN is now an important part of IBM's strategy to become a key provider in the telecommunication networking market. One additional factor that was clearly important in changing IBM's stance on ISDN was its desire to sell its networks in Europe, where standardization with the public networks is essential.[94]

Most large users have yet to become enthusiastic about ISDN. Because the kind of functionality they need is still along way off in an ISDN environment, they are developing their own private networks, using the TI, T3, and local- and wide-area network technologies that are available to them at the present time.[95] Many question whether ISDN will ever be more cost-effective than their existing networks, given the magnitude of their data needs and, hence, the tremendous economies of scale they enjoy.[96] In addition, as other networking standards are developed and private networks themselves serve to integrate voice and data, ISDN may prove redundant.[97] As a result, whereas large users have been strong proponents of the move towards OSI standards, they have not been as active in the ISDN standards-setting process. Their most important input to date has come from their participation in the ISDN User's Workshop established by NIST[98]

Small-business, residential, and rural users may actually have a much greater stake than large users in the timely development of ISDN standards. As described in chapters 5 and 8, they do not have the resources, nor do they enjoy the economies of scale and scope, that are required to establish and manage a private communication network. Thus, without ISDN, they will not have access to many of the economic advantages that new technologies afford. Notwithstanding the potential value of ISDN to these users, they have played a very small role, if any, in the ISDN standards-setting process.

In considering whether Congress should take additional steps to encourage the ISDN standards-setting process, certain questions and answers need to be kept in mind. These appear in table 11-1.

Open Systems Interconnection

Open systems interconnection (OSI) is an architecture for computer networks and a family of standards that permits data communication and data processing among diverse technologies. Like ISDN, OSI-based standards anticipate the development of particular applications or products. They provide a reference model that defines and categorizes seven layers of functions that need to be performed in any computer network if effective communication is to take place, as well as the protocols and services at

[91] As one PBX vendor described the competitive situation, given ISDN, it will be all too easy for third-party vendors to attach their voice and data devices to proprietary PBX systems. "Why should vendors go through the R&D expense of developing and implementing the standand [on their products] when someone else can come out with a nicer terminal to plug into their PBX?" as cited in, Elizabeth Horwitt and Kathy Chin Leong, "PBX Vendors Pressured For ISDN Links," *Computerworld*, Sept. 12, 1988, p. 80.

[92] Ibid; see also, Valovic, op. cit., footnote 90; and Joseph Brau, "1987: The Year When Networking Became Part of the Bottom Line," *Data Communications*, January 1988.

[93] Ibid. See also Valovic, op. cit., footnote 90, and Elizabeth Schultz, "PBX Upgrades Travel the Bumpy Road to ISDN," *Telephony*, Nov. 28, 1988, pp. 36-39. The position that AT&T finds itself in is telling. As noted by Steven Titch, having invested so heavily in developing the 53SS switch, AT&T has a tremendous interest in seeing ISDN come to market. However, its aggressive sales efforts have offended many of the BOCs, who have now accused the vendor of failing to support the embedded base of 1AESS. Steven Titch, "Network Gear," *CommunicationsWeek*, December 1988, p, C1O.

[94] Barbara Depoma, "Into ISDN in a Big Way: Once a Skeptic IBM is Quickly Becoming a Major ISDN Proponent," *CommunicationsWeek*, Oct. 26, 1987.

95 Valovic, op. cit., footnote 90.

[96] T. Travers Waltrip, "ISDN and the Large Corporation: 1s ISDN the Best Solution for Big Telecom Users in the Corporate World? Maybe No," *Telephony*, May 9, 1988.

[97] Ibid.

[98] John Foley, "Users Demand Role in ISDN," *CommunicationsWeek*, June 13, 1988, pp. 1, 70. Among the major ISDN problems remaining that were cited by users were the ISDN numbering plan, wiring standards, subrate adoption, and equipment incompatibility.

Table 11-1--Integrated Services Digital Network: Factors Affecting the Choice of Federal Options

1. Apart from the value to individual stakeholders, of what value is the setting of standards in this area from a societal perspective?	Important for maintaining the viability of the public switched network. For reasons of equity, so as to assure that the new information services are available to residential users, to small businesses, and in rural areas.
2. What is the cost of waiting for standards to be developed in the marketplace or through a voluntary consensus process?	In the case of ISDN standards, there is some danger that, given the growing competition among vendors, proprietary solutions will be implemented before specifications can be adopted and products implemented to conform to them. There is a danger also that U.S. standards, and the U.S. standards-setting process, will become out of sync with international standards developments, with negative consequences for the communication industry.
3. How likely is it that, in the absence of government intervention, de facto or voluntary standards will be adopted in the near term?	Not likely, given the lack of user demand and the uncertain market for ISDN products.
a. To what extent do vendors share a common interest in developing standards and agree on the appropriate standard?	Vendors have all committed to conforming to ISDN narrow band standards, although some have greater stakes in these standards (AT&T, the RBOCs) than do others (IBM, providers of T1 multiplexer, other system integrators). Competition among vendors is extremely intense.
b. To what extent are users eager to standardize? Do they agree on a standard? What leverage do they have vis a vis vendors in the marketplace?	Many users, especially large users, remain unconvinced about the value of ISDN, although interest in ISDN products is dearly growing.
4. To be effective in promoting standards, what level of government involvement would be required? How far would the Federal Government need to go in the direction of setting standards? What kinds of government involvement might be appropriate?	Moderate effort. Greater technology/R&D support. Support for broader public policy input into the standards-setting process. Increased coordination of U.S. position on ISDN for presentation at international standards-setting fora.
5. How susceptible are standards to technological change? How many possible options or choices of standards are there?	Moderately susceptible to change. Integrated approach attempts to allow for compatibility over time. However, the time required for moving towards B-ISDN appears to be getting shorter and shorter.

SOURCE: Office of Technology Assessment, 1990.

each layer (see figure 11-3).[99] These layers are designed to be independent of one another so that altering one layer will not require alterations in others.[100] These seven layers are, themselves, generally divided into three groups:

- the four lower layers (physical, data linking, networking, and transport), which handle the interconnections of end systems;
- layers 5 and 6 (session and presentation), which support the exchange of information between end systems using data transfer facilities provided by the transport service; and
- layer 7, the applications layer, which provides for interworking between applications processes in end systems.[101]

Like ISDN, OSI-based standards are international in scope and are being developed in international standards-setting bodies. However, whereas ISDN

[99] Hack, op. cit., footnote 1, p. 15. See, for a further description and discussion, Harold C. Folts, "A Tutorial on the Interconnection Reference Model," *Open Systems Data Transfer 2-21*, June 1982. Reprinted in William Stallings (ed.), *Computer Communications: Architecture, Protocols, and Standards* (Silver Spring, MD: IEEE Computer Society Press, 1985).

[100] Hack, op. cit., footnote 1. See also, Bryan Wood, "Standards for OSI—Present Status, Future Plans," *Telecommunications*, March 1988, pp. 32-36.

[101] Ibid.

standards are being established by CCITT, OSI standards are being worked out by the Joint Technical Committee 1 (JTCl)[102] of ISO and the International Electrotechnical Commission (IEC).[103] Although CCITT and ISO cooperate in setting standards[104] —and ISDN is being developed to conform to the OSI reference model—there are some important differences between the two organizations. These are sometimes reflected in how stakeholders perceive the standards-setting processes and the standards that emerge from them.[105] Developed to coordinate telecommunication among nations, CCITT is a treaty organization whose decisions are binding on its signatories. ISO, on the other hand, evolved in response to the market need for standards; thus, it is a voluntary organization that develops standards through a consensus-building process, and its decisions are not binding on the participants.[106]

Just as the European nations provided the initial support for ISDN, they were also quite prominent among the original supporters of OSI, and for much the same reason. The Europeans were eager to prevent the further consolidation of IBM's control of network standards through SNA, its proprietary network model.[107] But unlike ISDN, the demand for OSI among users, both in the United States and Europe, was quite high. This demand reflected an appreciation of the need for computer interconnectivity to keep pace with the enhanced role of information and communication in a service-based economy.[108]

The development of standards for OSI is now maturing as a process, both with respect to the evolution of the standards themselves and in terms of their use in information technology systems and related equipment.[109] Considerable progress has been made since ISO published its first OSI documents. The standards for levels 1 through 6 are quite well developed. Although some applications standards for level 7 still need to be set, during the past year the progress in this area has been quite impressive.

Looking at these developments, most observers agree that, over the long term, the move to OSI standardization is inevitable.[110] However, there is much less agreement about when and how this will come about. There are still a number of obstacles to full implementation of OSI, and considerable uncertainty with respect to how these might be overcome.

[102] The Joint Committee is made up of the information technology committees of the ISO and the International Electrotechnical Commission, a voluntary standard-setting body that is devoted to developing electrical and electrotechnical standards. To avoid a growing competition between these two organizations for the responsibility of setting computer standards, the information technology activities of these two groups were merged in 1987.

[103] The International Standards Organization was established in 1946 by delegates from 64 countries. Similar to ANSI, the ISO is a nongovernmental, voluntary institution. There are presently 72 "full members" of the ISO representing national standards associations, such as ANSI. In addition, there are 17 "correspondent members," representing governmental institutions from countries that do not have national standards bodies. Besen and Saloner, op. cit., footnote 1, pp. 14-15. See, for a further description, Edward Lohse, "The Role of the ISO in Telecommunication and Information Systems Standardization," 23 *IEEE Communications Magazine,* January 1985, pp. 18-24.

[104] The CCITT has been involved in setting some data communication standards, the most important of which was CCITT Recommendation X.25 for packet switching. Unlike the OSI standards, the CCITT data communication standards were developed on an ad hoc basis and not as part of a grand design that would provide compatibility of different protocols and system architectures. Besen and Saloner, op. cit., footnote 1, pp. 17-18.

[105] Carl Cargill, Senior Standards Consultant, Digital Equipment Corp., personal communication, Mar. 13, 1989.

[106] Ibid. To become a Draft International Standard, a proposal must have the approval of 75 percent of those participating in a relevant technical committee. These draft standards become international standards once they have been adopted by the Council of the ISO. Besen and Saloner, op. cit., footnote 1, pp. 15-16.

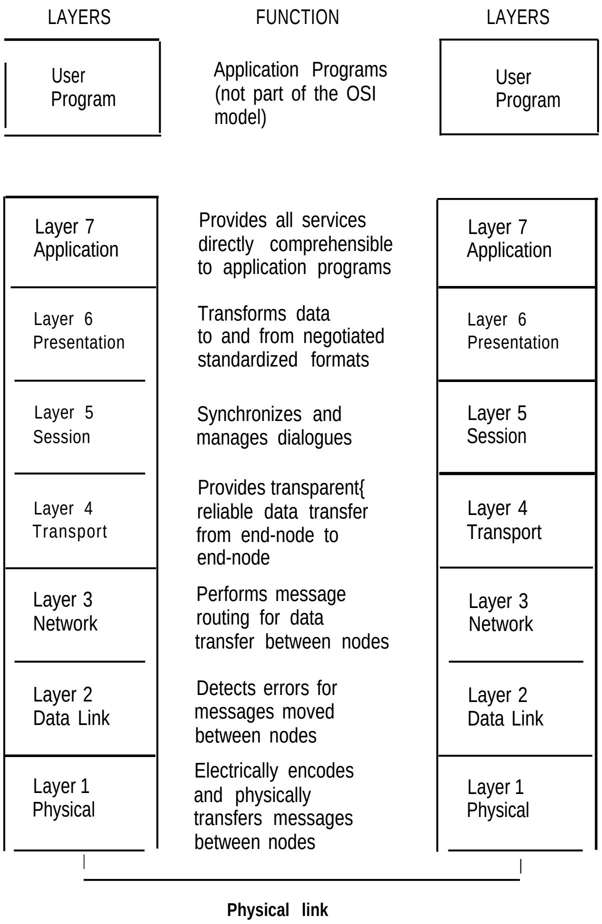
[107] Hack, op. cit., footnote 1, p. 17. SNA, which was developed by IBM in 19'74, provides a layered architecture similar to that of OSI, with the highest layer---equivalent to OSI's Layer 7—being served by several IBM applications, including Systems Network Architecture Distributed Service (providing store-and-forward facilities), Distributed Office Support Systems (providing centralized document storage and distribution services), and Document Interexchange Architecture/Document Content Architecture (providing support and defining the format for document transfer across the network). SNA strengths are that it is now available and supported by IBM and virtually every major computer vendor. It has an installed base of 40,000 networks worldwide, is coherent, and its extensions appear to promise a substantial gain in functionality. For a discussion, see DeBoever, op. cit., footnote 20.

[108] & some observers have described the stake for users: "The rapid implementation and growth of data communication systems in recent years has left far too many users and suppliers unable to adequately design, control, and deploy and manage networks. Because product standardization remains more theory than practice, mismatched equipment and islands of incompatible networks are preventing too many companies' various departments and branches from sharing data. That's too bad, because the data invariably represents vital information, which the companies could usc to do a better job at whatever business they are in, if only interpremises networking weren't such a devilishly difficult game." Titch, Semilof, and Berrigan, op. cit., footnote 17, p.m.

[109] For a discussion, see Wood, op. cit., footnote 100.

[110] Timothy Haight, "O Say Can You *See* OSI Yet," *CommunicationsWeek,* *CLOSEUP* June 6, 1988, pp. C10-C14.

Figure 11-3--OSI Reference Model



SOURCE: National Institute of Standards and Technology (Formerly National Bureau of Standards),

One obstacle already noted is the lack of application standards. It is at the level of applications, layer 7, where the greatest functionality is provided. This is where choices are made about how to treat a communication-as a file transfer, a virtual terminal session, or a computer-aided design.[111] And, in line with this choice, it is at layer 7 that the protocols in the 6 lower layers that are required to execute this function are automatically selected. Now that the 6 bottom layers of the OSI reference model are near completion, the application layer is expected to grow dramatically, in number as well as usefulness. There is, however, still much to be done.[112]

In addition to defining the seventh layer of the OSI reference model, further steps also need to be taken to specify standards for specific environments, as well as to implement products that conform to these specifications.[113] Without such specifications, there is a strong possibility that vendors will, in the meantime, develop incompatible, proprietary interfaces. The problem, however, is in getting this process under way. As Haight has described it:

> Products to interconnect many different computers via OSI may not be released until vendors see the market, which may not exist until users see applications . . . which may not be written until software developers see OSI on enough systems to be sure that a market will exist. . . [114]

Another major question that needs to be resolved is how the migration to OSI will take place.[115] Competing with OSI as a networking standard are IBM's SNA, and TCP/IP,[116] which was developed in the late 1960s with the support of the Department of Defense. Some companies have already invested heavily in these other networking products, and they

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[111] Evelyn Roux, "OSI's Final Frontier: The Application Layers," *Data Communications*, January 1988, pp. 137-See also, Lee Mantelman, "Upper Layers: From Bizarre to Bazaar," *Data Communications*, January 1988, pp. 110-128.

[113] Helen Pike, "Will TCP/IP Wither on the Vine?" *Computerworld*, Sept. 7, 1988, pp. 27-30.

[114] Haight, op. cit., footnote 110.

[115] For a discussion, see ibid.; see also, pike, op. cit., footnote 113, pp. 27-30; and Elizabeth Horwitt and Patricia Kefe, "Firms Forecast OSI Migration Plans," *Computerworld*, Nov. 7, 1988.

[116] TCP/IP was the first peer-to-peer protocol developed for multivendor environments. Today, TCP/IP support is available for most processors, and this is its chief strength, For the long term, however, it is considered by many to be outdated and incomplete, For a discussion, see DeBoever, op. cit., footnote 20; see also, Haight, op. cit., footnote 110; and Pike, op. cit., footnote 113.

are unsure about what their next steps should be.[117] Their choices are quite numerous—perhaps so numerous as to be overwhelming.[118] But not making a choice can be very costly for users. Also, if many users fail to act, the move towards OSI standardization would certainly be curtailed. Depicting the dilemma faced today by users, and the potential consequences for standardization, one trade journal notes, for example:

> For many organizations, the network has become a leviathan, clumsily adrift in a sea of equipment from a fleet of vendors. With each passing day, these networks grow more cumbersome for users to manage and vendors to keep afloat. If not brought under control soon, such networks may become impossible to streamline-either because the unifying technology doesn't exist or because integrating all the pieces would be prohibitively expensive . . . . As companies continue to grow and diversify, it becomes increasingly difficult to create corporate standards.[119]

Vendors also find themselves in a difficult situation with regard to OSI. They all recognize the need to provide connectivity and interoperability, given the growing user demand. To effectively compete to do so, however, means becoming a "total solution" provider. Taking such a step can be quite costly, entailing:

- in-house research and development;
- the acquisition of companies with specialized skills; and
- the development of strategic alliances with vendors who can offer complementary skills and products.[120]

Not only will companies have to build bridges and move towards OSI; they will also have to provide support for their old network architecture, at least during the transition, as well as provide interfaces to IBM's latest extensions to SNA—all the while offering high functionality and efficiency.[121] Not all vendors will be able to acquire the resources necessary to execute such a strategy, especially since, as a result of standardization, many traditional communication products—PBXs, T1 multiplexer, and modems—are beginning to resemble commodities, drawing in narrower and narrower profit margins.[122]

Despite these difficult problems, there are a number of reasons for being somewhat optimistic about the future of OSI standards. Users, for example, continue to be very active, and very effective, in pressing for OSI interconnectivity. Recent surveys of Fortune 1000 companies indicate that more than 50 percent intend to use at least some OSI-based networks by the early 1990s.[123] In 1986, a number of vendors and some users joined together to form the Corporation for Open Systems, whose purpose is to develop conformance testing tools and procedures to aid vendors and users. In addition, user and vendor working groups and organizations have developed to define specifications of more general protocol definitions. To this end, for example, Boeing Corp. successfully took the lead in generating the Technical and Office Protocol (TOP) initiative, while General Motors did the same for the Manufacturing Automation Protocol (MAP).

[117] For a discussion see, Christine Bonafield and Paul L. Korzeniowski, "Neither Standards, Nor Understanding," *CommunicationsWeek, CLOSEUP*, Sept. 12, 1988, p. C1O. As noted: "Within corporations that employ data networks . . senior management often is reluctant to invest in complex new technologies-either because the decision-makers don't recognize the potential benefits or because these executives worry that the technology will become too quickly outmoded. Within many vendor and user companies alike, moreover, there's often a culture gap. The staff assigned to *designing*, implementing and administering local area networks may not be the same group of people who oversee wide area networks. Under such circumstances, network integration doesn't happen naturally, if at all. And within the communications industry m general, the networking technology and concepts are so complex that few organizations are able to find and retain enough people sufficiently skilled to cope with the challenges. "

[118] As outlined by Haight: "According to the people at the crossroads, there is no singular smooth migration path. There are at least six. The way to OSI can lead through gateways, either at the applications or at the transport level. h can wind through dual protocol stacks, located either at a host computer or at a workstation. Finally, some say the answer is writing OSI applications on top of TCP/IP transports, while others say exactly the reverse, putting applications now used with TCP/IP onto OSI transports. " Haight, op. cit., footnote 110, p. Cl 1.

[119] Titch, Semilof, and Berrigan, op. cit., footnote 17.

[120] Bonafield and Korzeniowski, op. cit, footnote 117.

[121] Dale Kutnick, "0S1 A High Stakes Game to Play," *Computerworld*, Sept. 12, 1988, p. 19.

[122] Ibid.; see also, Bonafield and Korzeniowski, op. cit., footnote 117.

[123] Kutnick, op. cit., footnote 121, p. 19.

One of the most prominent of the user groups working on behalf of OSI is the U.S. Government.[124] After 10 years of providing general support for OSI standards, the U.S. Government has recently developed the Government Open Systems Interconnection Profile (GOSIP), a specification that is compatible with industry specifications for OSI.[125] Moreover, in 1983, when it became increasingly obvious that the OSI standards-setting process was becoming bogged down for lack of specifications, the National Bureau of Standards (now the National Institute for Standards and Technology, or NIST) organized a workshop for implementors, which is held five times annually. The workshop is an open international forum, representing more than 200 computer manufacturers, semiconductor manufacturers, word-processing vendors, process control vendors, communication carriers, and industry and government users from the United States, Canada, and Europe.[126]

Also creating an impetus for OSI is the further development of layer 7 applications standards. For example, two crucial OSI applications-Directory Services (DS) and Virtual Terminal (VT)--are scheduled to be approved by ISO by the end of this year. While these standards are being brought forward for approval, some vendors have formed an industry support group to develop standard interfaces between these OSI protocols. Comprised of 12 industry members, this group will initially develop standard programming interfaces between OSI's messaging standard (X.400) and software applications for OSI, such as spread sheets and electronic mail.[127]

Taking all of these factors into account, some observers of the standards scene look to the future and predict that OSI and SNA will provide dual standards for computer networking that serve to complement, rather than compete with, one another-although the cost of interconnection may not be trivial.[128] Others are less sanguine. Concerned that competition among vendors to become the dominant system integrator will forestall the move towards interoperability, some have even suggested that the government play a more active role in facilitating the transition to OSI.[129] In assessing what role Congress might play in this regard, certain questions and answers, which serve to summarize the discussion above, need to be taken into account. These are listed in table 11-2.

Open Network Architecture

As a key component of the FCC's Computer 111, Phase 1 Decision, Open Network Architecture (ONA) is the network design conceived by the FCC to assure that enhanced service providers could gain equal access to exchange carriers' networks for the purpose of implementing new services.[130] The underlying idea was that, if the Bell Operating Companies could provide their competitors equal access to their networks, they would no longer be required to provide enhanced services through separate subsidiaries.[131] To assure that such access would be available, it was necessary to make the telephone companies' basic network services (referred to as Basic Service Elements, or BSEs) available in a uniform fashion.

124Within the government, NIST has responsibility for helping agencies to implement OSI.

125The Department of Defense has taken the lead in requiring GOSIP in future network acquisitions, having issued a policy statement in 1987 outlining a 2-year transition from TCP/IP to OSI. Shirley M. Radack, "U.S. Government Moves Towards Implementing OSI Standards," *Standards*, Department of Commerce, pp. 82-83.

126Ibid.

127Kelly Jackson, "New Applications Move OSI Closer to Implementation," *CommunicationsWeek, Nov. 4, 1988,* p. 31.

128DeBoever, op. cit., footnote 20.

129See, for example, Timothy H@@, "Industry Standards: The Book, The Movie," *CommunicationsWeek*, June 13, 1988, p. 20.

130As defined by Computer III, "ONA is the overall design of a carrier's basic network facilities and services to permit all users of the basic network, including the enhanced service operations of the carrier and its competitors, to interconnect to specific basic network functions and interfaces on an unbundled and equal access basis."

131According to one account, the concept of ONA stemmed from an Ameritech proposal to develop a concept called Feature Node/Service Interface (later to be called Intelligent Network 2), which would permit exchange carriers to program their own switching machines. Ameritech's suggestion to the FCC that, if such a capability were made available on an equal basis to the exchange carriers competitors there would no longer be a need for separate subsidiaries, was the seed from which the ONA idea evolved. However, telephone companies now avoid associating ONA with the Intelligent Network 2, since the technology to execute such capabilities is still a number of years away. See, for a discussion, John G. Williams, "ONA and the Future of Exchange Networks," *Telematics, vol.* 5, No. 8, August 1988, pp. 1-6; See also, Henry Levine, "Implementing Open Network Architecture: Will Push Ever Come to Hug? *Telematics*, vol. 4, No. 12, December 1987, pp. 3-6," In appreciating this account, it should be remembered that the idea of achieving a common general network model that would allow for inflexible interconnection and interoperation with all other networks was already in the air, with the study of ISDN and OSI. See A.M. Rutkowski, "Open Network Architectures: An Introduction," *Telecommunications,* January 1987, pp. 30-40.

Table 11-2-Open Systems Interconnection: Factors Affecting the Choice of Federal Options

1. Apart from its value to individual stakeholders, of what value is the setting of standards in this area from a societal perspective?	Important to support strategic use of communication technologies by the business community, and to foster service-based economy. Important for industry structure, insofar as the cost of gateways and other forms of system integration are not trivial, and may not be affordable to small- and medium-sized businesses.
2. What is the cost of waiting for standards to be established in the marketplace or through a voluntary, consensus process?	There is some danger that, given the intense competition among vendors, proprietary solutions will be implemented before specifications can be adopted and products implemented to conform to them.
3. How likely is it that, in the absence of government involvement, de facto or voluntary standards will be adopted in the near term?	Increasingly likely, given the pressure and leverage of large user groups. Possibility for dual standards.
a. To what extent do vendors have a common interest in standardization and agree on the appropriate standard?	All vendors are moving to support OSI. Continued support for IBM's System Network Architecture also likely, given size of installed base.
b. To what extent are users eager to standardize? Do they agree on a standard? What leverage do they have vis a vis vendors in the marketplace?	Most vendors plan to move towards OSI. Migration strategies differ, however. Eager for standards and migratory solutions. Considerable market power.
4. To be effective in fostering standardization, what level of government involvement would be required? How far would the Federal Government need to go in the direction of mandating standards? What kinds of government involvement might be the most appropriate in this regard?	Low to moderate effort. Greater technology/R&D support. Support for broader public policy input into standards process. Continued facilitation of user/vendor interaction.
5. How susceptible are standards to technological change?	Moderate. Integrated approach tends to allow for compatibility over time. No apparent rival approach on the horizon.

SOURCE: Office of Technology Assessment, 1990

As described by Besen and Saloner, ONA creates standards requirements in two different respects:

> Both the interfaces with the basic service elements and the number and nature of these elements are standards issues. The first involves an obvious standards concern since the design of these interfaces will determine whether a competing supplier can employ a particular element in offering his service. Less obvious is why the second is a standards issue. If components can be obtained only on a bundled basis, the interface between them is completely inaccessible to the competing supplier. But the economic effect of an inaccessible interface is exactly the same as if it were accessible but incompatible with the supplier's equipment. Providing components only on a bundled basis is the limiting case of interoperability.[132]

In contrast to OSI—where the impetus for standardization stemmed, to a large extent, from the activities of the marketplace-the Federal Government has been the primary moving force in ONA standards, with ONA becoming the cornerstone of the FCC's deregulatory policy.[133] To achieve its ends, however, the government did not become directly involved in setting standards, or even provide much guidance; rather, in its Computer III orders, it called on the RBOCs to meet with the competitive enhanced service industry in an ONA Forum Process.[134] Lacking expertise in advanced architectures, the FCC left many ONA details to be worked out by the industry players involved.[135] It called for the filing of plans by February 1, 1988, merely stating that its approval of them would

[132] Besen and Saloner, op. cit., footnote 1, pp. 40-41.

[133] It should be noted that this is not the first time that the Federal Government has used standards to promote competition and deregulation. As part of the Carterfone decision, for example, all terminal equipment was required to be connected through standard plugs and jacks. Similarly, the Modified Final Judgment, which requires that the Bell Companies provide equal access, prohibits them from employing technical standards or network plans to discriminate against users. For a discussion, see ibid., pp. 38-40.

[134] Report and Order, CC Docket No. 85-229 (released June 16, 1986) at paragraph 217.

[135] According to Rutkowski, the FCC believed that: "private standards organizations, such as the [ECSA] T1 Committee, should play a major role in resolving relevant standards issues that may arise among carriers and enhanced service providers participating in enhanced service markets." Op. cit., footnote 131, p. 34.

depend on the extent to which they met the requirement of Comparably Efficient Interconnection (CEI)--that is, interconnection on an equal access basis. Not much consideration was given to the role of the States in the ONA process. However, the FCC did point out the difficulty involved in differentiating between intrastate and interstate service elements, and suggested that if jurisdictional differences were to occur, they might be worked out in the Federal/State Joint Board.[136]

The forum process consisted of national meetings conducted with the aid of Bell Communications Research Inc. (Bellcore) and meetings that were sponsored by the individual holding companies. As an additional input into the process, the RBOCs also commissioned studies to be undertaken by the enhanced-service providers, and conducted a number of meetings with users. The first public forum was held in October 1987, and the second in January 1988.[137] Although the participants skirted many of the toughest issues, these forums did serve to initiate a dialogue.[138]

That more was not accomplished at these forums can be explained, in part, by the absence of FCC guidance, by the general "marketing" approach pursued by the RBOCs, and by the discrepancy between the short time period in which participants had to prepare, and the complexity of the problems with which they had to deal. To gain a sense of the complexity of this issue, one need only compare the situation created by ONA to the problems generated by long-distance equal access requirements. As one commentor summarized it:

> . . . equal access required one of the largest mobilizations of manpower and capital the communication industry has ever known. Even before implementation, the government and private sector poured considerable energy into it. . . . And yet, equal access was basically a single application-a network interface developed through discussions between experienced local exchange carriers, and technically sophisticated long distance carriers. . . . By contrast, ONA is not one interface, but dozens---conceivably, hundreds-at many different levels in the network. Wrestling with the concept at industry forums are local exchange carriers less knowledgeable about data than they are about voice, sharing the mat with information service providers of varying sophistication and size.[139]

Given the perpetuation of a number of ONA issues, the RBOCs called for the creation of an Information Industry Liaison Committee (IILC), to be established under the sponsorship of the Exchange Carriers Services Association (ECSA).[140] Its stated purpose is "to serve as an inter-industry mechanism for the discussion and voluntary resolution of industrywide concerns about the provision of [ONA] services and related matters. ''141 Although somewhat less formal than other standards-setting committees, the IILC conforms to the voluntary, consensus approach typical in the United States. However, whereas a positive value is generally placed on this approach in other standards-setting bodies, in the case of the IILC it has proved to be a source of some criticism. A number of participants feel, for example, that if the difficult issues are ever going to be addressed, there will have to be greater interest and participation on the part of the FCC.[142]

[136]Ibid.

[137]For a description of the proceedings of this Forum, and the Positions adopted by the participants, see A.M. Rutkowski, M. Gawdun, and N. Merely, "The RBOC'S Views on ONA, *Telecommunications,* January 1987, pp. 43-54; and Amy G. Epstein, "Doubts in the User Community," *Telecommunications*, January 1987, pp. 88-89.

[138]Cathy Clarke, "The Strategic Implications of Open Network Architecture," *Telecommunications*, March 1988, p. 47; see also A.M. Rutkowski, "OpenNetworkArchitectures: A February 1987 Update, "*Telecommunications*, March 1987, pp. 79-83. According to most observers, the second meeting was the more substantive of the two. At the first meeting, many of the participants reported that they were distrustful of the proceedings and the intentions of the RBOCs, believing them to be only participating perfunctorily in the forum process Responding to these concerns at the second workshop, and using Bellcore's Notes on *the BOC Intra-LATA Nework as* a primer, the BOCs shared their views of the network with the other members of the communication industry.

[139]Steven P. NoWick, "For openers . .," *CommunicationsWeek*, ONA Report, June 29, 1987, p. 4.

[140]According to one observer, th, proposal followed a critical comment b, Judge Harold Greene, chastising the ECSA for not having yet issued a single standard. See John Foley, "ECSA Establishes New Committee to Meet FCC's ONA Requirements," *CommunicationsWeek,* Oct. 26, 1987, p. 42; for a discussion of the HLC, see Joseph W. Waz, Jr., "inter-Industry Consultation on ONA Plans: Is the IILC the Answer?" *Telematics*, *vol.* 5, No. 12, December 1988, pp. 1-5.

[141]As quoted in ibid., p. 2.

[142]Ibid.

Participants have also criticized IILC on the grounds that its rules and membership tend to favor the carrier industry.[143]

Building on the common ONA model developed by Bellcore,[144] the forum process, and inputs from groups such as the IILC, the RBOCs filed their ONA plans in February 1988, as required.[145] Common to all plans is the division of the network services into: 1) Basic Service Arrangements (BSAs)-the underlying method of connecting an enhanced service provider to and through the RBOC network; 2) Basic Service Elements (BSEs)—the optional network capabilities such as automatic number identification, which are associated with a particular BSA; and 3) Complementary Network Services-the network functions that allow customers to connect to the network.[146] All plans include essentially the same list of 118 network capability requests made by enhanced service providers. The RBOCs generally agree, moreover, that equal access can be provided without collocation (i.e., physically located within the central office), which some argue would be damaging to the network. They also agree that services should not be technology-driven, but rather developed in response to market demand. The plans differ considerably, however, on a number of fundamental items, including those involving the allocation of costs, pricing, and the order of deploying services.

Not surprisingly, given the RBOCs hesitancy to use the ONA process to confront fundamental issues, many of the concerns expressed by stakeholders upon review of the ONA plans had already been foreshadowed in previous interactions among the RBOCs and other stakeholders in the communication industry. Considered to be most problematic were: 1) the lack of uniformity among plans; 2) the inadequate degree of unbundling of services; 3) the failure to provide for collocation; and 4) the bases for establishing costs and, hence, pricing.[147] As one remedy to resolving these problems, many proposed that the FCC take a more active role in the standards-setting process.

The National Telecommunications and Information Administration (NTIA) also took issue with the ONA filings, characterizing them as "an important first step," but "not acceptable as filed." Like an increasing number of others, NTIA called on the FCC to "set forth a definitive set of principles for ONA" and to provide for a "neutral interindustry entity" to work out unresolved ONA issues.[148]

Many State representatives also were displeased with the outcome of the ONA process. 149 Some were concerned about the impact it might have on the public network and on the ratepayer.[150] Others viewed the ONA plans as providing for just one more encroachment by the Federal Government on State jurisdiction. As Gretchen Dumas, principal counsel for the California Public Service Commission, pointed out:

> . . . All these problems and questions for states arise because there is a basic question as to where state jurisdiction is in the midst of this significant change in regulatory practice. . . . The FCC has tried to resolve this problem . . . by finding that the states can regulate any non-enhanced service "use" of a BSE. The problem is how can a state ensure that BSEs are not being used for basic service. . . . the basic thrust of the new FCC policy in Computer 111 is to allow telephone company involvement in enhanced services on a nonstructurally separated basis, to consider such services as competitive and unregulated, and to preempt any state regulation of

143 Ibid.

144 The BOC Special Report No. 4, published by Bellcore in November 1987, provided the BOCs with a common basis for communication in planning for ONA.

145 See Clarke, op. cit., footnote 138; see also, Michael Warr and Ellis Booker, "Comparing the ONA Plans: A First Look," Telephony, Feb. 23,1988.

146 Ibid.

147 Anne-Marie Roussel, "Bells ONA Proposals Deemed Unacceptable," *CommunicationsWeek*, May 23, 1988, pp. 42-43. See also, "Colocation Issue Heating Up, Likely to Stall ONA Progress," *Data Communications,* March 1988, pp. 70-74, and Ellis Booker and Deborah Pfeiffer, "Interface '88: A Smoldering ONA Controversy," *Telephony,* Apr. 25, 1988, pp. 38-40.

148 "RHCs Say ONA Plans Meet FCC Rules: NTIA Calls Rules Insufficient," *Enhanced Services Outlook,* June 1988, p. 3.

149 See, for one discussion, Gretchen Dumas, "Open Network Architecture: Equal Access for Enhanced Services," *Telematics,* vol. 4, No. 7, July 1987, pp. 5-7; see also, "Supreme Court Case, FCC Jurisdiction and ONA," *The ESC Monthly Report*, March 1988, vol. 2, p. 3.

150 Steven Titch and John Foley, "Bell Filings Portend More, Trickier Talks, *CommunicationsWeek*, Feb. 8, 1988, pp. 1, 56."

intrastate enhanced service which is not entirely consistent with FCC policy.[151]

Given the tremendously high stakes involved, it is only natural that the setting of ONA standards would generate such strong controversy.[152] As was intended, ONA will have major impacts on competition in the telecommunication market, redefining the boundaries among market segments, altering barriers to entry, changing the economics of providing services, and restructuring the delivery technologies that are used.[153]

The local exchange carriers will be radically affected by ONA, one way or another.[154] By opening up their networks, they risk exposing themselves to much greater competition. At the same time, they will need to absorb the cost and disruption entailed in implementing their ONA plans. However, if they fail to follow through on ONA, they could lose the opportunity of taking part in developing and profiting from the potentially lucrative information services market. Thus, adopting a company position on ONA has entailed many complex and critical choices, each made under conditions of considerable uncertainty and within a very short timeframe. These decisions will have far-reaching ramifications within the RBOCs, affecting their marketing strategies, regulatory posture, relationship to their competitors, as well as their network plans.[155] As one observer has described this impact:

> new services-determined by inputs from the [RBOC] marketing plans—will influence network evolution and planning for open interfaces. . . . The consequences of these decisions, moreover, will have a direct effect on potential revenue, profitability and growth.[156]

Despite these difficult choices, most RBOCs welcomed the ONA process, envisioning it as a significant market opportunity.[157]

Moreover, the ONA process has the potential not only to restructure the telecommunication industry, but also to radically alter major segments of the information services market, ranging from those industries involved with electronic publishing, database retrieval, and voice message storage, to those providing network burglar alarms.[158] Like the local exchange carriers, information service providers face a future fraught with uncertainty. No one knows what the size of the actual market for information services will be, or how information providers should relate to telephone carriers in order to maximize it. Many in the information industry have already made substantial investments in the network architecture as it has traditionally existed, based on existing industry boundaries. As these boundaries change, information providers could find themselves in the wrong business, with technically obsolete equipment and vulnerable to the competition of new and more up-to-date players.[159]

In spite of the controversy surrounding ONA, FCC tentatively approved large portions of the RBOCs' ONA plans, on the provision that some revisions would be made. The ONA process is far from over, however; many outstanding issues remain. Still to be addressed, for example, are the issues of how costs will be allocated and services priced, as well as how jurisdictional authority will be divided between the Federal Government and the States.[160] There also continues to be considerable disparity among the different RBOC approaches to ONA, a fact that, as many have pointed out, undermines the very nature of standards. The one factor that will certainly ensure that ONA remains on the policy agenda for a long time, however, is the rapid pace of technological change. Designed, for the most part, around the technology as it presently exists, the ONA plans will need to be continually

151 Dumas, op. cit., footnote 149, p. 6.

152 For a discussion, see Jim Kennedy, "For Whom the Bells Toil," *CommunicationsWeek*, June 29, 1987, pp. 10-11, p. 21.

153 Ibid.

154 Ibid.

155 Ibid. See also, Robin Williamson, "Planning the Right Moves," *CommunicationsWeek*, Special Issue on ONA, June 29, 1987, p. 15.

156 Ibid.

157 Ibid.

158 Jennifer Bater, "Competitive Pull," *CommunicationsWeek*, Special Issue on ONA, June 29, 1987, pp. 17, 20.

159 Ibid.

160 Clarke, op. cit., footnote 138.

revised to take into account the changes that will come with the Intelligent Network 2 and ISDN.[161]

Although there have been many critics of the ONA process over the past 2 years, most people agree that the idea still has merit. In fact, many would like to see the concept of ONA developed further.[162] In the minds of some, the importance of ONA cannot be overestimated. As one who has thought extensively about the subject described it:

> The importance of ONA is tied to the fact that ultimately, if successfully implemented, it will become a gateway between public and private networks and become the means whereby a host of smaller entrepreneurial service providers will gain critical access to the next generation of increasingly software driven and highly programmable BOC super switches. . . . If ONA can be made to work. . . then the same kind of creative explosion that took place in the development of an extraordinary range of PC software and service in the computer industry will finally be free to occur in telecommunications . . . . More importantly, it would allow this type of creative development to be done by those who should be doing it—smaller, creative, and entrepreneurially minded service providers who can then "test run" their services in the open marketplace 163

As already noted, many believe that to carry this process further, the government will need to assume a greater role. Others, although acknowledging that the government might play a facilitating role, believe that the process can be best worked out in the marketplace.[164] In assessing which role is most appropriate for the Federal Government, consideration should be given to the questions and answers outlined in table 11-3, which draw from this analysis.

161For a discussion of the impact of technological change on the ONA process, see Richard Solomon and Loretta Anania, "Paradoxes and Puzzles of Digital Networks, Part 1," *Telecommunications*, January 1987, pp. 26, 28; and Anthony Rutkowski, "Computer IV: Regulating the National Public Information Fabric," presented at ICCC-ISDN '87, Dallas, Texas, Sept. 16, 1987.

162See, for one, Williams, op. cit., footnote 131.

163Tom Valovic, "ONA: The Gateway Between Public and Private Networking," *Telecommunications*, March 1988, p. 31

164See for example, Dan Hubbard, "ONA: A BOC perspective," *Telecommunications*, March 1988, p. 36.