Communication Technologies to Promote Foreign Aid Goals

3

The foreign aid goals of promoting sustainable economic growth, democracy, and political stability do not always go hand in hand. For these goals to be mutually reinforcing, aid policies must be designed to foster a number of criteria. Developing countries must have access to new growth opportunities, and their markets must be free and competitive to better take advantage of them. In addition, their governments must be representative, accountable, and competent in meeting public needs. Finally, their citizens must engage with one another, and cooperate to find solutions to common problems.

Recent advances in communication technologies provide new opportunities for developing countries and foreign aid organizations alike to help meet these criteria. To expand their trading opportunities, for example, developing countries can use high-speed broadband global networks to link up to foreign markets. Similarly, low-cost networked information technologies, such as the Internet, can be used to facilitate political and community participation. Equally important, social services—such as health care and education—can now be provided via satellite on a much more cost-effective basis.

Recognizing this potential, many developing countries are poised to make major investments in communication infrastructure in the hope of fostering economic development and facilitating the integration of their markets into a knowledge-based global economy. Foreign assistance organizations are similarly considering telecommunication-related programs to reduce the costs and enhance the benefits of providing foreign aid.

The time is ripe to make such investments. The costs of communication technologies are plummeting, while their performance is improving phenomenally. Soon these technologies will be essential given an increasingly information-based and electronically networked global economy. Countries that take advantage of these technologies will gain competitive advantages, while countries that fail to recognize the potential, or who cannot gain access to these technologies, will probably experience decline. In Third World countries, advanced communication technologies can play a special role. These technologies not only allow countries to leapfrog to a modern infrastructure; they can also serve as a catalyst, helping to promote social and economic behavior more conducive to development.

Although recent advances in communication technologies hold promise to improve political and economic conditions in Third World countries, the realization of this promise is far from certain. As history bears witness, the evolution of technologies is replete with disappointments and unintended consequences.

If communication technologies are to prove effective, their capabilities and characteristics must be well matched to the task at hand. Communication technologies are not equal in this regard; for any given purpose, some are much more suitable than others. If, for example, communication technologies are to have a democratizing effect, they need to be widely available, easily accessible, and capable of supporting two-way interactions. On the other hand, communication technologies that are intended to reinforce a sense of community, or to support activities internal to a particular business or firm, may need to be more restrictive with respect to both content and access.

Successful outcomes also depend on the social, economic and political context in which technologies are deployed. If, for example, developing countries do not have the requisite skills and expertise, they will be unable to use technologies effectively. Equally important, if Third World leaders use communication technologies solely to perpetuate their own control, or to reinforce unproductive practices, technology deployment may serve to make countries worse off. To be effective, technology deployment strategies must be closely linked to complementary social and economic policies that address other, often more formidable, developmental barriers.

The stakes in selecting appropriate technology policies for development are extremely high. Many of these choices will be irreversible, at least in the short and medium terms. Once a decision is made, technology tends to become firmly fixed on a given trajectory.[1] This pattern is especially evident with networked information technologies, which require vast amounts of capital and social investment. Thus, periods of rapid technology advances, such as are occurring today, provide a rare opportunity for reassessing and redirecting both the nature of a particular technology itself, and the economic and social relationships that are structured around it.[2]

This chapter seeks to better inform this important decisionmaking process. To this end, it does the following: 1) presents a framework for analyzing communication technologies and social change; 2) lays out the existing evidence relating technology change to economic development, democracy, and political stability; 3) characterizes the range of situations presently to be found in developing countries; 4) identifies recent trends and advances in communication technologies; and 5) analyzes the implications of these trends for developing countries.

A FRAMEWORK FOR ANALYZING COMMUNICATION TECHNOLOGIES AND SOCIAL CHANGE

Communication technologies have little direct impact on society. Rather, they affect relationships, indirectly, by providing structure to communication processes. It is communication processes themselves—which may or may not be technology based—that give rise to social opportunities and impacts. Advances in communication technologies can, however, provide a catalyst for change. By altering the nature of communication processes as well as human perceptions, they can restructure the way that people interact and carry out activities.[3] To evaluate the potential of new communication technologies to promote foreign aid goals, it is necessary to define and characterize these interconnections.

[1] Brian W. Arthur, "Positive Feedbacks in the Economy," *Scientific American,* February 1990, pp. 92–99.

[2] For a discussion of how institutions get locked in, see Douglas North, *Institutions, Institutional Change, and Economic Performance* (Cambridge, UK: Cambridge University Press, 1990).

[3] See Daniel Katz and Robert L. Kahn, *The Social Psychology of Organizations* (New York, NY: John Wiley & Sons, Inc., 1966).

Communications Defined

To relate communication and information technologies to the process of economic development, democratization, and political stability requires a definition of communication that can serve equally to describe social phenomena as well as technology. Previous ways of defining communication are inadequate in this regard, so a working definition for this discussion is needed (see box 3-l).

The word "communicate" comes from the Latin root *"communis,"* signifying communion or the idea of a shared understanding of, or participation in, an idea or event. In this original sense of the word, communicate was used as a noun of action that meant "to make common to many (or the subject thus made common)."[4] Toward the end of the 17th century, the notion of imparting, conveying, or exchanging information and materials was incorporated into the concept.

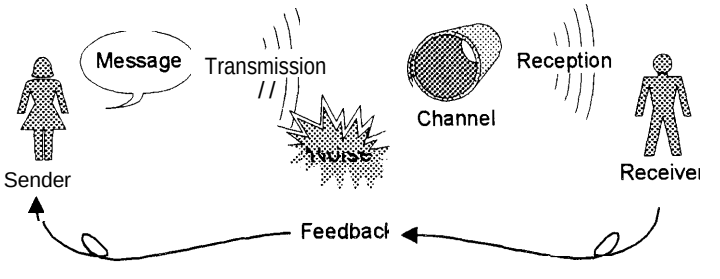
BOX 3-1: The Shannon-Weaver Model o

Academic researchers have traditionally defined communication in accordance with the sender/receiver model developed by Shannon and Weaver in their work on information theory.[1] As depicted below, this model characterizes communication as a systemic process, the main components of which include: sender, message, transmission, noise, channel, reception, and receiver, Despite a long history, this model is less useful today, given the convergence of information and communication technology and an interactive, multimedia environment in which communication no longer takes place in a linear fashion. With a computerized bulletin board, for example, how does one identify and distinguish between who is the sender and who is the receiver of a message? And similarly, who is considered the sender of a message when the receiver can now access information on demand?

The Shannon and Weaver model is also inappropriate for analyzing social processes and policy issues, The somewhat passive notions of "message," "sender," and "receiver, " draw attention to the problems of effective communication. However, they downplay any problems involved in, or issues about, who gets to formulate, send, and access information; on what basis, and with what objectives and effects, It is, in fact, precisely these kinds of issues that may determine whether, and the extent to which, communication and information technologies serve U.S. foreign aid goals.

1 Claude Shannon and Warren Weaver, The Mathematical Theory of Communication (Urbana, IL: University of Illinois Press, 1949), p. 5.

SOURCE: Office of Technology Assessment, 1995

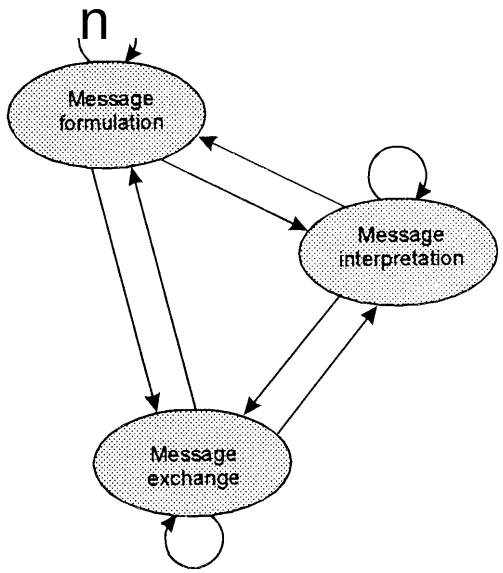


4 Daniel Czitrom, *Media and the American Mind* (Chapel Hill, NC: The University of North Carolina Press, 1982), p. 10

This sense of the term became increasingly popular with the development of railroads, canals, and roads.[5] Both connotations are germane to the issues addressed here.

To incorporate both perspectives, this study defines communication as "the process by which messages are formulated, exchanged, and interpreted." As depicted in figure 3-1, which describes this communication process, the definition used here assumes that these three activities are related to one another in a process insofar as they are all required for an act of communication to take place. In light of interactive technology, however, the process in which these activities are related is not considered to be linear; nor does the process entail a predictable sequence of events. Technology and human beings are also understood to be interchangeable at any point in the process, and they can come together in any number of ways. Moreover, the process of communication is not viewed, as in the past, as a mere transmission process. As defined here, it includes the application and content that is communicated.

FIGURE 3-1: The Communication Process



SOURCE: The Office of Technology Assessment, 1995

Communications and Society

Defined broadly in this fashion, it is clear that communication is the basis for all human interaction and one of the means for establishing and organizing society. Without it, a society could not survive. It is the means by which group norms are established, expectations are voiced, individual roles are assigned, change is enacted, and social control is exercised.

Communication, for example, is inherent in the coordination of all economic activity. The exchange of information is at the heart of the market system.[6] A market relies on the communication of information to identify buyers and sellers, allocate resources, and establish prices. Within firms, the availability of timely and accurate information is key to decisions about whether to enter or exit markets; how to secure financing; how to organize working relationships; and how to market and distribute goods. Where adequate information is not available, markets will fail and economic performance will suffer because of higher business costs. Likewise, firms that lack adequate market information will be at a competitive disadvantage.

Communication and information also pervade political life. Without them there could be no nation; for it is through the process of communication that people first develop a sense of community and a shared set of values that legitimize political authority.[7] By magnifying and amplifying some actions, the communication process distinguishes between what is a private act and what is a public affair. It organizes what appear to be random activities to show how individuals and groups are related to one another in the pursuit of power, providing a roadmap for individu-

[5] Ibid and Raymond Williams, *Key Words: A Vocabulary of Culture and Society* (New York, NY: Oxford University Press, 1976), pp. 62-63.

[6] For an in-depth discussion, see James R. Beniger, *The Control Revolution: Technology and the Economic Origins of the Information Society* (Cambridge, MA: Harvard University Press, 1986).

[7] See Karl Deutsch, *Nationalism and Social* Communication (New York, NY: Free Press, 1963).

als who want to influence the course of political events.[8] Citizens rely on the communication process to gather information; identify like-minded people; organize their forces; and articulate their political preferences. Furthermore, because it generates a common fund of knowledge and information, the communication system facilitates productive and rational debate. Without some form of knowledge and understanding of how others are informed and what they believe, individuals could not make reasoned and sensible arguments and decisions.[9]

Communication is similarly the process by which culture is developed and maintained. Only when people develop language, and thus a way of communicating, can a culture emerge and be imparted.[10] Information—the content of communication—is the basic source of human intercourse. Thus, the communication of information permeates the cultural environment and is essential to all aspects of social life. It is the means by which knowledge is created and shared, roles are negotiated, and social relationships are legitimated.[11] Through communication, culture is both maintained and changed; behaviors, and the values that underlie them, are accepted, questioned, or reinterpreted according to circumstances.[12]

Supporting all forms of human activity, communication runs like a thread entwined throughout the course of history. As Lucian W. Pye has described it:

> Communication is the web of human society. The structure of a communication system with its more or less well-defined channels is in a sense the skeleton of the social body which envelops it. The content of communications is of course the very substance of human intercourse. The flow of communications determines the direction and the pace of dynamic social development. Hence it is possible to analyze all social processes in terms of the structure, content, and flow of communications.[13]

How communications processes are ordered, therefore, will have a major impact on developing countries and their ability to achieve economic, political, and social goals.

Technology Advance as It Affects Communication Processes and Economic, Political, and Social Outcomes

Communication processes do not occur in a vacuum; they are facilitated and sustained by an underlying network of individuals, institutions, and technologies that provide the means and mechanisms for formulating, exchanging, and interpreting information, and for creating the necessary linkages among these activities. As part of the infrastructure, communication and information technologies not only support communication processes; they also mediate them, restructuring the way in which they take place.

Communication and information technologies can affect communication processes in a variety of ways. For example, they can alter:

- the speed of communication,
- the cost of communication,
- the distance that, within any given period of time, information can travel,
- the amount of intelligence/functionality that can be transferred,
- the relationships and interdependencies among parties to an act of communication, and
- the perceptions of the parties communicating.

It is these changes in communication processes—*and not the actual deployment of tech-*

[8] Lucian Pye (ed.), *Communications and Political Development* (Princeton, NJ: Princeton University Press, 1965), p. 6.
[9] Ibid.
[10] Beniger, op. cit., footnote 6, pp. 84–91.
[11] Donald P. Cushman and Dudley D. Cahn, Jr., *Communication in Interpersonal Relationships* (Albany, NY: State University Press, 1985); and Martin Lawrence LeFleur, *Theories of Communication* (New York, NY: David McKay Co., Inc., 1970).
[12] When people communicate, meaning is both assumed and negotiated—some things are taken for granted, and others are interpreted in new ways or brought up for explicit discussion. When people communicate, they are both differentiating and integrating—displaying their distinctiveness as well as demonstrating their commonality.
[13] Pye, op. cit., footnote 8, p. 4.

nology itself—that eventually gives rise to social and economic opportunities and impacts. Thus, for example, communication technologies such as fiber optics and optical switches, which increase the speed and reduce the cost of communication, can foster economic growth by permitting a greater number of transactions to take place. Similarly, inexpensive, stand-alone media technologies—such as videotapes and video cameras—have served in Eastern Europe and a number of developing countries to enhance political participation (and, on occasion, to increase political instability) by reconfiguring relationships so that citizens could bypass existing information gatekeepers.

Because the impacts of communication technologies are indirect, change takes place in an evolutionary, rather than a revolutionary, fashion.[14] Moreover, the path change follows is not direct; it zigzags and meanders in response to the openings and obstacles encountered along the way (see box 3-2).[15]

Technology advances are tempered by social forces as well as by the historical conditions under which new technologies are brought into use.[16] These forces often override the idealistic aspirations and hopes that are attached to technological change. If, for example, the social and technological infrastructure is inadequate to exploit the benefits of new advances, some technologies will be slow to develop or perhaps never be applied at all.[17]

Whether or not new technologies are developed, and who bears their costs and reaps their benefits, will also be determined by the responses and reactions of those who have a stake in maintaining the status quo.[18] Made in the context of existing institutional structures, laws, and practices, technology choices will depend on who the key decisionmakers are; how they perceive their needs, interests, and objectives in the light of new technology; and the power and authority they have to determine events.

RELATING CAUSES TO EFFECTS

Given the complexity of the relationships involved, anticipating how communication technologies might affect the prospects of Third World countries is decidedly difficult. Nonetheless, to make sound telecommunication investments, developing country leaders and foreign aid providers must assess the full range of associated benefits and costs. They also need to under-

[14] As described by Braudel with respect to the industrial revolution, "When one is talking about social phenomena, rapid and slow change are inseparable. For no society exists which is not constantly torn between the forces—whether perceived as such or not—working to undermine it. Revolutionary explosions are but the sudden and short lived volcanic eruption of this latent and long term conflict." Fernand Braudel, *Civilization and Capitalism 15th-18th Century: The Perspective of the World*, vol. 3 (Berkeley, CA: University of California Press, 1992), pp. 537–538.

[15] Analytical models differ with respect to the degree and timing of how society and technology influence one another. According to one school of thought, technology is essentially neutral before it has been developed. And it is only as technologies are exploited and molded in accordance with particular social, economic, and political conditions that they take on a determining force of their own. For this view, see Clifford Christians, "Home Video Systems, A Revolution?" *Journal of Broadcasting*. vol. 17, 1973, pp. 223–234. Others think of technologies as being biased in favor of particular outcomes at the moment of their conception because they are envisioned and designed with certain purposes and practices already in mind. For this perspective, see Raymond Williams, *Television Technology and Cultural Form* (New York, NY; Schockien Books, 1973).

[16] The development of the penny press is one example. Many social reformers hoped that it could be used to reestablish a broad moral and political consensus across the United States after the turmoil caused by the Civil War. Social and economic conditions worked against them, however. The penny press emerged not only in a period of cultural upheaval and transition, but also in a period of intense competition for advertisers and readers. Instead of trying to improve the cultural and moral standards of people, newspaper publishers felt compelled to adopt any sensationalist device so long as it would bring in additional readers. Czitrom, op. cit., footnote 4, pp. 92–93.

[17] Such was the case in ancient Alexandria, for example. Although inventors had the theoretical knowledge necessary to create primitive versions of a steam engine and a wheeled cart, these ideas lay dormant and only became practicable in application centuries later in conjunction with the industrial revolution. Langdon Winner, *Autonomous Technology: Technics Out of Control as a Theme in Political Thought* (Cambridge, MA: MIT Press, 1977), pp. 11–12.

[18] For an historical account of the conservative role that communication stakeholders played with respect to new technology developments, see Brian Winston, *Misunderstanding Media* (Cambridge, MA: Harvard University Press, 1986), pp. 15–34.

BOX 3-2: The Printing Press as an Agent of Change

The printing press had a major impact on Europe.[1] In fact, the printing press is often viewed as a "revolutionary" information technology responsible for the Reformation. Its incorporation into the existing social, economic, and political framework occurred over time, so its impact was filtered by historical events.

Printing greatly increased the speed and reduced the costs of reproduction, and thus facilitated the dissemination of ideas. By increasing the general level of literacy, it also made more people susceptible to, and eager to partake of ideas. As a result, the market for information products and literary works grew, and the economic value of these works was greatly enhanced. Later, as books and manuscripts moved beyond monastery shelves and became simultaneously available to many people, they began to serve as an important forum for public discussion. Printing and the widespread use of books also fostered new relationships among scientists, artists, intellectuals, and their geographically distant counterparts. As Eisenstein has pointed out:

> The fact that identical images, maps, and diagrams could be viewed simultaneously by scattered readers constituted a kind of communication revolution itself.[2]

Occurring at the time of religious and political turmoil, printing presented the monarchs of Europe with both a political threat and an economic opportunity. While direct censorship was the most effective means of confronting the political threat brought about by the new technology, it also stifled the printing industry, and thus limited the government's economic benefits from printing. Seeking to both end the dissemination of heretical and seditious literature, but still profit from the burgeoning printing trade, the English government aligned itself with publishers. In exchange for an agreement to enforce the censorship laws, the government granted the publishers' guild, known as the Stationers, a monopoly right to print, publish, and sell works—a copyright.[3]

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[1] For the classic account, see Elizabeth L. Eisenstein, The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early Modern Europe, vols. I and II (Cambridge, England: Cambridge University Press, 1982).

[2] Ibid., vol. 1, p. 56.

[3] Stephen Stewart, *Law of International Copyright and Neighboring Rights* (London, England: Butterworths & Co., Ltd., 1983).

SOURCE: Office of Technology Assessment, 1995.

stand the conditions under which success will most likely occur.

To gain a sufficiently broad understanding of these issues, it is useful to consider historical evidence drawn from analogous situations. Only an historical picture can capture all the variables and their relationships to one another. Comparing historical inferences to statistical data, it is then possible to suggest whether, and the extent to which, the conclusions of such analyses might be generalized.

An Historical Overview

To select an historical case that is somewhat analogous to the situation in developing countries today, one need look no further than the United States. Judged by European standards of the time, the United States was, in its earliest years, "underdeveloped." By the turn of the 19th century, however, the United States had been forged into a major industrial nation spanning the continent and a multiplicity of cultures. Telecommunications, as described below, played a major role in this economic and political transformation.

The important role that communication (and transportation) technologies played in the rise of the United States economy can be seen by tracing the development of these technologies in conjunction with the nation's industrial develop-

ment. Between 1830 and 1887, a plethora of new technologies emerged, which gradually replaced many of the social and institutional communication networks that had hitherto sustained economic activities in the New World (see table 3-1). The deployment of these technologies, together with the social and organizational changes that they facilitated, increased economic activity and fostered economic growth in a number of interrelated ways, many of which served to reduce transaction costs (see appendix A for a detailed account).

These effects can be summarized as follows. First, communication technologies dramatically increased both the speed and the number of economic transactions that could take place. Second, by diminishing the relevance of geographic distance, communication technologies facilitated the expansion of trade and markets. At the same time, the development of mass media technology served to reinforce national markets by helping to mold tastes and preferences into a more uniform cast. This increased market size, in turn, led to greater specialization, standardization, and economies of scale. By enhancing intrafirm coordination, communication technologies allowed businesses to grow vertically and horizontally, and thus to exploit these economies.

Communication technologies also restructured relationships among economic actors, making some better and some worse off. Most vulnerable were those who—like jobbers and local retailers—were either replaced or bypassed, by technology. Winners were those who, being the first to gain access, were able to use communication technologies to reorganize their activities in response to the fundamental social and economic changes entailed in the process of industrialization, thereby gaining a competitive advantage.

The role of communication, however, was not constant over time. Rather, it increased along with technology advance, and as markets grew and business processes became more complex and information-intense. Initially, for example, middlemen and their personal networks provided the medium by which market information was transported, and market interactions consisted almost entirely of face-to-face exchanges. With the onset of industrialization, mediated communication replaced most of this primary contact.

Just as communication technologies served to promote U.S. economic growth and development, so too they played a critical role in the political evolution of the United States. Like political leaders in many developing countries today, the U.S. Founding Fathers were faced with the mammoth task of "building" a nation in the context of a democratic political system. At a minimum, this effort entailed establishing national sovereignty and national security; maintaining internal security and social welfare and ensuring an open political system based on participation, deliberation, and representation.[19]

Communication technologies, and the rules that governed their use and development, were critical not only to carry out these activities, but also in determining the relationship—as well as resolving the tensions—among them (see appendix A for a detailed description). Serving as a mechanism for both national integration as well as individual (and group) differentiation and participation, these technologies provided a mechanism for balancing the need for political participation as well as social control (see box 3-3).[20]

[19] The United States was designed to be a representative or republican form of government. This design reflects the Founders' belief that, while government should be based on popular sovereignty, it should also protect the minority against majority rule. Thus while power was given to the people, it was done in a limited, or restricted, fashion. Qualified participants were defined narrowly to include only white, property-owning males. Moreover, the President and the Senate were not directly elected by the people but rather were indirectly chosen by the Electoral College and the State legislatures. And finally, "the people" were themselves divided into two constituencies—one at the federal and one at the state level.

[20] For example, many political theorists have argued that some constraints are necessary in order to preserve democracy. Aristotle, for example, favored "constitutional government" but was opposed to "direct democracy," which he called perverted because it failed to protect the rights and interests of the minority. James Madison made much the same case in *The Federalist Paper. Aristotle in Twenty-Three Volumes, XXI Politics*, translated by H. Rackham (London: Heineman, 1977), Book III, p. 207.

TABLE 3-1: Selected Innovations in Information Processing and Communication, 1830–1887

Year	Innovation
1830s	Wagon lines carrying freight between rural towns and ports begin to operate on regular schedules.
1837	Telegraph demonstrated, patented.
1839	Express delivery service between New York and Boston organized using railroad and steamboat.
1840s	Freight forwarders operate large fleets on canals, offer regular through-freight arrangements with other lines.
1842	Railroad (Western) defines organizational structure for control.
1844	Congress appropriates funds for telegraph linking Washington and Baltimore; messages transmitted.
1847	Telegraph used commercially.
1851	Telegraph used by railroad (Erie). First class mail rates reduced 40–50 percent.
1852	Post Office makes widespread use of postage stamps.
1853	Trunk-line railroad (Erie) institutes a hierarchical system of information gathering, processing, and telegraphic communication to centralize control in the superintendent's office.
1855	Registered mail authorized, system put into operation.
1858	Transatlantic telegraph cable links America and Europe, service terminates after 2 weeks.
1862	Federal Government issues paper money, makes it legal tender.
1863	Free home delivery of mail established in 49 largest cities.
1864	Railroad postal service begins using special mail car. Postal money order system established to insure transfer of funds.
1866	Telegraph service resumes between America and Europe. "Big Three" telegraph companies merge in single nationwide multiunit company (Western Union), first in United States.
1867	Railroad cars standardized. Automatic electric block signal system introduced in railroads.
1874	Interlocking signal and switching machine, controlled from a central location, installed by railroad (New York Central).
1876	Telephone demonstrated, patented.
1878	Commercial telephone switchboards and exchanges established, public directories issued.
1881	Refrigerated railroad car introduced to deliver Chicago-dressed meat to Eastern butchers.
1883	Uniform standard time adopted by United States on initiation of American Railway Association.
1884	Long-distance telephone service begins.
1885	Post Office establishes special delivery service.
1886	Railroad track gauges standardized.
1887	Interstate Commerce Act sets up uniform accounting procedures for railroads, imposes control by Interstate Commerce Commission.

SOURCE: Reprinted by permission of the publishers from *The Control Revolution* by James R. Beniger, Cambridge, MA: Harvard University Press.

BOX 3-3: Politics and Communication Technologies

Political organization is constrained by the prevailing modes of transportation and communication, and it changes with advances in these modes. Before the age of modern communication and transportation, political philosophers—ranging from Plato and Aristotle to Rousseau and Montesquieu—agreed that size and population served to limit democracy. Based on the model of the Greek city-states, the ideal size for a democracy was a unit "so small that any citizen could travel on foot from the most remote point in a city-state to its political center and return in one day."[1] Similarly, the population of a democracy had to be small and contained enough to allow interaction among its members. A polity so configured provided not only for popular representation, but also for effective government administration.

[1]James W. Carey, *Communication as Culture: Essays on Media and Society* (Boston, MA: Unwin Hyman, 1989), p. 3.

SOURCE: Office of Technology Assessment, 1995.

Summarizing how communication technologies affected the evolution of American politics, four major impacts can be identified. First, communication technologies helped to integrate the nation by extending nationally oriented messages over broad geographic areas in a manner that bypassed traditional local, cultural, or socially based information gatekeepers. Second, communication technologies simultaneously provided mechanisms for individuals and groups to access information, identify and organize like-minded people, and promote their ideas at all levels of government, thereby holding the government accountable and assuring the representation of their views. Third, communication technologies provided government the means to administer laws, maintain order, assure the national defense, and promote the general welfare in an increasingly complex and interdependent social and economic environment, which required dealing with events such as industrialization, the Depression, and the Second World War. Finally, by supporting all of these functions on a relatively equal basis, communication technologies helped to maintain the balance—necessary to sustainable democracy—between participation and control.

Looking at the role of communication technologies in American politics, however, it is clear that these technologies have been neither equivalent nor technologically neutral with respect to political outcomes. The telegraph and mass media not only fostered national integration; they also diminished the interests of particularistic groups. The telephone, on the other hand, facilitated political organization at all levels. Cable broadcasting increased the number of outlets available for competing political perspectives. With such a wide range of communication technologies available, striking the appropriate balance between participation and control was more easily accomplished.

Channeling information to some gatekeepers while circumventing others, communication technologies also helped to determine the distribution and locus of political power. Over the course of American history, for example, the role of information gatekeeper was shifted from the local newspaper proprietor, to the legislative representative, to the political party leader, to the television news analyst, transforming American politics in the process (see box 3-4).

Although communication technologies strongly influenced American politics, these technologies were not autonomous in their effects. Fully aware of their political potential, the U.S. Founding Fathers established a basic legal framework in the Constitution that served to establish the general direction in which communication technologies have evolved. Within that framework, politicians, vendors, users and other stakeholders have all sought—both in the market-

BOX 3-4: The Role of Communication Gatekeepers

"...The important point about the way in which electronic and mass media operate is the fact that, as new sources of information or belief, they create counterweights to established authorities. Simultaneous radio coverage of the war, a moon walk or whatever absorbs and fascinates the mass audience directly, cuts out traditional local purveyors of information and interpretation. It is not the imam or the chief of state who tells the people what happened and what it means. The people were there, along with the camera crew. The broadening of the arena of action transfers authority from the village bigwig returned from a visit to the district town, to nouveau powerful national leaders and eventually beyond them to world figures."[1]

[1]Ithiel de Sola Pool, "Direct-Broadcast Satellites and Cultural Integrity," in Arthur Asa Berger (ed.), *Television in Society*, (New Brunswick, NJ: Transaction Books, 1987), p. 231.

SOURCE: Ithiel de Sola Pool.

place as well as in the political arena—to ensure that these technologies are developed in accordance with their preferences. Thus, in interpreting the impact of communication technologies in Third World countries, the specific institutional context in which they evolve must be kept in mind.

Statistical Evidence Linking Telecommunications to Economic Development and Democracy

Although historical evidence provides a good picture of the ways in which, and circumstances under which, communication technologies can affect economic growth, democracy, and political stability, it provides no real measures of the magnitude of such impacts. This kind of quantitative information is useful, especially when making investment decisions. Unfortunately, existing statistical analyses of the impact of telecommunications focus solely on the telephone, and on its impact on economic growth per se. Despite this limitation, these analyses do corroborate the conclusion that telephone deployment and economic growth are positively related. They suggest, moreover, that the benefits of telephone deployment are greater to the extent that deployment occurs in conjunction with other development-related variables—such as education and physical infrastructure development.

Statistical regression and correlation analysis relating telecommunications to economic growth dates back to 1963, when Jipp first demonstrated a strong correlation between telephone density and national wealth.[21] Since then, there have been a number of cross-sectional and time series studies linking telecommunications and economic development.[22] The conclusions of these analyses were inconclusive, however, because the models used were overly simplistic—accommodating only a few independent variables—and the data on telecommunications services—drawn from developed and less developed countries alike—were for the most part incomparable. Even more troublesome, these studies, while linking telecommunications deployment to economic growth, failed to demonstrate causality.[23]

[21] A Jipp, "Wealth of Nations and Telephone Density," *Telecommunications Journal*, July 1963, pp. 199–201.

[22] See, for discussions, Robert J. Saunders, Jeremy J. Warford, and Bjorn Wellenius, *Telecommunications and Economic Development* (Baltimore, MD: John Hopkins University Press, published for the World Bank, 2nd ed., 1994), pp. 85–98.

[23] Ibid.

More recent studies have addressed this problem of causation. For example, examining data from 60 nations for the years between 1960 to 1973, Hardy found that causality operated in two directions. Telecommunications investment increased to a significant degree with economic growth; similarly, although to a lesser degree, economic growth expanded along with investment in telecommunications.[24] Cronin, et al., came to a similar conclusion in their 1991 analysis, which was based on 31 years of U.S. data.[25]

To explain the relationship between telecommunications and economic development, Cronin et al. performed a sector-by-sector analysis looking at the impact of telecommunications on productivity.[26] Their quantitative results show that investments in telecommunications infrastructure are causally and significantly related to national total factor productivity.[27] The investigators found that advances in telecommunications production and enhanced consumption possibilities for end-userindustries account for 25 percent of the total direct and indirect aggregate productivity gains in the United States since 1978.[28] Dholakia and Harlam, using statistical data for the 50 states in the United States, also found a strong causal link between telecommunication infrastructure and economic development. Comparing resource inputs, using a multiple regression analysis, they found that the link between telecommunications and economic growth is greatest when inputs such as education and physical infrastructure are considered simultaneously.[29]

To explain the relationship between telecommunications and economic development, some researchers have pointed to the ability of telecommunications to reduce transaction costs (i.e., the information related costs entailed in doing business). According to Leff, for example, telecommunications not only lowers transaction costs within markets; these benefits also spill over to make other economic institutions more efficient.[30] Norton similarly found that reduced transaction costs due to telecommunications account for macroeconomic growth. His study suggests, moreover, that benefits of reduced transaction costs may be greatest for developing countries where adequate market information is very costly, to the extent that it is available at all.[31]

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[24] Andrew P. Hardy, "The Role of the Telephone in Economic Development," *Telecommunications Policy*, vol. 4, No. 4. December 1980, pp. 278–286. In this study, Hardy used a path analysis and cross-lagged correlation techniques, with time-lagged offsets on one year. See Heather E. Hudson, *Economic and Social Benefits of Rural Telecommunications: A Report to the World Bank*, March 1995, p. 11.

[25] Francis J. Cronin, Edwin B. Parker, Elisabeth K. Colleran, and Mark A. Gold, "Telecommunications Infrastructure and Economic Growth: An Analysis of Causality," *Telecommunications Policy*, vol. 15, No. 6, December 1991, pp. 529–535.

[26] As the authors note, "Studies have found that highly developed national economies are correlated with highly developed telecommunications infrastructure. In fact, the evolution of this research, employing state-of-the-art statistical techniques, has now confirmed the existence of a feedback process in which telecommunications investment enhances economic activity and growth, while economic activity and growth stimulate demands for telecommunications infrastructure investment. This relationship has been found, in general, to hold at the national, state and sub-state level of analysis and for definitions of telecommunications infrastructure investment including total investment, cable and wire and central office equipment." Francis J. Cronin, Elisabeth K. Colleran, Paul L. Herbert, and Steven Lewitzky, "Telecommunications and Growth," *Telecommunications Policy*, December 1993, vol. 17, p. 677.

[27] Total factor productivity refers to the changes in final output per unit of combined labor, capital, and material inputs.

[28] Cronin, et al., op.cit., footnote 26, p. 678.

[29] Ruby Roy Dholakia and Bari Harlam, "Telecommunications and Economic Development: Econometric Analysis of the U.S. Experience," *Telecommunications Policy*, vol. 18. No. 6, August 1994, pp. 470–477.

[30] In his 1984 study, Leff pointed out four significant relationships: 1) lower communication costs serve to reduce resource allocation decision costs between rural and urban sectors: 2) with lower communication costs, the optimal amount of search rises increasing the quantity and quality of decisionmaking; 3) by increasing the opportunities for arbitrage, lower communication costs make financial markets more efficient, resulting in lower capital costs; and 4) lower communication costs lead to more information on the probability distribution of prices, and permit the transformation of uncertainty into risk. See Nathaniel H. Leff, "Externalities, Information Costs, and Social Benefit-Cost Analysis for Economic Development: An Example from Telecommunications," *Economic Development and Cultural Change*, vol. 32, January 1984, pp. 255–276.

[31] Seth W. Norton, "Transaction Costs, Telecommunications, and the Microeconomics of Macroeconomic Growth," *Economic Development and Cultural Change*, vol. 41, October 1992, pp. 175–196.

THE CONTEXT IN DEVELOPING COUNTRIES TODAY

Both the historical and the statistical data relating telecommunication to economic and political development are drawn almost exclusively from experiences in Western countries, which share a common historical and institutional frame of reference. Many of these commonalities are absent in developing countries today. Thus, to anticipate how communication technologies will affect political and economic development in Third World countries, one cannot simply transpose the lessons from the past. As has always been the case, the impact of today's technologies will depend to a considerable degree on the specific social, economic, and political context in which they evolve.

The development challenges facing Third World countries today are monumental. Unlike the countries of Western Europe, developing countries do not have the luxury of executing the processes of nation-building, economic growth, and democracy in a sequential fashion, spread out over centuries (see box 3-5). Instead, these three processes must be carried out simultaneously, even though they are not always mutually reinforcing.[32] Compounding their problems, developing countries must deal with these challenges in an open, and increasingly networked, global economy. To be successful in such an environment, they must become further integrated into the world economy. Yet being more open, these countries run the risk that international players, with agendas of their own, could undermine their efforts at nation-building by competing for economic resources as well as political loyalties.[33]

Deteriorating social and economic conditions in many Third World countries magnify their problems. Over the past three decades, income disparity across the globe has doubled. Now, the richest 20 percent of the world's population receives an income that is 150 times the amount received by the poorest 20 percent.[34] Nearly 35 percent of the world's adult population is, moreover, illiterate. In addition, infant mortality rates continue to hover at 114 deaths per 1,000 live births.[35]

Third World resources to meet these challenges are severely limited, especially in the least developed countries.[36] Having yet to recover

BOX 3-5: The Development of Markets in Western Europe

Without markets, economic growth cannot take place. In Western Europe, it took 300 years for markets to become firmly established. And their emergence required no less than the consolidation of political authority; the secularization of society; the establishment of property rights that were free from feudal obligations; and the division of society into groups and rankings that, while based on economic interest, permitted social mobility. Today, developing countries are attempting to do in a few years what it took the ruling powers of Europe three centuries to accomplish.

SOURCE: Office of Technology Assessment, 1995.

[32] Thus, for example, democracy and political stability are not, as has generally been believed, highly correlated. Statistical evidence shows that, in becoming mature democracies, countries experience a difficult transition period when mass politics tends to exacerbate nationalism and national aggression. See Edward D. Mansfield and Jack Snyder, "Democratization and War," *Foreign Affairs*, vol. 74, No. 3, pp. 79–80.

[33] For a discussion of the relationship between local political participation and globalization, and its effect on the nation state, see Zdranko Mlinar, "Local Response to Global Change," *Annals of the American Academy of Political Science*, July 1995, No. 540, pp. 145–156.

[34] *Human Development Report 1993* (New York, NY: United Nations Development Program, 1993), p. 11.

[35] Ibid., pp. 11–12.

[36] The World Bank defines these "low income country" as those with a gross domestic per capita income of less than U.S. $635.

from the debt crisis of the 1980s, many countries continue to experience low growth rates, with the average for all developing countries ranging between 1.4 and 1.6 percent.[37]

In the area of sub-Saharan Africa—where these problems are the gravest—only marginal improvements in per capita income and consumption are anticipated, even under the most positive growth scenarios.[38] Assuming a less favorable global economic environment, a number of Latin American countries will probably also experience difficult times. Continued unrest in the Soviet Union and Eastern Europe would make economic growth in this region problematic as well (see table 3-2).[39]

The short term steps that many developing countries are taking to relieve their immediate social and economic problems could complicate, or even jeopardize, their prospects for long term sustainability. For example, in some cases, there has been excessive cropping, grazing, and timbering in areas that are already extremely fragile from an ecological standpoint (see table 3-3).

Population growth and per capita income growth will put new strains on the global environment. In 1960, the world's population was about 3 billion. The world population today stands at 5.3 billion and—according to a midrange forecast—it could increase by 70 percent to roughly 9 billion by 2030. Moreover, if global per capita incomes increase at an estimated rate of 80 percent, world economic output could grow to as much as $69 trillion by 2030, 3.5 times more than at present.[40] If pollution

TABLE 3-2: Developing Regions: Growth of Real GDP
(percentage changes per year)

Developing region	Trend 1974–90	Recent estimates 1991–93	1994–2003 Forecast	1994–2003 Low case
All developing countries	3.4	0.9	4.8	3.6
Sub-Saharan Africa	2.1	1.7	3.9	2.4
Middle East and North Africa	0.9	3.0	3.8	3.2
Europe and Central Asia (ECA)	3.1	-9.8	2.7	1.5
South Asia	5.0	3.5	5.3	4.2
East Asia	7.3	8.3	7.6	7.1
Latin America and the Caribbean	2.5	3.2	3.4	0.8
Memorandum item				
All developing countries, excluding ECA	3.5	4.6	5.2	4.0

SOURCE: *Global Economic Prospects and the Developing Countries*, A World Bank Book, 1994.

[37] *The Least Developed Countries Report* (Geneva, Switzerland: UNCTAD, 1995).
[38] *Global Economic Prospects and the Developing Countries* (Washington DC: World Bank, 1994), pp. 1–7.
[39] Ibid.
[40] Developing countries per capita incomes are estimated to grow by 140 percent. Calculated from data contained in World Bank, World Development Report, 1992 (Washington, DC: World Bank, 1993).

TABLE 3-3: Estimates of Environmental Damage in Selected Countries

Country and Year	Form of Environmental Damage	Annual Costs as a Share of GNP (percent)
Burkina Faso (1988)	Crop, livestock, and fuelwood losses from land degradation	8.8
Costa Rica (1989)	Deforestation	7.7
Ethiopia (1983)	Effects of deforestation on the supply of fuelwood and crop output	6.0–9.0
Germany (1990)[1]	Pollution damage (air, water, soil pollution, loss of biodiversity)	1.7–4.2
Hungary (late eighties)	Pollution damage (mostly air pollution)	5.0
Indonesia (1984)	Soil erosion and deforestation	4.0
Madagascar (1988)	Land burning and erosion	5.0–15.0
Malawi (1988)	Lost crop production from soil erosion Costs of deforestation	1.6–10.9 1.2–4.4
Mali (1988)	On-site soil erosion and losses	0.4
Netherlands (1986)	Some pollution damage	0.5–0.8
Nigeria (1989)	Soil degradation, deforestation, water pollution, other erosion	17.4
Poland (1987)	Pollution damage	4.4–7.7
United States[2] (1981) (1985)	Air pollution control Water pollution control	0.8–2.1 0.4

1 Federal Republic of Germany before unification.
2 Measures the benefits of environmental policy (avoided rather than actual damages).

SOURCE: "Environmental Damage Robs Countries' Income," *World Bank News*, March 25, 1993, based on David Pearce and Jeremy Warford, *World Without End* (Washington, DC: World Bank, 1993)

keeps pace with this projected development, the environmental damage could be astronomical.

The problems facing developing countries are inextricably linked to one another, as the case of population control clearly illustrates. Most population studies now show, for example, that pregnancy decisions in Third World countries are both determined by, and have an impact on, a number of other interrelated social, economic, and environmental factors. For example, the correlation between fertility rates and education is particularly strong.[41] According to the World Bank, women in developing countries who have no secondary education generally bear up to seven children. In contrast, those who have attended secondary school average only three births.

Levels of education as they affect birth rates are related, in turn, to the health of both women and children. In developing countries, pregnancy is the primary cause of death for women of childbearing age. In fact, in some parts of sub-Saharan Africa, it is not unusual to find one maternal death per 50 live births.[42] Of equal note, when mothers are educated and have fewer children, they provide better care for their children, whose health and prospects of survival are greatly enhanced as a result. In addition, girls born in such families are more likely to be educated and

[41] "Battle of the Bulge," *The Economist*, vol. No. 7879, Sept. 3, 1994, p. 23.
[42] Partha S. Dasgupta, op. cit., footnote 41, pp. 42–45.

thus less likely to marry early, have multiple pregnancies, and repeat the cycle.[43]

Some form of intervention is needed if developing countries are to extricate themselves from these downward spirals of deterioration. Overwhelmed by short-term problems of immediate survival, most Third World countries have, unfortunately, only limited resources to invest in altering their futures. Thus, notwithstanding recent improvements in infrastructure for transport, power, water, sanitation, telecommunications, and irrigation, there are today more than one billion people in the developing world who lack access to clean water, and nearly two billion without adequate sanitation.[44]

One ray of hope is the recent economic progress made by a number of Third World countries. Unlike most developing countries, which continue to be mired in civil conflicts, political instability, and economic decline, 12 countries have improved their economic performance during the first half of the 1990s, with significant increases in per capita output.[45] Included are Bangladesh, Benin, Cambodia, Equatorial Guinea, Guinea-Bissau, the Lao People's Democratic Republic, Lesotho, Mozambique, Myanmar, Sao Tome and Principe, the Solomon Islands, and Sudan.[46]

As was the case with the "newly industrializing countries" a decade earlier, the success of these 12 can be attributed, in part, to their ability to maintain internal stability while reaching outward to the global economy. If other less developed countries are to be similarly successful, they too must gain the inner capacity that will give them the flexibility to adapt to the structural changes taking place in their external environment. Most important, they must—as described below—be prepared to compete in a global knowledge-based economy, where production takes place on a worldwide, but decentralized and flexible, basis. The first countries to adapt to these changes will gain a significant competitive advantage, while countries failing to do so will fall behind.

LEVERAGING COMMUNICATION TECHNOLOGIES

Communication and information technologies, as they are advancing today, can make a critical difference in determining Third World success or failure. Ideally, these technologies can serve both to foster economic development, democracy, and political stability and to balance these processes, so as to make them more mutually reinforcing. These technologies can, moreover, make it easier for developing countries to reinforce national and local community ties while at the same time fostering their global integration.

Technology Trends

Present advances in communication and information technologies can best be summarized in terms of the following seven trends. It is these trends that are altering the technical characteristics and capabilities of the infrastructure in Third World countries, and changing the manner in which communication processes will likely be carried out.

Greatly Improved Performance at Decreasing Costs

The technical performance of all network components has greatly increased at the same time that the costs have fallen. This, more than any other development, will have a pervasive impact on the communication infrastructure. Many of these improvements result from advances in computer technologies which are increasingly ubiquitous throughout all communication systems.

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[43] Ibid.

[44] *World Development Report 1994, Infrastructure for Development* (Washington DC: World Bank, 1994), p. 1.

[45] *The Least Developed Countries Report*, op. cit., footnote 37. Viewing the situation more pessimistically, some OTA reviewers point out that continued progress in these 12 countries is by no means a foregone conclusion.

[46] Ibid.

Advances in computer architecture and software have also helped to harness the processing power in communication applications. In the past, switching mechanisms were used to replicate the manual operations entailed in placing a telephone call. The development of common channel signaling and intelligent databases now permits network switches to operate as computers, making real-time routing decisions based on the status of the network, call loads, and the characteristics of callers. With new developments in fast packet switching technologies, such as frame relay and asynchronous transfer mode (ATM), these kinds of intelligent network operations can be executed with much greater flexibility and increasing speeds.

Advances in transmission technologies are keeping pace with, if not exceeding, those in switching. Developments in fiber optics, which provide an excellent medium for transmission, have been most significant. With minimum transmission loss, fiber allows many more signals to travel over longer distances with smaller numbers of repeaters than does copper wire. Thus, it can support new broadband applications such as video telephony, multimedia services, and very high speed data services.

The capabilities of lightwave transmission, for example, are doubling every year, a trend that is likely to continue for another decade. Already, commercial systems have been developed that transmit 2.4 gigabits (billion bits) per second. Within the next few years, the use of laser systems and wavelength division multiplexing on a single fiber will permit the transport of multiple channels of information yielding a capacity of 40 gigabits per second.[47] These gains in capacity have, moreover, been matched by a decline in price. At present, the price per unit of transmission for fiber optics has been dropping at a rate of 40 percent per year.[48]

Network performance has also been improved through the use of digital compression technology, which reduces capacity requirements by selectively eliminating redundant data.[49] When used together with advanced switching technologies, digital compression can greatly enhance the capacity of existing copper-based networks. Thus, for example, it is now possible to transmit data at speeds of 10 megabits using twisted pair wire. Moreover, researchers claim that, by compressing signals in the channel rather than at their source, copper telephone wire can be upgraded to achieve the capacity of fiber, thus greatly reducing the need for infrastructure investment.[50]

Major strides are also being made in video compression, which requires considerably more bandwidth than data and voice.[51] With compression technology, for example, it is now possible to fit multiple video signals into a satellite transponder or a 6 MHz cable channel—an amount of space that previously could only accommodate an analog signal.[52]

Digital compression has also facilitated advances in storage technologies (see figure 3-2). Consider, for example, CD ROM—the cheapest

[47] David Brody, "Internet@Crossroads $$$," *Technology Review*, May/June 1995, p. 28. With wave division multiplexing, each fiber optic cable can accommodate multiple channels by assigning each data stream a different wave length or color.

[48] Michael J. Mandel, "This Investment Book Gives the Economy Running Room," *Business Week*, July 25, 1994, pp. 68–70.

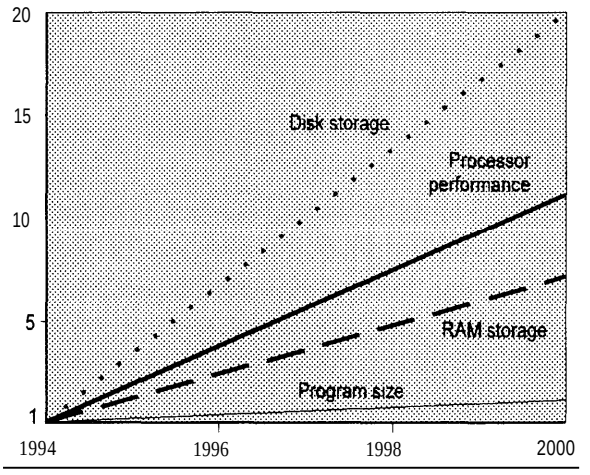
[49] In the case of audio, for example, a compression algorithm will eliminate that portion of the information that the human sensory system would typically select out before a message reaches the brain. See Mary Ann O'Connor, "The Latest in Compression Technology," *CD-ROM Professional*, January 1994, p. 153.

[50] Paula Bernier, "Compression Helps Copper Equal Fiber," *Telephony*, Jan. 31, 1994, pp. 9–10.

[51] As opposed to the 64-kb/s streams that are typically used for voice telephone to the home, video signals require approximately 140 Mb/s of bandwidth. With digital compression, signals can be compressed to about 1.5 Mb/s for videocassette recorder-quality movies, and to about 12 MB/s for real-time compressed video. See Richard Karpinski, "Video Dial Tone: Putting the Pieces Together," *Telephony*, July 25, 1994.

[52] Richard A. Langhans, "A Beginner's Guide to Digital Compression," *Satellite Communication*, November 1994, p. 24.

FIGURE 3-2: Projected Improvement Factors in Computing



SOURCE: *IEEE Spectrum,* January 1995.

storage media available today.[53] Using existing technology, the entire *Encyclopedia Britannica* and the complete works of Charles Dickens can now be stored on a single disk. Electronics companies are, however, working on a standard—High-Density CD ROM—that will increase CD-ROM storage capacity by an order of magnitude to *6.7* gigabits.[54] These high-capacity CD-ROMS can be used to distribute interactive video, much as audio CD-ROMs are presently being used.[55]

The Convergence of Communication Functions, Media, and Services

Technology advances over the last decade have also led to the convergence of communications functions and media. For example, data processing and telecommunications were once clearly distinct sets of operations, carried out by quite different economic actors. This is no longer the case. Digital switching and data processing now serve as the centerpieces of modern communication networks. With the deployment of fast packet switching and the integration of further intelligence into communication networks, it has become increasingly difficult to distinguish between the functions of switching and transmission.

One major technology advance contributing to this trend is digitization-the process of transforming "analog" messages (a spoken work, a picture, a letter) into signals made up of discrete pulses that can be transmitted, processed, and stored electronically. When in a digital form, audio, video and textual messages can be combined and recombined, allowing information to be integrated in a way that was previously impossible.[56]

In the case of telephony, digitization was first introduced in the short-haul exchange of the telephone network in the early 1960s, and into the long-haul sectors and local exchange markets in the 1970s. With the development of digital loop technologies providing digital connectivity to the customer, it became possible to offer digital data services. Transmitting digital data is much more efficient than transmitting analog data because the data do not have to be converted into tones simulating voice signal. Improvements in the performance and reliability of digital technologies, together with a reduction in their size and cost, have also fostered these developments.

The development of lightwave technology also spurred the trend towards convergence. Given the generous bandwidths provided by fiber optics, telecommunication providers were no longer technically precluded from transmitting high-speed digital images.

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[53] Alan J Ryan, "It's All in the Disc," *Datamation*, vol. 41, No. 3, Feb. 15,1995, pp. 61–62. See also, Barry Fox, "CDs: The 'e' Generation," *New Scientist,* Sept. 10, 1994, pp. 33–35; and Stephanie Losee, "Watch Out for the CD-ROM Hype," *Fortune,* Sept. 19, 1994, pp. 127-140.

[54] Michale Nadeau, *CD-ROM World,* vol. 10, No.1, January 1995, p.10.

[55] Nancy K. Herther, "CD-ROM at Ten," *Online,* March/April 1995, pp. 86–93.

[56] As described by Steward Brand, "With digitalization all of the media becomes translatable into each other—computer bits migrate merrily-and they escape from their traditional means of transmission....with digitalization the content become totally plastic-any message, sound, or image may be edited from anything into anything else." Steward Brand, *The Media Lab: Investing the Future at MIT (New* York, NY: Penguin Books, 1988), p. 19.

Epitomizing this trend towards convergence are broadband networks. Based on a common set of standards, these networks are designed to provide efficient interconnection for all possible communication services. Because they do not require separate systems for voice, data, and video, such networks are truly integrated. To provide broadband capacity, networks take full advantage of digitization, advanced switching, and lightwave technology.

The effects of digitization are being experienced far beyond the realm of telecommunications. For example, providing the ability to integrate and process voice, video, and text, digitization is giving rise to a wide range of multimedia applications that are designed to run on networked technologies.[57] Today, for example, voice, fax, and visual data can all be provided interchangeably on the desktop, so that information accessed from a database can be seen as well as heard. Multimedia software programs can be used to enhance all types of computer applications—business, education, and entertainment alike—with sounds, brilliant images, and outstanding animation.

Decentralization of Intelligence Throughout Communication Systems

The greatly improved performance of computer technologies and their convergence with communication technologies have facilitated the dispersal of intelligence and control throughout communication systems. More and more, systems are becoming defined and driven by software, which provides network structure and functionality, determining such critical features as interconnection, interoperability, and ease of use. Software-defined communication facilities are not only more flexible and versatile, they empower users, giving them greater control over network access, configuration and use.

This dispersal of intelligence throughout communication systems is well illustrated in the intelligent network (see box 3-6). The first computer-controlled switching systems were deployed 20 years ago. In the 1970s, when advances in integrated circuit technology permitted the creation of a solid-state exchange, telecommunication providers began to deploy digital switches. With the deployment of even more powerful microprocessors, faster computing speeds, and larger memories, it became possible to locate intelligence not just in the central office switch, but also at nodes throughout the network. Because these "intelligent" nodes can communicate in real time with one another, as well as with other networks, communication based on this kind of architecture offers greater flexibility—they can respond to network problems and to changes in user demand, optimize network capacity, and ensure greater system and service reliability. Moreover, because software databases and intelligent switches can be accessed and modified by customers as well as by service providers, the integration of intelligence into the network allows users greater control over the provisioning of their services.

Intelligence can also be delivered directly to users with hand-held personal computers or at the desktop. Personal digital assistants (PDAs), for example, can now be programmed to execute tasks on the user's behalf. With PDAs connected to intelligent wireless networks, users can instruct an agent on the network to contact them on receipt of a message. In turn, messages can be instructed according to their content to be immediately responded to; to be forwarded to a fax or personal computer; or otherwise dispensed with.[58] Similarly, with fax on demand, callers can dial a telephone, listen to a voice menu describing the various documents they can receive by fax, and opt either to receive the fax at a specified location

[57] Multimedia refers to the ability to combine text, high-quality graphics, sound, animation, photo images, and video into a single interactive presentation in conjunction with networked computer technology. See Joseph C. Otto, "Multimedia—What is It?" *Business Forum,* summer/fall 1994, pp. 8–9.

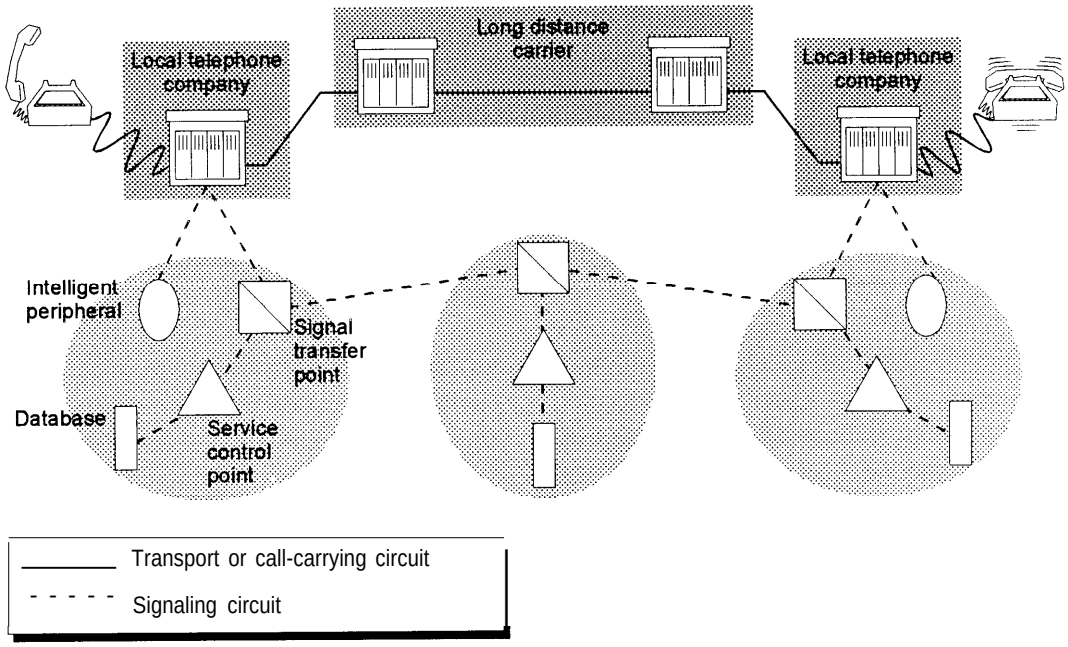
[58] Robin Gareiss, A Value Added Service With Brains," *Data Communications,* January 1995, pp. 66–70.

BOX 3-6: The Intelligent Network

The advanced intelligent network, elements of which are currently installed in today's public switched telephone network, envisions greatly increased operating efficiency as well as a broad array of sophisticated network services by separating the call transport (i.e., the voice circuit) function from the signaling and control function and employing the powerful software in the switches.

Imagine, for example, an instance where a caller places a call to a family member who, while on vacation, has indicated that calls from certain numbers are to be rerouted to the new location and given a unique ring to indicate priority. In this illustration, the vacationer would have preprogrammed the priority telephone numbers (other calls might be routed to an answering service or machine) and the new destination number by dialing into the intelligent peripheral and inputting these data. When the caller dials the number, the local switch queries the signal transfer point for billing and accounting information. It also ascertains from the service control point a clear path through the local network to the point of presence of the caller's long-distance carrier of choice. The signaling networks of the two local exchange companies and the long distance carrier interact to learn the status of the called party and, thus, how to set the call up; in this case, the call has been redirected to a telephone address in a new location, so a third local company is involved and once again the status of the called party is learned (for example, if the line was in use, the network would direct local carrier A to transmit a busy signal to the caller) and establishes a calling path. Local carrier C is also instructed to deliver the special ring.

SOURCE: Office of Technology Assessment, 1995.



or have it automatically transmitted, perhaps to a PC, as an editable document.[59]

Intelligence is also increasingly being incorporated into home-based customer equipment. Consumers can now, for example, program their telephones, their home security systems, and their VCRs, while at the same time interacting with their televisions.

Unbundling of Communication Services and Functions

Unbundling refers to the ability to separately purchase communication services or functions that were formerly available only as a single unit. Linked to the trends of convergence and decentralized intelligence, this phenomenon is becoming increasingly prevalent in all communication systems.

Unbundling first appeared in telecommunications with the Carterfone decision of 1968,[60] which allowed customers to add equipment to their telephones as long as they did not adversely affect the operation of the telephone system or its usefulness to others. A clarification of this decision by the Federal Communication Commission (FCC) in December 1988 extended its provisions to microwave systems and computers. The Carterfone decision ruptured the well-established arrangement whereby AT&T was assigned the responsibility of providing national end-to-end telephone service. Applied broadly, these decisions encouraged the entry of new entrepreneurs who wanted to plug into the network with new kinds of customer-premise equipment, or enhance the value of their private systems by interconnecting with the public network.[61] Thus, they cleared the way for the development of entirely new communication industries. Today, the unbundling of the communication infrastructure is clearly demonstrated by the emergence of a whole range of competing communication equipment and service providers.

Unbundling has also occurred in the computer and computer networking environment. With greater standardization and advances in interconnection devices such as routers, bridges, and intelligent hubs, computer networks can be more easily interconnected into larger networks. Most computing functions, moreover, are no longer hard wired into systems themselves but rather are rendered in software, which is available in a number of different varieties. And, with developments in applications program interfaces (APIs), different software programs are increasingly portable from one computing system to the next.

Increased Portability

Miniaturization and the ability to unbundle intelligent equipment from the communication infrastructure are also increasing the portability of communication products and services as well as the mobility of users. Employing portable equipment, such as pagers and cellular telephones, users can communicate from any geographic location. These technologies serve a number of niche applications, such as taxi dispatching, mail tracking, and point-of-sale. Many are now outfitted to handle data and fax transmission as well as voice.

Although all mobile technologies are based on cellular architecture, they differ with respect to the types of services that they can provide (see box 3-7). Paging devices and networks operate, for example, on a receive-only basis. Although palmtop computers have CPUs with limited memories, they can run a wide variety of applications, such as calendars, schedules, and spread

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[59] Ron Levine, "Surprise! Fax Servers Smarten Up," *Datamation*, May 15, 1995, p. 63.

[60] The Carterfone was a device that permitted callers to use the telephone network to communicate directly with others located at remote mobile radio terminals. It was not the first telephone attachment to be developed outside of the Bell System. As Alan Stone has pointed out, there have always been inventors developing attachments that could supplement or even substitute for Bell equipment. However, both AT&T and state regulatory authorities strongly opposed the use of such components, viewing them as inimical to the well-established requirement that AT&T provide end-to-end service. For a discussion, see Alan Stone, *Wrong Number: The Break Up of AT&T* (New York, NY: Basic Books, Inc., 1989), pp. 87–90.

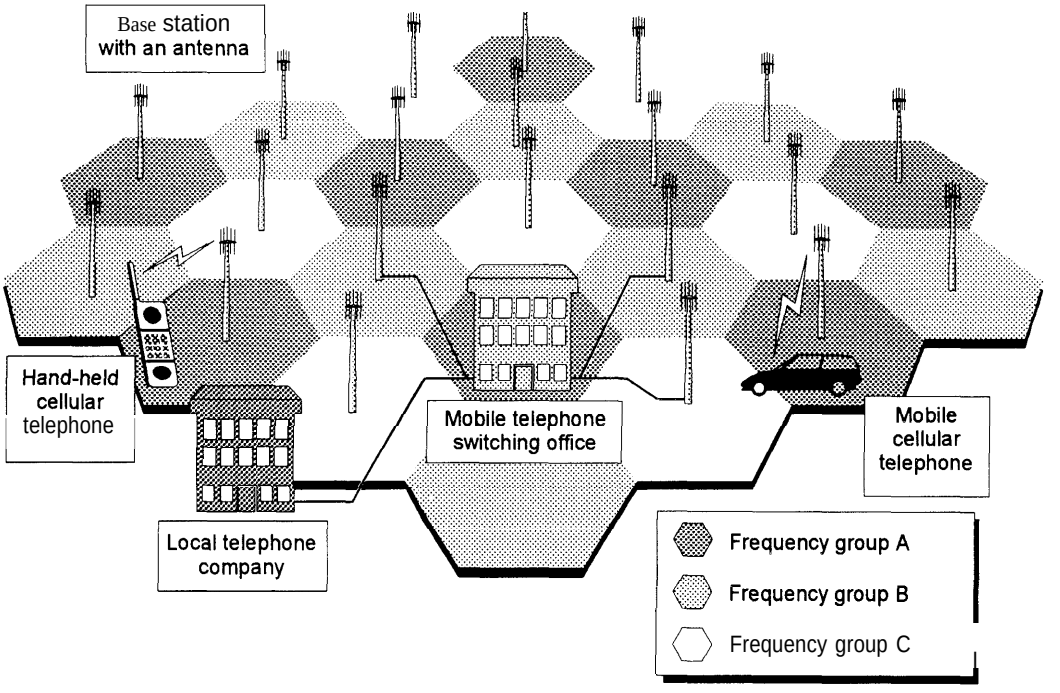
[61] To sort out this issue, the FCC undertook a series of computer inquiries called Computer Inquiry I, II, and III, none of which fully resolved this problem.

BOX 3-7: Cellular System Architecture

Modern terrestrial systems use a cellular architecture that provides coverage within many low-power transmitters. Each of the low-power transmitters in a cellular system provides coverage to an area a few miles, known as a cell (see figure). Cells are often drawn as circles or hexagons, but real-world cells are irregular in shape because buildings and trees obstruct the radio waves. By deploying enough transmitters or base *stations,* cellular operators provide continuous coverage wherever their customers are likely to be. Because users often pass through several cells as they travel through a city, a cellular system has to automatically *hand-off* the call from base station to base station. As the user nears the edge of a cell, the system reassigns the user to a new cell by determining which of the other base stations in the area can provide the strongest signal,

The cellular architecture makes efficient use of the spectrum and increases system capacity. In a conventional single-tower system, each channel can only be used by one customer at any one time. By contrast, a cellular system allows a channel used in one cell to be reused by a different user in another cell, as long as there is enough separation between cells to minimize interference. Network operators can further increase system capacity by splitting large cells into smaller ones, The greater the number of cells, the greater the number of users who can use a channel at the same time.

SOURCE: Office of Technology Assessment, 1995



sheets. Wireless local area networks (LANs) are limited in range, but when equipped with wireless interface cards and antennas, they can interconnect with mobile units or a fixed network. Wireless wide area networks (WANs) can provide wide area coverage for low bandwidth data services at a rate of 19.2 kbps.[62]

Improved Ease of Use

As technologies become more sophisticated and communication systems more complex, systems interfaces that make it easier for people to interact with technology in human terms are becoming increasingly important. Enhancements in computer-processing and storage technologies, for example, have led to the development of icon-based graphical user interfaces, such as are found in the Windows environment. Advances in speech processing and its integration into computer and communication systems are also playing an important role in making these technologies more accessible. By the turn of the century—given the present rate of progress in computerized analysis of natural languages, together with increased computing power—estimates are that it will be possible to recreate practical spoken conversation.

Equally important have been the development of search engines and navigational tools for sorting through the vast amounts of data that are increasingly available on-line. Most revolutionary in this regard have been the recently developed tools designed to browse the Internet, including for example, Gopher, Mosaic, and Netscape. Simply by pointing and clicking a mouse, users can conduct searches using key words from menus resembling tables of contents. Moreover, many navigation tools now allow users to organize and arrange vast amounts of information into clusters of related documents, as well as keep track of searches.[63]

Increased Networking Capability

Although seemingly paradoxical, the unbundling of the communication infrastructure, in conjunction with the distribution of intelligence throughout communication systems, has led to the simultaneous reintegration of communication systems through the process of computer networking. A computer network is a collection of computers that communicate with each other using common protocols. The computers may be personal computers, commonly used in homes and businesses, or they may be larger workstations, minicomputers, mainframes, or supercomputers. Transmission can be provided using coaxial cable, optical fiber, satellite links, twisted pair lines, or telephone lines. Connections between hosts can be limited to a local area (local area networks, or LANs), or they may provide long-haul connectivity (wide area networks, or WANs). Employing such systems, data in the form of text, voice, and video can, in principle, be stored, modified, and exchanged by anyone, anywhere in the world.

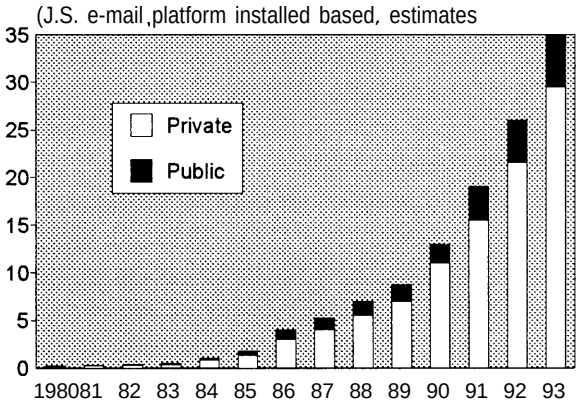
[62] Tomasz Imielenski and B. R. Badrinath, "Wireless Computing," *Communication of the ACM*, vol. 37, No. 10, October 1994, p. 18.

[63] "Searching With a 3-D Gopher," *The Internet Letter*, vol. 2, No. 8, May 1, 1995, p. 3; Greg R. Noless, "On the Nets," *Database*, December 1994, pp. 79–81; and "With InfoMagnet, Listserv Searches Are a Breeze," *The Internet Letter*, May 1, 1995, p. 4.

Computer networks offer a number of benefits. At a minimum, they can provide electronic mail (see figure 3-3). Increasingly, they are being used to link businesses together, supporting a wide range of applications such as remote processing, shared information systems, enterprise integration, groupware and electronic data interchange (box 3-8). With standardization of the technology and the integration of ATM switches into the network, broadband applications—such as high speed local area networks, desktop videoconferencing and video entertainment services will continue to evolve.[64]

Nothing attests to the benefits of networking more than the recent phenomenal growth of the Internet. The Internet is a global computer network that provides technical compatibility and transparent connectivity based on a widely used suite of protocols—TCP/IP (see box 3-9). It is currently made up of approximately 5,000 networks to which 500,000 computers are connected. Originally funded through Department of Defense's Advanced Research Projects Agency (ARPA), and later the National Science Foundation (NSF), to support defense communication and research, the Internet today is a worldwide communication network that provides a platform for the delivery of a wide range of services, a number of which are now being provided on a commercial basis.

FIGURE 3-3: Growth of Private and Public Electronic Mail Networks



SOURCE: Electronic Mail and Micro Systems, Jan. 1, 1994, pp. 1-10

The Impact of Technology Advances

Table 3-4 lays out the interrelationship between today's technology advances and the social and economic changes likely to take place in developing countries. Column 1 summarizes the technological trends (listed above) and the technological developments reinforcing them; column 2 lays out the technological implications of, and the new applications that result from, these trends; while column 3 identifies their social, economic, and political impacts.

In examining this table, it is important to note that it is the new capabilities and applications that advanced technologies make possible that give rise to social, economic and political impacts, and not the technologies or the trends themselves. Secondly, it is necessary to keep in mind that technologies are not neutral with respect to their impacts and outcomes. Different trends give rise to different kinds of impacts, all of which must be taken into account.

64 Asynchronous transfer mode (ATM) is a high. speed virtual circuit oriented cell-switching technology that provides communication at speeds between 45 and 155 Mbps. ATM can support different kinds of services such as voice, data, image, video and multimedia, including real-time information, over a single network. Using ATM, networks are easier to run, more reliable, and more flexible. See for discussions, Jonathan Reeves, "Low-Speed Access: Extending the Reach of ATM," *Telecommunications*, February 1995, pp. 23–29; Harry Flinsenberg, "Broadband Network Evolution," *Telecommunications* February 1995, pp. 32–37; Alwyne Sinclair, "ATM: Today's Network Solution," *Telecommunications*, October 1994, pp. 83–84; and James J. Lane, "Is ATM a Miracle or Another Terrible Mistake," *Telephony*, Oct. 24, 1994, p. 28.

TABLE 3-4: Impact of Technology Advances

Technology Trends	Technology Capabilities and Applications	Social, Economic, and Political Impacts
Increased performance at greatly reduced cost — e.g., microelectronics, fiber optics, voice and video compression, fast-packet switching, very high-density storage technology	Permits LDCs to leapfrog to advanced technology; maximizes advantage of existing technology. Technologies also provide greater geographical coverage.	National political/economic integration; more efficient markets and more effective political control and administration, Potential for the erosion of national boundaries due to reinforcement of global ties — e.g., PeaceNet, EcoNet, etc.
Technology convergence due to digitization, wideband transmission, compression technologies, and standards developments	Cost efficiencies in service due to economies of scale and scope and greater networking versatility. Greatly enhanced applications, such as real-time video transmission, videoconferencing and multimedia applications for the home, the desktop, or (less expensively) public point-of-sale terminals.	Greater support for the low-cost provision of public services such as health care and education Multimedia is especially useful in LDCs given high illiteracy rates. Supports business applications, such as computer-aided design, desktop fax, videoconferencing.
Unbundling of communication functions and services due to the emergence of competing technologies, the dispersal of intelligence throughout communication networks, the demand of large users, and deregulatory communication policies.	Permits users to separately purchase communication functions and services Allows for greater flexibility in network design and architecture More networking, options and freedom to customize networks to minimize costs or to match specific needs, Lower costs also due to greater competition among vendors and service providers interoperability, network integration, and network management likely to require greater technology expertise.	Democratic process likely to benefit from greater diversity of communication sources and network designs. Allows developing countries to manufacture low-end components and gain technology expertise. Less elaborate and expensive systems may provide more “appropriate” technology to meet developing country needs. On the other hand, problems of interoperability and increased complexity can create new information bottlenecks with consequences for politics and the economy. Technology experts and system integrators become new information gatekeepers.
Increased ease of use as a result of advances in storage, microelectronics, speech recognition, and search engines. Applications include simple-to-use graphic user interfaces (such as Windows), network browsers (such as Netscape), and intelligent agents,	Supports greater network access and usage, promotes deployment, and reduces the level of expertise required to take advantage of information technologies.	Reduces access barriers with positive benefits for both competitive markets and democratic politics,

TABLE 3-4: Impact of Technology Advances (Cont'd.)

Technology Trends	Technology Capabilities and Applications	Social, Economic, and Political Impacts
Decentralized intelligence throughout communications systems due to software-driven and software-defined communication networks	Provides for two-way interaction and greater user control. Applications include interactive television, personal digital assistants, desktop publishing, intelligent networks, and expert systems. Provide a platform for creating value-added services, such as 800 number, point of sale, credit authorization,	In most LDCs, two-way, interactive media can support local grass-roots participation, thereby enhancing democratic processes Provides an opportunity to develop specialized or local content to reinforce community ties. Value-added services provide or substitute for a lack of an information infrastructure (banks, insurance, legal
Increased networking capabilities due in part to advances in integration and switching technologies such as routers, intelligent hubs, and asynchronous transfer mode (ATM), frame relay, together with advances in wideband transmission technologies such as SON ET, and software support applications such as CAD-CAM, EDI, groupware, as well as the development of standards and networking protocols such as TCT/IP and application programming interfaces.	Supports distributed client-server computing and cooperative work applications such as e-mail, E D 1, computer-integrated manufacturing, teleworking and groupware. Provides support for the development of specialized functional networks, such as financial services networks or special interest group networks such as EcoNet.	Supports democratic politics by helping individuals locate information, identify like-minded people, deliberate, and voice opinions Networks help businesses and firms reduce their costs by integrating processes and information, and to gain a strategic advantage by developing exclusive networks that lock in customers and suppliers Without access to advanced networking technologies, developing countries may become locked out.
Increased mobility and portability due to distributed intelligence and advances in wireless technologies such as satellite/VSAT, cellular telephony, PCS, radio paging, digital radio, and wireless LANs, WANs, and PBXs	Low-cost alternative to wireline technologies for use in difficult-to-reach, high cost areas Greater ease and speed of deployment. Allows for greater network flexibility and support for remote information access and processing. Applications include wireless networks based on a mesh rather than hub architecture When combined with unbundled, intelligent peripherals, wireless networks support the widespread distribution of information and '(intelligence" to all areas. Applications include CD-ROM libraries or expert health care systems	Facilitates open markets and democratic politics by supporting access to political and economic information and communication networks as well as to expertise and "intelligence" from and to anywhere. Facilitates network configuration and shared information systems, which support the competence of local governments, and reinforces community ties.

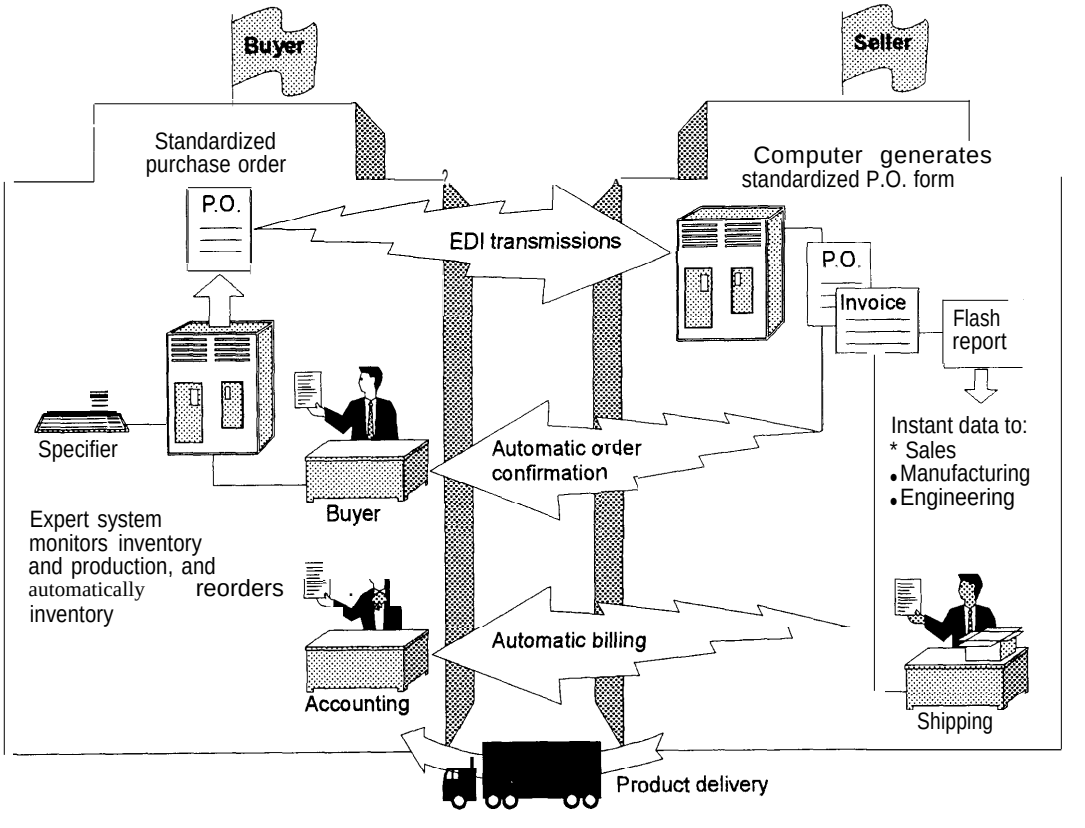
SOURCE: Office of Technology Assessment, 1995.

BOX 3-8: Electronic Data Interchange (EDI

Electronic data interchange (EDI) is a notable example of how information and communication technologies are emerging as important strategic tools for efficient and effective business operations. EDI is essentially the modern, computer-based method by which companies order, invoice, and bill their products and services. Such common transaction functions as invoices, shipping notices, and bills, which traditionally have entailed the transfer and processing of paper documents, are replaced by electronic transfers between the business computers (see figure).

EDI improves the efficiency and effectiveness of operations by enabling businesses to purchase supplies and to produce and distribute products precisely when and where they are needed. The company's computer system, for example, will initiate a purchase order and execute the purchasing transaction when an item is requested and removed from the inventory. The price, terms, and conditions of the contract are all stored in the computer. In addition to the considerable savings gained as inventory costs are reduced, EDI also minimizes human clerical error and the considerable processing costs involved with paper transactions. By reducing or eliminating the prolonged and often error-plagued paper trail, large retailers and manufacturers are able to gain a competitive advantage by streamlining transactions with their suppliers and buyers.

SOURCE: Office of Technology Assessment, 1995.



BOX 3-9: The Internet

The Internet is the largest network of computer networks in the world. It is a three-level hierarchy consisting of backbone networks that may span thousands of miles, regional or mid-level networks, and local area networks belonging to government agencies, universities, businesses or organizations. The Internet is unique for its ability to support a wide variety of applications and for the impact that these applications will have in the industrialized and developing world.

The Internet dates back to 1969 when ARPAnet, a pioneering longhaul network funded by the U.S. Department of Defense's Advanced Research Projects Agency (ARPA), became operational. The impetus for ARPAnet's creation was the desire for a computer network that would remain operational in the event that part of the network was destroyed by a nuclear explosion. The ARPAnet therefore had no central control center. Rather, each node on the network was equally capable of sending and receiving packets of data throughout the network.

A breakthrough in the achievement of such resilient packet switched networking was the development of transmission control protocol/internet protocol (TCP/IP). A *protocol* is a set of formal rules describing how to transmit data across a network. TCP, or "transmission control protocol," converts messages into streams of packets at their source and then reassembles the packets into messages at their destination. IP, or "Internet Protocol," makes sure that packets are routed to their proper destination.

Included among the TCP/IP protocol suite are a number of tools that allow users of networks with TCP/IP capability to send electronic mail to other users, participate in discussion groups, carry out distance computing, and locate and retrieve text, data, software and other information available for public access. Special computers on TCP/IP networks called "servers" or "hosts" facilitate these applications by responding automatically to queries from other servers or from personal computers that are linked to the network. TCP/IP networks will also support video transmission and, more recently, real-time voice traffic.[1] Access to an "Internet server," sometimes called a "point of presence," is the key to the applications mentioned above.

Surprisingly, the Internet is not technology specific. Networks that make up the Internet incorporate communication technologies as diverse as traditional twisted pair copper telephone lines and the latest short-haul laser transmission technologies. Satellites and undersea fiber optic cables are used to link networks separated by large land areas or by oceans.

The Internet has doubled in size every year since 1988, and analysts estimate that as many as 30 million people in 90 countries worldwide have full Internet access, that is, are linked to networks with TCP/IP capability. A still larger group of people in an additional 70 countries are able to send and receive electronic mail to computers on the Internet through networks such as USENET, UUCP, FidoNet, and BITNET. Based on the geographic distribution of Internet hosts, it is estimated that 70 percent of Internet users are in the United States with nearly half of those users residing in California.[2] Globally, sub-Saharan Africa is by far the least-connected part of the world.

Internet networks currently transmit data at maximum speeds of 45 Mbps, however, a new very high-speed backbone network service (vBNS) initiated in the spring of 1995 will connect six U.S. supercomputing sites and permit initial data transmission rates of 155 Mbps. The vBNS initiative is a five-year, $50 million cooperative agreement between the National Science Foundation and MCI Telecommunications Corporation. The project will facilitate research in advanced Internet routing technologies and in areas such as energy efficiency and the environment. By the end of the five-year program, data transmission rates may reach 2.2 Gbps (2,200 Mbps).[3]

(continued)

BOX 3-9: The Internet (Cont'd.)

The ARPAnet was replaced by the National Science Foundation (NSF)-funded NSFNet, which until recently spanned the continental United States and had connections outside the U.S. to Canada, Mexico, Europe and the Pacific Rim. NSFNet itself ceased to exist at the end of April 1995 when the cooperative agreement through which NSF carried Internet traffic over the NSFNet backbone expired. The proliferation of commercial backbones and regional network interconnections has eclipsed the need for a federally funded backbone and so NSF will now fund only four regional hubs or network access points (NAPs). These NAPs will serve as neutral interconnection points for all U.S.-based and international Internet traffic. NSF funding of these hubs will be phased out completely over the next four years, ending the federal government's financial support of the Internet.

[1] VocalTec Inc. of Israel began selling a Windows-based software package for voice transmission on the Internet beginning in February, 1995 and was followed by Electric Magic Co. of San Francisco, California in March, 1995. Camelot Corp. of Dallas, Texas expects to ship its version of voice enabling software at the end of June, 1995. Ricardo Castillo, "Standards Tug at Market for Internet Phone Calls," CommunicationsWeek International, Mar. 6, 1995, p. 9.

2 "Internet Notes," Telcom Highlights International, Mar. 1, 1995, p. 18.

3 "NSF Backbone Network Speeding Along," *High Performance Computing and Communications Week*, Apr. 20, 1995, vol. 4, No. 16. p. 3.

SOURCE: Office of Technology Assessment, 1995.

Technology Applications for Economic Development

As can be seen from this table, advances in communication technology can foster economic development in a variety of ways. If, for example, developing countries take advantage of greatly improved cost/performance ratios to deploy communication and information technologies on a national basis, they can increase the size and efficiency of their markets as a result of lower, information-related transaction costs. This possibility is very important for developing countries, where—in some cases—markets do not exist for lack of information (see box 3-10).[65] There will also be productivity gains, because larger, better integrated markets will allow Third World businesses to gain greater economies of scale and scope—a benefit that was not available to them, in most cases, until now.

The trend towards decentralized intelligence throughout communication systems will alsogive rise to economic benefits. Within developing countries there is a lack of people with mid-level skills required for knowledge workers and middle management. Nor is there an adequate commercial and legal structure—such as banks, insurance companies, commercial lawyers, and stock companies—to permit Third World companies to effectively exploit many new business possibilities. With the type of interactive, intelligent information systems that decentralized intelligence allows, businessmen in developing countries can access the required information services via technology. Intelligent networks also provide a platform on which Third World countries can, over the long run, develop their own services and service industries. By taking advantage of such possibilities, the country of Singapore, for example, has become one of the leading business service providers in the world.

[65] For a discussion of market failures in developing countries, see Karla Hoff, Ayishay Braverman and Joseph Stiglitz (eds.), *The Economics of Rural Organization* (New York, NY: Oxford University Press/World Bank, 1993). As the authors of these papers point out, developing country markets are characterized by imperfections of institutions, structures and operations, so that economic signals and incentives fail to reflect the "real costs of commodities or factors." For a discussion of market failures in rural credit markets, see, Timothy Besley, "How Do Market Failures Justify Interventions in Rural Credit Markets," *World Bank Research Observer*, vol. 9, No. 1, January 1994, pp. 27–47.

BOX 3-10: Markets and Information

Communication is inherent in the coordination of all economic activity. A market relies on the communication of information to identify buyers and sellers, allocate resources, and establish prices. Within firms, the availability of timely and accurate information is key to decisions about whether to enter or exit markets, how to secure financing, how to organize working relationships, and how to market and distribute goods. Where adequate information is not available, markets will fail and economic performance will suffer because of higher business costs. Likewise, firms that lack adequate market information will be at a competitive disadvantage.

SOURCE: Office of Technology Assessment, 1995.

Technology Advance in Support of Democracy

The prospects for democracy in developing countries are also greater due to technology advances (see box 3-11). For example, improved networking capabilities, which make it possible to develop specialized, distributed, many-to-many applications such as bulletin boards and groupware, can help individuals locate information; identify like-minded people; deliberate their ideas; organize their activities; and lobby for their points of view. Already, such networks are being used to link special interest groups across national boundaries and with considerable effect (see box 3-12).

The trend towards the unbundling of communication functions and services can also have a significant payoff for democracy. Given the greater flexibility in network design and architecture that unbundling allows, developing countries can deploy customized, lower cost systems in remote areas, thereby extending information access on a much wider basis. The diversity of communication networks is also important for democracy because it permits a greater variety of information sources. This capability is especially important in developing countries, where communications have typically been generated at the center of power and then disseminated outward. Different communication technologies often have different geographic biases, with some being more capable than others in supporting communication both to and within remote areas.[66]

Technology Advance To Support Political Stability

Just as technology advances hold promise to foster economic development and democracy in Third World countries, so too they can play a supportive role in helping to sustain political stability in these areas. For political regimes to be stable, they must not only prove themselves competent in carrying out the affairs of government, they must also be able to assure that basic public needs are met. In addition, if governments are to provide such services without themselves becoming overbearing, the capacity of voluntary associations and local government must be simultaneously upgraded.[67] Communication technologies have something to offer in all three regards.

Taking advantage of the trends toward networking and decentralized intelligence, for example, developing country leaders can, like businessmen, enhance their governing capability by using interactive expert systems and databases (see box 3-13). For even greater benefit, these systems can be networked to let govern-

[66] John Carey, "Space, Time and Communication: A Tribute to Harold Innis," in James W. Carey (ed.), *Communication as Culture: Essays on Media and Society* (Boston, MA: Unwin Hyman, 1989), p. 3.

[67] As described in *Human Development Report 1993,* "Changing the power equation requires the organization of a countervailing force, or even a revolution. People's organizations—be they farmers, cooperatives, residents' associations or consumer groups—offer some of the most important sources of countervailing power. And they often exercise it more effectively through the sharing of information and ideas—it is ideas, not vested interests, that rule the world for good or evil." op. cit., footnote 34, p. 29.

BOX 3-11: Communication and Democracy

Communication and information pervade political life. Without them there could be no nation; for it is through the process of communication that people first develop a sense of community and a shared set of values that legitimize political authority. By magnifying and amplifying some actions, the communication process distinguishes between what is a private act and what is a public affair. It organizes what appears to be random activities to show how individuals and groups are related to one another in pursuit of power, providing a roadmap for individuals who want to influence the course of political events. Citizens rely on the communication process to gather information, identify like-minded people, deliberate their points of view, organize their forces, and articulate their political preferences. Furthermore, because it generates a common fund of knowledge and information, the communication system facilitates productive and rational debate. Without some form of knowledge and understanding of how others are informed and what they believe, individuals could not make reasoned and sensible arguments and decisions.

SOURCE: Office of Technology Assessment, 1995.

BOX 3-12: EcoNet

EcoNet is a virtual community of over 10,000 individuals and organizations in over 90 countries who are working for environmental preservation and sustainability. Members of EcoNet have access to hundreds of private and public online electronic mail conferences through which they exchange information and collaborate on environmental initiatives of local, national or global concern. Individuals or organizations in the United States may pay to join EcoNet through its parent organization—the Institute for Global Communications (IGC) in San Francisco—which is part of the larger Association for Progressive Communications. The EcoNet Internet server provides a gateway not only to the home pages of member organizations such as the National Audubon Society and the Earth Island Institute, but also to the Internet sites of thousands of organizations and government agencies worldwide with information on environmental issues.

SOURCE: Office of Technology Assessment, 1995.

ment officials remotely access the global store of information.[68] Secondly, communication technologies can also be used to distribute public services such as distance healthcare and educational services much more cost effectively. Technology convergence, which provides the platform for nontextual multimedia applications, is especially promising, given the high illiteracy rates in developing countries. Multimedia can also greatly improve the overall quality of healthcare and educational applications (box 3-14). Finally, both of these developments can be used in similar fashions to empower voluntary organizations and local governments.[69]

[68] For discussions of the implications of not having access to scientific and technological information see, Jacques Gaillard, *Scientists in the Third World* (Lexington, KY: University of Kentucky Press, 1991) and Phillip W. Jones, *World Bank Financing of Education: Lending, Learning and Development* (London, UK: Routledge, 1992). Commenting on the lack of scientific journals, books, and other sources of technological information in developing countries, Gaillard notes that of the career scientists interviewed, 36 percent had no communication with scientists in countries where they had originally studied and done their research.

[69] As described by Pieter Kok, "The lack of information and appropriate technology often prevents sustainable community development. Even if community members know what they need, a lack of knowledge of available resources and how to use them effectively easily creates passivity or disinterestedness among beneficiaries. In other cases, it results in the perception that the community's contribution will not make a difference anyway. The result may be one-off development exercises initiated by outside agencies and a long-term dependency on their input." Pieter Kok, "The Role of Information and Technology in Community Empowerment and Development," *In Focus*, February/Market 1995, p. 25.

BOX 3-13: The Sustainable Human Development Network Program

In many developing countries, decisionmakers do not have access to up-to-date information needed to make key policy decisions. One program designed to assist in this regard is the Sustainable Human Development Networking Program (SDNP), established by the United Nations Development Program in May 1992. Participants include 12 countries from Africa, Asia, and Latin America.

The aim of SDNP is to link users and providers of information on sustainable human development via computer networks that operate over the Internet. Designed to complement existing systems, SDNP provides support both for network deployment and training, information generation, and the norms of information sharing and exchange. The program is open to all interested parties, including national governments, non-governmental organizations, academics, business, and the media. The SDNP program builds on local talent and expertise. In addition, each node on the system operates independently of each other, and definitions of sustainable human development are determined locally. Seed money is provided upfront, but projects are intended to become self-financing, so that funding will gradually be reduced by as much as 50 percent or more.

SOURCE: Raul Zambrano, "The UNDP Sustainable Development Network," *Bulletin of the American Society for Information Science,* February/March 1995, pp. 23–24.

DEVELOPMENT CHALLENGES AND OPPORTUNITIES FOR THE FUTURE

How successful developing countries are in employing communication and information depends not only on their present situation and resources, but also on future developments and events. Three major trends are critical in this regard: 1) the emergence of a competitive global economy; 2) the trend towards a knowledge-based economy; and 3) the shift to decentralized, flexible, networked economic activities. Communication and information technologies are not only driving these trends; they can also help developing countries adapt to them.

The Emergence of a Competitive Global Economy

In the period following the second World War, most Third World countries pursued economic development strategies that sought to shelter their economies from global markets. Modeled after the ideas of the renowned Latin American economist Raul Prebisch, these policies aimed to discourage the production of exports—through the use of quotas, taxes, and licenses—while at the same time promoting the domestic production of import substitutes.

The limitations of such an approach became all too clear in 1982, with the onset of the international debt crisis.[70] The few countries that had pursued growth strategies based on export promotion and austerity measures survived the upheavals with their economies intact, whereas those that followed policies based on import substitution did not. Most successful in this regard, for example, were the East Asian countries—Korea, Taiwan, Singapore, and Hong Kong. Between 1960 and 1989, these countries increased their exports from $2 billion (which constituted 5 percent of all developing country exports) to $246 billion (or 32 percent of all developing country exports).[71]

The rapid emergence of a competitive global economy makes any development strategy based on artificial trade barriers increasingly untenable. Pursuing such policies, developing countries will suffer not only by channeling growth away from

[70] See chapter 2 for a discussion.

[71] See Anne O. Krueger, *Economic Policies at Cross Purposes: The United States and the Developing Countries* (Washington DC: The Brookings Institution 1993), p. 105.

BOX 3-14: Project SHARE

Project SHARE, a three-year collaboration on the part of Intelsat and the International Institute of Communications, is one example of the international community working together to use tele-education and telemedicine applications to address the health care and education needs of developing countries. Beginning in 1985, Intelsat made transponder space on its global satellite network available for free to over 20 projects located throughout the world. A total of 22 countries participated in Project SHARE medical projects, while 43 countries took part in various educational projects. Most projects involved interactive or at least one-way video broadcasts and were either one-time events or longer term, recurring projects. In total, over a billion people participated in one or more SHARE projects, which together would have cost in the millions of dollars if provided commercially.[1]

Among the lessons learned from Project SHARE are that cost and lack of technical expertise are significant hurdles to the development of communication infrastructures in developing countries. Often satellite video services were impractical in rural areas of developing countries for lack of earth stations or supporting communication links and equipment. In other cases successful projects were discontinued because the financial or human resources did not exist to sustain them. Another insight gained from Project SHARE is that projects that combined education and health/medicine content were often the most successful and generated the most enthusiasm among participants. This observation highlights the value of telecommunication networks as providing an infrastructure for multipurpose communication.

[1] Joseph Pelton, "Project SHARE: the IIC INTELSAT Experiment in Distance Learning," *Vision and Hindsight, The First 25 Years of the International Institute of Communications,* Winsbury/Fazal.

SOURCE: Office of Technology Assessment, 1995

sectors such as agriculture, which are increasingly recognized as being critical for economic success. By failing to integrate themselves into the expanding global economy, they will also cut themselves off from the many new opportunities that growth in world trade affords.

The integration of the international economy is being driven by a number of related developments. Included among these, for example, are:

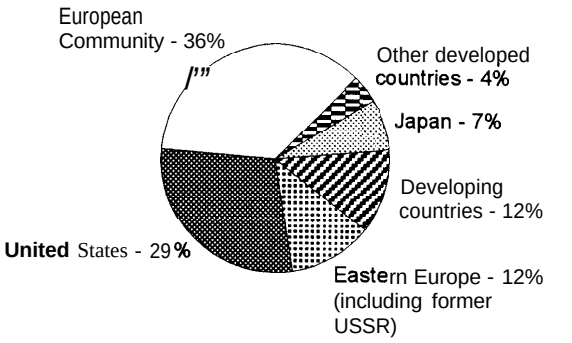
- the increasing similarity among countries with respect to tastes, infrastructure, distribution channels, and marketing approaches;
- the emergence of a global capital market, as witnessed by the large flow of funds between countries;
- declining tariff barriers and the establishment of regional trading agreements;
- shifting opportunities for competitive advantage due to technology restructuring;
- the integrating role of advanced information and communication technologies;
- uneven world economic growth that has fanned the flames of international competitiveness; and
- the emergence of new global competitors, principally from East Asia.[72]

Together, these developments have led to a global economy in which patterns of international trade primarily reflect patterns of international production. Specialization takes place on the basis of parts and specialized components, rather than—as in the past—on the exchange of finished products. Thus, interfirm and intrafirm trade is steadily replacing interindustry trade.[73] Today, for example, Japan provides approximately 40 percent of U.S. component parts in electronics and automobiles.[74]

[72] Michael Porter (ed.), *Competition in Global Industries* (Boston, MA: Harvard Business School Press, 1986), pp. 408–409.
[73] Robert Gilpin, *The Political Economy of International Relations* (Princeton, NJ: Princeton University Press, 1987).
[74] Porter, op. cit., footnote 73.

Patterns of direct investment abroad also highlight this trend toward global economic integration and interdependence. Between 1960 and 1988, for example, direct investment abroad by all firms in all nations increased by over 10 percent per year to more than $1.1 trillion (see figure 3-4).[75] Most important for developing countries, foreign direct investment (FDI) now serves as a major source of capital. Such investment, for example, is today three times greater than the amount of aid funding provided by foreign governments. In 1994, FDI in Third World countries totaled no less than $179.9 billion.[76]

FIGURE 3-4: Share of Major International Joint Ventures



SOURCE: Institute for the Future, "The Electronic Enterprise," contractor report. Prepared for the Office of Technology Assessment, May 1993.

Multinational corporations are also driving the trend toward globalization. To compete in today's global economy, companies must integrate their activities on a worldwide basis, allocating activities among a number of countries to gain the greatest advantage.[77] Depending on the particular case, for example, firms might disperse most of their production facilities (e.g. facilities for design modification, fabrication, and assembly) to foreign countries, while focusing their own domestic production on the fabrication of key components. Alternatively, firms might decide to manufacture their products domestically but transfer abroad downstream activities such as distribution, sales, marketing, and service. When not fully integrated into multinational corporations, these firms are networking their activities across global boundaries through a variety of arrangements such as cross-licensing of technology, joint ventures, orderly marketing agreements, offshore production of components, secondary sourcing, and crosscutting equity ownership .78

These developments also have implications for developing countries. In the past, for example, most largescale Third World companies were subsidiaries of foreign firms. Because the parent firms were located, and directed their operations from, abroad---close to their major suppliers and markets—there were few positive "spillovers" for developing countries. Today, this is no longer the case. Local firms that partner with global companies as suppliers or value--added providers have much more to gain, as India's export-oriented software industry clearly attests.[79] Working with foreign firms, Indian software contractors have been able to access the latest standards, technological platforms, productivity tools, quality requirements, and upfront financing, all of which have been critical to their success.

The Trend Towards an Information-Based Economy

There is an interrelated trend toward a networked information-based economy that will likely have equally important implications for developing

75 John W Rutter, "Direct Investment Update: Trends in International Direct Investment," U.S. Department of Commerce, International Trade Administration, September 1989.

76 "Private Investment to Poor Nations Hits a Record High at World Bank," *The Washington Post*, Jan. 23, 1995, p. A14.

77 Porter, op. cit., footnote 73.

78 Peter Cowhey and John Aronson, *Managing the World Economy: The Consequences Of Corporate Alliances* (New York: Council on Foreign Relations, 1993),

79 Nagy Han, Ken Kuy, and Erik Arnold, *The Diffusion of Information Technology: Experiences of Industrial Countries and Lessons for Developing Countries,* World Bank Discussion Paper, No. 281 (Washington , DC: World Bank, 1995), p. 120.

countries.[80] As information comes to serve increasingly as a primary resource and a key factor of production, many developing countries will find themselves at a new, major crossroad. Given the knowledge, expertise, and intellectual wherewithal, Third World countries have a unique opportunity to "leap frog" from a preindustrial era to an information age. Failure to take advantage of this opportunity, however, may leave developing countries yet further behind.[81] In today's economy, information is treated more and more as a commodity to be bought and sold in the marketplace. As the economic value of information increases, so do the economic rewards of those who have the greatest access to it.[82]

The trend toward a networked, information-based economy results, in part, from the deployment of information and communication technologies. These technologies provide numerous ways to improve efficiency and increase productivity, and thus engender growth. Information is, for example, reusable. Unlike capital resources such as steel and iron, it requires very few physical resources to produce and distribute. Information can be used, moreover, to substitute more efficiently for labor and to improve the overall efficiency of the productive process itself. As productive processes become increasingly complex, the largest reserve of economic opportunities will be in organizing and coordinating productivity activity through the process of information-handling.[83]

Technology advances have also given rise to new businesses that specifically cater to business information needs. Information can now be processed in a variety of new ways, adding to its value from the point at which it is created or composed to the point at which it is assimilated or used. As the opportunities for creating new information products and services have increased, so too have the number of commercial providers. Responding to the increased demand for information, the new technologies have spawned a rapidly growing industry. For example, in 1992, the worldwide market for online services totaled $10.1 billion, a 9.2 percent increase from $9.3 billion in 1991 (see box 3-15).[84]

If developing countries deploy advanced communication technologies in tandem with developed countries, they can also compete in this expanding global market on a more equal basis. One of the first countries to recognize this opportunity was Singapore, which has greatly prospered as a result. By 1990, Singapore had become the 17th-largest trading nation in the world, and was home to the regional headquarters of more than 600 multinational corporations.[85]

When, for example, in the early seventies multinational corporations began to transfer their manufacturing operations from Singapore to lower cost labor countries such as Malaysia, Thai-

[80] OTA, *Electronic Enterprises*, op. cit., footnote 4.

[81] As described by Manuel Castells, "The critical point is that the current dramatic transformation of the world economy into a dynamic, highly integrated system could bypass entire countries or the majority of their population. ...Within the framework of the new information economy, a significant part of the world population is shifting from a structural position of exploitation to a structural position of irrelevance." Martin Carnoy, Manuel Castells, Stephen S. Cohen, and Fernando Cardoso (eds.), *The New Global Economic in the Information Age: Reflections on Our Changing World* (University Park, PA: Pennsylvania State University Press, 1993), p. 37.

[82] As noted by Merrifield, "Wealth will no longer be measured primarily in terms of ownership of fixed physical assets, but rather in terms of time-critical access to needed resources; and to knowledge-intensive value-added operations. The value-added dimension, moreover, will be the deciding source of the comparative advantage required for industrial competitiveness. This shift in the basis of wealth formation is a major break with the past, a discontinuity that is driven by accelerating forces of change. One of these factors involves an explosion of technology that has created about 90 percent of all scientific knowledge over just the last 30 years. Moreover, this knowledge base is likely to double again in the next 15 years. D. Bruce Merrifield, "Global Strategic Alliances Among Firms," *International Journal of Technology Management, Special Issue on Strengthening Corporate and National Competitiveness Through Technology*, vol. 7, 1992, p. 77.

[83] Charles Jonshur, "Information Resources and Economic Productivity," *Information Economics and Policy I* (North Holland: Elsevier Science Publishers, 1983), pp. 13–35.

[84] *Online Services: 1993, Review, Trends & Forecast* (Wilton, CT: SIMBA/Communication Trends, 1993), p. 11.

[85] Robin Mansell and Michael Jenkins, Networks, Industrial Restructuring, and Policy: The Singapore Example," in *Technovation*, vol. 12, No. 6, Sept. 1992.

BOX 3-15: Annual Online Publisher Growth

The online services market is growing rapidly. Worldwide sales in 1992 topped $10.1 billion. Of this amount, North American-based companies accounted for 60 percent and European-based companies accounted for 32 percent. Annual sales growth was 9.2 percent in 1992 and averaged 9.1 percent between 1983 and 1992 in the number of databases, database producers, and online services (vendors who distribute database information. While these numbers are large, they are only a subset of a much larger information market that includes the sale of information and services over private networks, electronic data interchange (EDI), networking offered by value-added networks (VANs), airline customer reservations systems (CRSs), real-estate multiple-listing services (MLSs), electronic funds transfers (EFTs), and automated teller machines (ATMs).

SOURCE: Gale Directory of Databases, Volume 1: Online Databases, Gale Research, Detroit, MI, 1993.

land, and Indonesia, the Government of Singapore was quick to adopt a more service-oriented, export-led strategy. Recognizing the role that the communication and information infrastructure might play in capturing the benefits of global trade, government officials undertook to create a totally electronic trading environment, with the aim of transforming Singapore by the end of the century into an "intelligent island." By providing multinational corporations efficient, one-stop global networking and value-added trade services, Singapore was able to establish itself as the major trading hub in Asia.[86]

As the benefits of using communication networks increase, so too do the costs of not having access to them. Opportunity costs are especially high in the case of networking technologies because they give rise to "first mover advantages." Thus, as Singapore clearly recognized, the first country to establish a technology-based global trade network can gain a hefty competitive advantage, not just because the capital costs entailed are so high, but also because electronic networks require considerable "learning by doing." Moreover, once business users have expended the energy, expertise, and financial resources required to use a particular network, and have become linked up with other network users, they tend to get "locked in."[87]

The Trend to Decentralized, Flexible, Networked Economic Activities

To gain competitive advantage in a knowledge-based, global economy, firms must also adopt entirely new ways of doing business. Global customers are now more diverse and sophisticated, and new, highly skilled competitors require communication networks to participate in foreign markets. Success in the global economy no longer depends only on achieving efficiency and cost reduction.[88] Increasingly, it depends on the effectiveness of businesses—their ability to innovate, respond just in time, focus on quality, and establish more cooperative interfirm and intrafirm relationships. To enhance their effectiveness, firms are taking advantage of more timely and appropriately packaged information to help them shift from business models based on mass production to those centered around the concept of flexible, decentralized production.

Networked information technologies are especially useful in helping firms to restructure and

[86] "Asia-Pacific Telecom Hubs: Let's Make A Deal," Data Communications Magazine, vol. 24 No. 8, pp. 53–54.

[87] See Joseph Farrell and Garth Saloner, "Horses, Penguins and Lemmings," in H. Landis Gabel (ed.), *Product Standardization and Competitive Strategy* (The Netherlands: North Holland, 1987).

[88] R. Ray Gehani, "Concurrent Product Development for Fast Track Corporations," *Long Range Planning*, vol. 25, No. 6, pp. 40–47, 1992.

reengineer their operations to be more competitive. Businesses are using these technologies to reorganize their activities into more versatile and flexible networks and teams. Some businesses, for example, are using networking technologies to build long-term, integrated business relationships with their customers and suppliers. Others are teaming up with outside firms for specific short-term ventures. Some of these business relationships, operating through electronic networks, cross national as well as organizational boundaries. Networking technologies such as wide area networks (WANs), videoconferencing, computer integrated engineering, and manufacturing and electronic data interchange (EDI) are necessary to support these flexible business arrangements (see box 3-16 and box 3-17).[89]

In addition to having an impact on how firms conduct their business, information and communication technologies also affect the size, structure, and openness of markets. As these technologies are integrated into reliable commercial networks, more trade will take place in electronic markets, online. How these electronic markets evolve, and the form that they take, will have significant consequences for the functioning of the global economy. Electronic markets can reduce the net costs of doing business, and thus improve overall efficiency and expand trade. However, if these networks fail to interconnect, or are unevenly deployed, they could create technological barriers to trade and restrict competition.[90]

For Third World countries to compete on an equal footing and partner with companies in the First World, they too will need to reorient their businesses away from mass production towards just-in-time, flexible production. While information and communication technologies are not necessarily essential to carrying out these organizational changes, having access to them can greatly expand a firm's opportunities and enhance its efficiency by reducing transaction costs (see appendix A).[91]

With networking technologies, even small businesses will be able to expand their activities.[92] A small business serving a single niche market in a developing country, for example, can increase its size by using communication technologies to identify similar niche markets in other countries. Small firms in developing countries can also use networking technologies to partner with the growing number of globally dispersed firms that outsource many activities to Third World countries. Or, alternatively, small businesses can use communication networks to link their operations together, allowing them to function and compete as if they were much larger entities. This kind of networking approach was used, for example, by the Italian clothing manufacturer, Benneton, with remarkable success.[93]

National governments have not been alone in recognizing the potential for information networking to enhance global trade. Recently, for example, the U.N. sponsored the global Trade Point Program, which aims to promote trade through the establishment of a series of "trade

[89] OTA, *Electronic Enterprises*, op. cit., footnote 62.

[90] Ibid.

[91] Some of the most successful early applications of this approach, for example, took place in the industrial districts of Northern Italy and Baden-Wurttemberg, Germany, where technology was not an issue.

[92] As described by R. Badrinath, "Previously, gaining entry into distant markets was out of the question for a majority of [small and medium sized enterprises] SMEs. Even assuming that they could organize the finance and production aspects of their operations effectively, foreign marketing raised almost insurmountable obstacles. The process of market selection, buyer identification, visits abroad with quantities of samples, preparation of business offers and counter proposals, discussion of specifications and so on required large investments of time, energy, and resources. Today, much of this can be done without leaving the workplace, thanks to the telephone, fax and other telecommunication facilities." R. Badrinath, "Helping Small and Medium-Size Firms to Enter Export Markets," *International Trade Forum*, No. 2, 1994, p. 6.

[93] See Cristiano Antonelli, "New Information Technology and Industrial Organization—Experience and Trends in Italy," in *Information Technology and New Growth Opportunities* (Paris, France, OECD Development Center Studies, 1989).

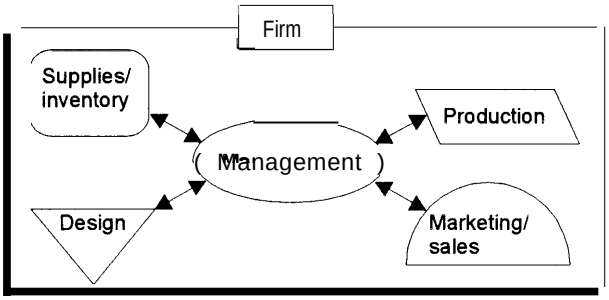
BOX 3-16: Networking for Economic Advantage

Networking provides new opportunities for businesses to enter new markets, gain strategic advantage, and reduce transaction costs. These networks are effective because they cut across traditional organizational boundaries, either within or across firms,

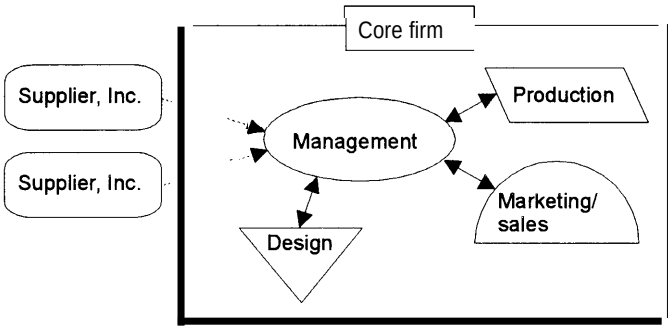
Business networks come in a number of varieties, As depicted in the figure, some networks are internal to the firm. They generally cut across traditional business functions, allowing firms to reorganize around processes that support team-based work for total quality control and just-in-time delivery. A wide range of groupware applications are being developed to support such networks. Businesses may also set up networks to create new interorganizational connections as can be seen in section B. An electronic data interchange (EDI) network might be used, for example, to connect a firm to its suppliers. Networking can also be used to support virtual corporations and agile manufacturing as illustrated in section C.

SOURCE: Office of Technology Assessment, 1995

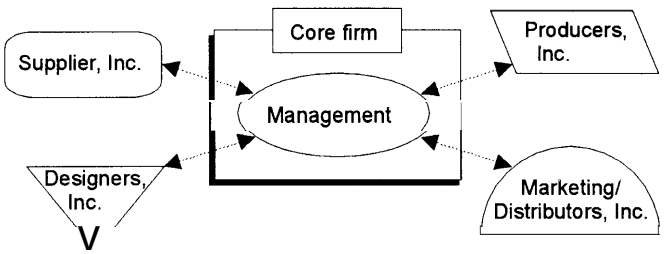
A: Fully-integrated firm



B: **Outsourcing**



C: Virtual corporation

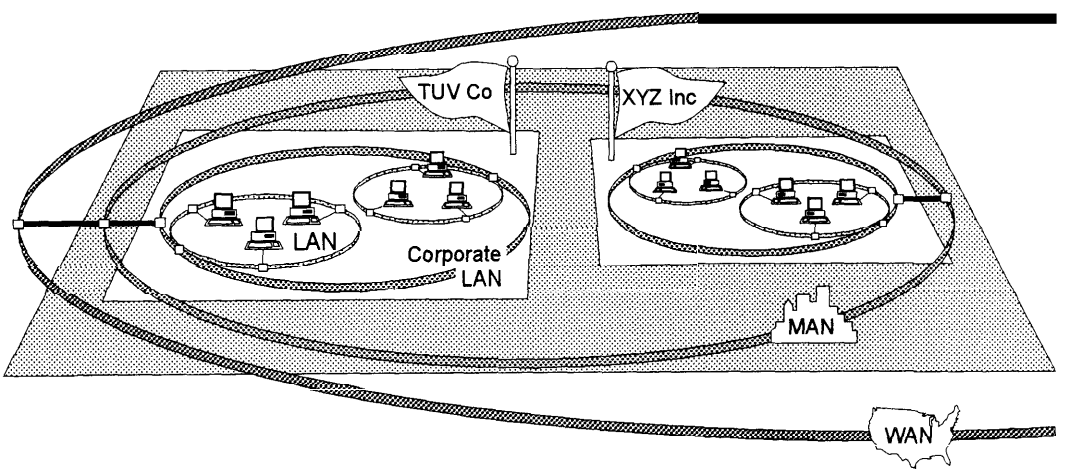


BOX 3-17: Networking for Enterprise Integration

Enterprise integration is presently facilitated by the use of shared information systems, across groups and facilities, so that teams can leverage the information resources of others, wherever they may be. To support enterprise integration, communication must be seamless and reliable so information can be relayed in a timely manner and without errors.

There are a number of technologies that support shared information systems. Networking options include local area networks (LANs), wide area networks (WANs), and metropolitan area networks (MANs), supported by a vast array of transmission and networking technologies, including asynchronous transfer mode (ATM), integrated services digital network (ISDN), fiber optics, satellite, and many other radio-based technologies. The figure illustrates how the data communications portion of the information superhighway is composed of a complex network of interconnected networks. A firm's internal computer network typically consists of several smaller, linked LANs, which in turn are interconnected to increasingly wider networks, MANs and WANs. Open systems architecture and object-oriented programming environment will enable systems to be built more efficiently and effectively to facilitate information-sharing. Client/server architectures that distribute data over a network of desktop workstations (as opposed to having the data reside in a central mainframe computer) will allow departments to own their own data and make it available to the people who need it. Software such as groupware and distributed databases will provide the ability to store, search, and refine disparate pieces of information.

SOURCE: Office of Technology Assessment 1995.



points" or trade facilitation centers that provide companies with greater access to communication networks and trade-related information. Already there are 59 such Trade Points in 45 countries serving as clearinghouses for trade leads, custom and tariff information, sources of financing, qualified freight forwarders and insurers, and market overviews. Trade Points offer services either physically, in a centrally located office, or online by connecting customers and service providers electronically. Depending on available resources, Trade Points may also offer the use of communication technologies such as voice and video conferencing, electronic mail, bulletin

boards and shared databases. In addition to the free resources offered on the Internet, Trade Points have begun to provide trade information generated by the private sector, as well as space on its Internet server for company home pages, on a fee basis. The U.N. estimates that 100 Trade Points will be in operation by 1996.