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The Neoliberal Networking Drive Originates in the United States

The architects of digital capitalism have pursued one major objective: to develop an economywide network that can support an ever-growing range of intracorporate and intercorporate business processes. This objective encompasses everything from production scheduling and product engineering to accounting, advertising, banking, and training. Only a network capable of flinging signals—including voices, images, videos, and data—to the far ends of the earth would be adequate to sustain this open-ended migration into electronic commerce.

To create such a system meant that the foundations of the world's electronic information infrastructure had to be recast. The new network system, within which the Internet loomed largest by the mid-1990s, required a sweeping metamorphosis of the structure and policy of existing telecommunications.

To set about this task, computer companies and leading telecommunications carriers allied themselves with the few thousand transnational enterprises that comprised their primary customer base. This partnership was animated by a shared political axiom: that corporate capital's ownership and control of networks should be put beyond dispute, even beyond discussion.[1] This neoliberal freedom to fashion networks into instruments of enterprise should remain unalloyed.

Neoliberalism comes by its name because its adherents' primary aim—paring unwanted state oversight and regulation of the economy to gain more unfettered freedom of action for private firms—resuscitates the liberal economic policy of Victorian Britain. Markets should be left alone to obey their presumed natural logic: so goes the laissez-faire doctrine that was reenshrined as domestic orthodoxy during the 1980s and

assumed global preeminence during the 1990s. Because the best economic outcomes were produced by negotiations among individual economic actors who were unencumbered by extraneous obligations, government regulation must be minimized.[2] Paradoxically, however, to actualize something approaching such a free-market regime in telecommunications today (just as in Britain during the 1840s), unremitting political intervention was necessary. Thus, as we will see, the evolution of networking comprised as much a political as an economic work in progress.

During the 1990s, a top-to-bottom overhaul of worldwide telecommunications drove toward completion. Two features of this transformation stand out, as we will see in chapter 2. First, the network system-building boom was of a magnitude that the world had never seen. Old networks were upgraded to support novel services, while capacious new systems sprang up at every level, from local loop to global grid. Equally significant, however, was a second feature of the emerging regime. Policymakers the world over simultaneously abandoned public-service policies for market-driven tenets and acceded to the integration of networks on a transnational scale. National welfarist controls over this critical infrastructure dropped away, while disparities in access widened.

This tumultuous transformation was triggered inauspiciously, by an obscure series of piecemeal changes beginning in the United States in the 1950s.

Liberalization of U.S. Network Development

During the mid-1950s, near the beginning of the digital computer era, U.S. government agencies and educational institutions possessed perhaps three-quarters of the nation's several hundred computer installations. Throughout the 1960s, however, the not-for-profit orientation of early computing shifted. By the mid-1960s, manufacturers, banks, insurance companies, utilities, and retailers were operating two-thirds of a greatly enlarged base—some 35,000 installations—of computing facilities.[3] Many computer applications sought to rely increasingly heavily on telecommunications to make data-processing power available more broadly throughout business organizations. Originating as discrete islands of computer *functionality* (as different classes of service, or discrete applica-

tions, are sometimes called) in payroll, accounting, inventory, and other administrative areas, disparate networks soon began to unfurl into other fields: sales, credit authorization, customer service, production scheduling, and research and development. In 1960, a mere thirty-one U.S. computer systems permitted *online use,* meaning that these computers might be accessed via remote terminals connected by telecommunications links. These early online applications were limited to such areas of *transaction processing* as airline ticketing. A scant six years later, however, one survey showed that more than 2,300 online systems had been installed by U.S. businesses. Through an uneven but continuing process, to which we return momentarily, more and more corporate services began to be placed online.[4]

Anticipating this rapid buildup of network applications as early as 1947, one trade association—the American Petroleum Institute—created a Central Committee on Radio Facilities. The head of this curiously named unit declared that "practically every division or branch of the petroleum industry can well be served by one or more adaptations of radio to effect economies in operation, increase safety, or raise efficiency."[5] Oil companies were far from unique in sensing the industrial potential of telecommunications. An interindustry trade group, the Microwave Users Council, was established in 1954. Growing corporate dependence on early computer-communications networks in turn prompted the largest U.S. companies from every economic sector to undertake a long march through the nation's regulatory arena.

The Long March

Throughout the twentieth century, the telecommunications system had become subject to extensive governmental oversight. Federal and state regulation served several ends. Foreign ownership of this strategic industry, to begin with, was deemed inimical to U.S. national sovereignty. Far-reaching precautions were taken, therefore, to ensure that the telecommunications industry remained in U.S. hands. Legislation strictly limited foreign ownership of U.S. telecommunications companies, which contributed to forestalling, within a vital sector, the corporate economy's trend toward transnationalization.

Because they were classed as public utilities and common carriers, telecommunications companies faced an array of additional obligations during the welfare-state era. Specialists refer to these mandates as *exit, entry,* and *operating controls*. State public utility commissions—in partnership with a transcendent national agency, the Federal Communications Commission—monitored the prices carriers sought to charge, the services they sought to provide, and the technologies they sought to utilize. Under the terms of prevailing policy, the industry adhered to an overarching norm of nondiscrimination: comparable service for every subscriber. Established policy also placed a premium on long-term industry stability, end-to-end network responsibility, and nationwide residential telephone service.

Business network users, allied with entrepreneurial industries emerging around a cluster of constitutive technologies—computers, aerospace, and military electronics—found these regulatory mandates increasingly inhibiting. Why were they not free to build networks just as they pleased? As early as 1957, business users began to lobby, as the Automobile Manufacturers Association put it in an obscure proceeding, for "the same latitude in the use and implementation of our communications facilities that we enjoy in the use and implementation of the many thousands of other tools, facilities and services necessary to the conduct of our business"[6]—including, preeminently, the computer. Between the mid-1950s and 1970, business users elaborated a policy agenda around a general objective: freedom to develop corporate network systems and services as they preferred.

Through a series of highly technical proceedings at the Federal Communications Commission and elsewhere, these users insisted that they had the right to

- Build wholly proprietary systems, using microwave and other nontraditional technologies, for internal corporate data and voice communications;
- Lease from the existing telecommunications carriers *private-line* circuits to interconnect specific branch plants and offices on a full-time, or *dedicated,* basis;
- Rely on an emerging class of competitive long-distance carriers, whose chief strategy in turn was to supply business users with specialized network services;

- Attach independently furnished computers and other specialized instrumentation (including, by the late 1960s, these burgeoning private and competitive voice and data networks themselves) to the nation's existing public telecommunications network (PTN);
- Obtain preferential pricing policies for the specialized telecommunications services and equipment on which they were pinning a growing share of their operations; and
- Prevent any extension of regulatory oversight to computer services that involved use of communications facilities—that is, networks.

This obtuse agenda demanded nothing less than an autonomous sphere of corporate network applications that was essentially free of regulatory oversight and was parasitic on the existing telecommunications network. Business users and their allies wanted to unburden both in-house proprietary systems and a new generation of competitive carriers of the billions of dollars worth of historical costs that were factored into the rates and rules attaching to the existing national telecommunications network—to cut free of the nation's historical commitment to universal telecommunications service. They sought systematic discrimination in favor of their own special-purpose networks and against the general-purpose public system on which ordinary telephone users relied.

I document below some of the consequences of this lengthy embrace of discriminatory policies. Even at the outset, however, it must be noted that this astonishingly successful campaign for domestic liberalization destabilized and reoriented the entire U.S. telecommunications system. As one insider acknowledged, networking technologies have "developed in a kind of golden nest over the past thirty years. . . . Special policies were crafted that not only insulated this entire sector from virtually every kind of public process or control, but also provided it with substantial public benefits, both directly through significant government funding, and indirectly by subjecting other related sectors like telecommunications to regulations designed to foster the development and growth of computer networking."[7]

Regulators embraced the fiction that computer networks—which in fact made *increasing* use of the existing telecommunications infrastructure—could be treated as if they existed independent of that infrastructure. Proliferating network systems were therefore freed by regulators to be configured and reconfigured as needed in support of business users' objec-

tives. The unregulated suppliers of these systems, chiefly computer companies, were effectively licensed to metamorphose from vendors of electromechanical business instrumentation (tabulators, typewriters, cash registers, calculators, and like machinery) into pioneers of next-generation network equipment and services.

Creating a liberalized networking sector required fiendishly complex operational details and consumed an entire generation's regulatory attention. Reduced to its essentials, however, it amounted to a straightforward and deliberate anachronism: regulators would simply draw a line, as if *computing* and *telecommunications* constituted clearly differentiable domains—which of course they no longer did. On the telecommunications side of the line, the existing rules of public service would continue to apply. However, on the computing side, established exit, entry, and price controls would be relaxed and progressively abandoned. So long as network applications were categorized by regulators as *data-processing* services, they could be pursued freely.

At first, this prodigal exception was reserved for business users, computer companies, and their offspring, pioneering network service providers. But the boundary line, of course, was unstable—not only because it was episodically subverted by specialized technical innovations but also because it existed chiefly as an artifact of the regulators' imagination. Through a series of proceedings that began in the mid-1960s, the Federal Communications Commission therefore drew and then redrew the line. As it did so, a greater and greater share of the burgeoning network industry was included on the liberalized computing side of the line. A critical watershed was reached in 1980. In its *Second Computer Inquiry*,[8] the FCC then decided that even regulated telecommunications companies, the core of the nation's telecommunications infrastructure, would be permitted to establish subsidiaries that could bypass existing regulatory strictures. Though at first this comprised a selective exception, it too was soon generalized. What had originated as a specialized networking industry endowed with exceptional market freedom was now set to expand comprehensively into the greater telecommunications system.

As a result of these decisions, the domestic telecommunications industry convulsed. Until the early 1970s, the nationwide telecommunications

network continued to be run by AT&T, which was the sole provider of long-distance service and the overall network manager (in cooperation with its own local service subsidiaries and a couple of thousand smaller providers). However, the FCC authorized a chain of new entrants, including both satellite companies and terrestrial carriers like MCI and Sprint. Momentum increased to open additional segments of the telecommunications market, beyond long distance—equipment supply, data services, satellite and international services, and ultimately local telephone service—to "competition." The AT&T divestiture, the largest corporate shakeup in world history, comprised only the most spectacular by-product of this transition to a neoliberal development policy.

With the benefit of hindsight, what should have been plain at the time is now painfully clear: even if it should entail the sacrifice of the bluest of blue-chip companies, the U.S. policymaking establishment was determined to grant business users maximum freedom to exploit information technology networks as a private matter. In fact, neither of the two unquestioned titans of the information industry in 1980 retains that luminary status today: an ensuing orgy of creative destruction has instead left IBM chastened but still strong and AT&T in questionable condition.

Of course, no one could have predicted these results. Liberalization was embraced first and foremost as a reflex of political intervention by leading banks, insurance companies, retail chains, automobile manufacturers, oil companies, aerospace firms, and other corporations, all of which sought to reorganize their business operations around networks. Around 1970, short-term lobbying to secure piecemeal regulatory changes shaded into long-term strategic planning. At about that point, corporate executives and government bureaucrats recognized that the stakes in this arcane area of policy were huge—that continued U.S. corporate stewardship of the exploding information technology industry might renew waning U.S. global political-economic power. Thus the impact of liberalization quickly began to extend beyond the theater of U.S. domestic telecommunications. This outward-rippling expansion led toward a comprehensive restructuring of the world's information infrastructure, which is examined in detail in chapter 2.

Innovating Network Technology

This ongoing process of liberalization prompted a multifaceted push into network technology development. Today's paramount network innovation—the Internet—emerged here, at the margin of the existing telecommunications order, in the newly authorized, expanding zone of liberalized development.

The Internet's emergence had nothing to do with free-market forces and everything to do with the Cold War military-industrial complex. In fact, "[f]or nearly the first ten years of its existence," writes one insider, "there was a single, cohesive, technical community through which the U.S. Department of Defense controlled every aspect of the Internet's funding and evolution."[9] The Internet's direct ancestor was the Arpanet, which in 1969 inaugurated a radical new system for routing digitized messages between interconnecting computers. Conventional telecommunications systems used a technology, perfectly appropriate for voice communication, called *circuit switching*. To connect calls, circuit switching established a dynamic link between the caller's and the recipient's phone lines; for the duration of their conversation, that link remained in place. The *packet switching* around which the Arpanet was structured, in contrast, imposed a procedure more appropriate for data interchanges. Every message was broken up into dozens of *packets,* assigned a destination address, and sent along one of a series of multiple paths across the network. Once the packets arrived at the recipient's site, they were reassembled in a split second in their original order, and thus the original message was reconstituted and received as sent. Circuit switching reserved network capacity on an exclusive basis for each conversation; packet switching allowed it to be shared effectively among multiple users.

The Arpanet was built to military specifications to allow previously independent computers to share resources. Packet switching was designed to provide *hardened* communications facilities, so that, its proponents apparently believed, even a nuclear attack would not prevent messages from getting through because packets could simply bypass damaged portions of the network.[10] Ahead lay the daunting technical challenge of interconnecting disparate *networks* of computers, which might be operating according to very different standards. By the early to mid-1970s, military sponsorship resulted in the invention of the *protocols,* or instruc-

tion sets, that made feasible such network intercommunication. The Transmission Control Protocol (TCP) and the Internet Protocol (IP) constituted the requisite suite of software instructions that, as the 1970s drew to an end, used satellites, mobile radio circuits, and fixed terrestrial lines to tie together with increasing effectiveness an expanding set of military networks.

Despite this expansion, what we now know as the Internet continued to be housed within the secretive netherworld of the garrison state. One of the Internet's primary features stems from its unique—and, in its original military context, unlikely—ability to further the goal of information sharing by facilitating common use of once-unbreachable individual domains. Its distinctiveness, and its attraction, lay mainly in its unparalleled ability to span between hitherto isolated computer resources.

Commercializable demand for information sharing, as we have begun to see, had been building up to torrential levels in at least three distinct ways: intraorganizationally, chiefly though not only within transnational corporations; interorganizationally, again mainly between and among such companies; and, finally, between corporations and individuals. In each case, however, enhanced forms of information sharing depended on improved means of network interconnection. Only through fluid new links between the disparate networks that were proliferating could new forms of information sharing be extended.

What we know as the Internet engaged this raging demand for information sharing by offering an unprecedentedly tractable technology for network interconnection. Internet technology had been created to work with the full variety of extant and prospective digital networks. Equally important, it did not hostage present-day need to some remote future vision: just deploying TCP/IP brought new forms of information sharing suddenly within reach. The Internet's astonishing versatility—its still rapidly evolving capacity to support novel as well as established forms of intercommunication—only added to its popularity.

The Internet was and is built by utilizing a set of commands, or protocols, that enable computers to set up an electronic space—cyberspace—with its own specific rules and functions. Although it was developed within the U.S. military-industrial complex, this foundational technology lies in the public domain. The rights to use it were made freely available,

at first to a select group of cooperating universities and other military contractors and then more widely. The result, as Robert H. Reid declares, was that "nobody owned the network. Virtually nobody made money from it directly. And almost every piece of software that governed or accessed it was free."[11] The Internet thus resulted "as much from the free availability of software . . . as from anything else."[12] Had a proprietary ethic been applied to it, in contrast, there can be little doubt that the Net would have been stunted during infancy.

During the 1980s, the National Science Foundation began to expand the use of this strategically important system beyond military applications. A new "backbone network" sponsored by the NSF provided high-capacity circuits to carry great loads of data traffic between five university-based supercomputer research consortia, also established via NSF sponsorship. The NSF also permitted existing regional and university computer centers to use Internet technology to physically connect to this backbone. Some 200 networks quickly did so.[13] Traffic rapidly grew, to the point that the military portion of the network was split off, while the NSF continued to develop its new civilian counterpart.

As this civilian NSFNET was further upgraded, its base of users was deliberately enlarged beyond computer scientists in universities, government agencies, and think tanks. Increasingly diverse communities of researchers found reasons to use NSFNET. File transfers—exchanges between one computer host and another—brought them hitherto inaccessible programs and data, and remote access distributed computer processing power to dispersed locations. As early as 1973, however, three-quarters of all traffic on the originating Arpanet comprised email.[14] Email was the NSFNET's paramount offering because it permitted researchers to communicate conveniently and informally with distant colleagues. Throughout the 1980s, efforts to increase the utility of email interchanges and the other services helped spur additional network interconnection, both among U.S.-based interuniversity systems and between networks being constructed around universities in other countries.[15]

The Internet, a term that came into use during the mid-1980s, denoted the decentralized set of networks—some 3,500 by late 1991—that connected to the NSFNET backbone. These individual networks, each run and funded on its own, developed informal organizational means of co-

operating with one another to direct traffic and set policy. Rapid-fire innovation continued within this loose-knit system to enhance underlying network capabilities, to develop means of interconnection for personal computers, and to establish and improve standards for the representation of information on the Internet. In 1989 the *hyperlink* technology that tied together Internet sites and documents was created at a European physics laboratory, and in 1992 a simple *graphic interface* to this electronic web (Mosaic) was developed by programmers at the University of Illinois.

The seeds of a market-driven approach to networking were sown early. The ongoing liberalization of U.S. network development freed the initial corporate sponsors of Internet technology (principally Bolt, Baranek, and Newman, a military contractor and consulting firm) to exploit its commercial applications. Outposts of market activity quickly materialized, particularly after the publicly funded technology of packet switching was spun off in the early 1970s. Private vendors such as Telenet now sought to furnish corporate users in dozens of cities with access to data services, such as remote access to computer facilities. Proprietary online subscription services, such as those provided by CompuServe (established in 1979), Prodigy (1982), and America Online (1985), emerged in this same space. Initially authorized by the Federal Communications Commission in 1973, such *value-added* or *enhanced* data services existed at—indeed, helped to constitute—the deliberately nebulous, and constantly receding, boundary of U.S. regulated telecommunications.[16] The originators of Telenet also voiced a proprietary attitude toward Internet technology, in an early attempt to impose draconian intellectual property standards on the Net.[17]

More portentous still was the hothouse growth, beginning in the early 1980s, of *local-area* data communications systems. The dominant technology for local-area networking was called Ethernet, a combination of hardware and software for linking workstations into office networks that was built around an "open," or nonproprietary, standard and offered publicly available documentation. Public ownership spurred the standard's wide diffusion; by 1998 Ethernet systems produced by about 100 vendors claimed $15.5 billion in annual sales.[18] Corporate America was likewise the major site for local-area network applications. Gulf Oil, for

example, was using email over a local-area network by the mid-1970s; and major vendors, like Xerox and Digital Equipment, were elaborating models for local network services.[19] By 1996 a dense warren of 1.3 million local-area networks, inhabited by perhaps 100 million users, honeycombed businesses and other organizations worldwide.[20] Although Internet technology was not integrated on a significant scale in local-area networks until the mid-1990s, the growth of these specialized intracorporate systems engendered a spiraling need for increased interconnectivity—for comparable computer resource sharing *beyond* immediate local settings. Local network proliferation therefore comprised a critical prerequisite for the eventual takeoff of the Internet as a decentralized network of networks.

The politics of telecommunications network liberalization, meanwhile, put an increasing premium on market-led development. This neoliberal economic policy was already crowding out parallel public-service initiatives. During the early 1980s, for example, the U.S. Postal Service was pressured by would-be private rivals to withdraw its proposal for a nationwide electronic messaging service called ECOM (Electronic Computer-Originated Mail). On the other hand, the rapid enlargement of NSFNET was contingent on the decision to permit commercial as well as university-based networks to interconnect with NSF's backbone network. The NSF's backbone itself was furnished under contract to a partnership between two corporate spearheads of the liberalization trend, IBM and MCI.

By 1992, the interconnection of disparate networks via the NSFNET had grown to the point that 5,000 systems, to which an estimated 4 million users had access, were making use of Internet technology (TCP/IP).[21] The not-for-profit system's growing mass and escalating momentum were now such as to draw a full-scale entrepreneurial intervention. Thus an effort commenced to restructure the Internet on starkly neoliberal lines.

In February 1994, the NSF announced that four Network Access Points (NAPs) would be built so that a new class of Internet operators might interconnect directly with each other to exchange traffic. The purpose of the scheme was to cede provision of the Internet backbone network directly to commercial carriers. Little more than a year later, the NSFNET

backbone was indeed supplanted by the NAP architecture, and the latter in turn became the Internet.[22] Additional NAPs, directly owned and privately controlled by corporate vendors, were likewise established.

Before turning to assess the further developments that propelled Internet technology into more intimate relation with the existing telecommunications infrastructure, we must first survey how networks evolved into a critical business necessity. This subject claims priority for two reasons. First, as already mentioned, today's Internet is simply inconceivable as a historical outcome absent prior development of inhouse corporate networks on a gargantuan scale. Second, this mushrooming information technology sector came to comprise the leading edge of the larger economy, which in turn lent irresistible momentum to the reconstruction of the world's information infrastructure.

The Evolution of Corporate Networking

Corporate reconstruction around networks was not limited to any sector but was economywide. The installed base of computers in the United States rose from 5,000 in 1960 to around 180 million by 1997 (95 percent of which were PCs).[23] Banks took a leading role. Between 1972 and 1985, the 1,000 largest U.S. banks increased the proportion of their operating expenses dedicated to telecommunications from 5 to 13 percent, and finance became the sectoral leader of overall corporate information technology spending. Citicorp's Global Telecommunications Network, the largest private system in the world, by the late 1980s linked offices in ninety-four nations, transmitted 800,000 calls each month, and supported $200 billion in daily foreign-exchange trades. Merrill Lynch, the largest U.S. securities firm, was then spending $400 million on telecommunications each year, well above the average for leading firms across all sectors.[24] By 1997, however, Merrill was spending this amount just in the U.S. domestic market, and the company's annual outlay for information technology overall had leapt from $800 million in 1993 to $1.5 billion.[25] Networked automatic teller machines proliferated; the number of U.S. ATMs increased from 95,000 in 1993 to 165,000 in 1998, while these bank-owned systems began to handle more transactions (11 billion annually, or 1.2 million every hour) than human tellers did.[26] The

enormous cost of system upgrades needed to furnish networked financial services itself helped fuel a massive bank-consolidation drive.[27]

Financial network applications harbored further profound political-economic consequences. They allowed exponential increases in the trading volumes of securities-market, foreign-exchange, and other speculative instruments,[28] so that stateless capital flows acquired the ability to overwhelm the national monetary policy objectives of even the largest economies.[29] As economic historian Richard B. DuBoff stresses,[30] indeed, finance helped pioneer globalized capital circuits.

Economy-Wide Network Investment

Despite the role assumed by finance, however, information technology investments were never confined to this single sector. Overall expenditures on telecommunications by a diversified list of top 100 business users at the end of the 1980s ranged from an annual low of about $20 million to a high of $1 billion, with a yearly mean between $50 and $100 million.[31] Throughout every area of economic activity, leading companies sought to integrate networks into core activities of production, distribution, marketing, and administration. By 1986, in consequence, more than one-third of all U.S. spending on capital facilities for telecommunications occurred *outside* the sphere of common carrier investment, and the resulting private networks—of which there were by now literally thousands—were growing by 30 to 40 percent a year.[32] Rapidly evolving was an operational business infrastructure, mastery of which served to endow particular companies with widely remarked competitive advantages.

Manufacturers from Boeing to General Motors raced to establish network systems, hoping to enhance their strategic capabilities by sharing corporate information resources inhouse among thousands of employees and, increasingly, also with customers and suppliers. To speed products to market, pharmaceutical and electronics manufacturers built supranational research and development facilities at multiple sites, linked by networks.[33] Rather than waiting until oil exploration ships returned to port, the American Petroleum Institute harnessed advanced satellite technology to transport oil-drilling site data collected at sea, thereby shaving a month off the time needed to analyze the data.[34] Extending just-in-time technologies innovated by automobile manufacturers, merchandisers like Target

and Kmart used computerized inventory management systems with point-of-sale scanners and bar-coded merchandise to pare expenses and keep shelves stocked.[35] Wal-Mart proved especially adept at exporting its data systems to support its rapidly growing worldwide operations.[36] 7-Eleven, the third-largest retailer in the world, likewise relied on a succession of specialized computer systems to link thousands of stores and supply depots.[37] Call centers, staffed by 1,000 to 2,000 employees wearing headphones and facing computer screens, bulked up in Britain and the United States as a new way of selling everything from life insurance to household goods.[38] "Building on its Lexis-Nexis database unit," on the other hand, "the Anglo-Dutch publisher Reed Elsevier rushed to place its 1,800 academic and trade journals (the company is the world's largest publisher of scientific periodicals) online."[39]

General Electric, a diversified industrial and financial company, began to convert its entire supply chain from paper to electronic networks, a move its executives boasted would annually save hundreds of millions of dollars.[40] Chrysler, on the eve of merging with Daimler-Benz, introduced a digital manufacturing system that it hoped would cut months off vehicle development time.[41] GM actually diversified substantially into communications by acquiring the satellite company Hughes Electronics. Its global rival, Toyota, envisioned a parallel metamorphosis, and by 1996 telecommunications furnished $820 million in annual revenues from some thirty-six investments made by the Japanese "motor" company (later, it decided to sell off these units).[42] Whirlpool, one of the world's two biggest makers of home appliances, networked its 2,000 product engineers to ensure that appliances manufactured in its thirty-five factories around the world could be built to a limited set of standard technology "platforms."[43]

We must not impute any overarching rationality to these reengineering projects. The waste they created, wrote the *Wall Street Journal,* was "staggering." According to a 1996 study, fully 42 percent of corporate information technology initiatives are abandoned prior to completion.[44] On the other hand, however, the economic impact of corporate reorganization around networks was indisputably large.

Between 1984 and 1993, the percentage of U.S. workers using computers doubled, from one-fourth to nearly one-half. In 1996, 7.4 million people worked in the U.S. information technology industry, while

industries that were major users of information technology employed about half the workforce.[45] Computers, telecommunications equipment, and software accounted for nearly 12 percent of overall U.S. capital stock by the mid-1990s.[46] The share claimed by the information technology sector in U.S. gross domestic product increased disproportionately, from 4.9 percent in 1985 to an estimated 8.2 percent in 1998.[47] Such statistics, of course, take no account of the transnationalization of corporate production and the attendant corporate investment in network gear outside national borders.

Both in absolute terms and as a proportion of total corporate capital investment, network applications occasioned a spectacular increase in capital expenditures that showed no signs of letting up. Two points about this trend stand out. First, in keeping with the transnational structure of corporate capitalism, information technology investments were accelerating worldwide. Second, however, these investments remained disproportionately great in the United States, which in 1995 accounted for some 40 percent of global information technology consumption. "There is no doubt," wrote an analyst, "that U.S. companies are now far more computer intensive than most of their major multinational rivals."[48] (Private telecommunications networks, correspondingly, were also far less visible in Europe and Japan.) Intel's then CEO even chided Asian economic leaders, declaring that the economic crisis there might turn into long-term economic stagnation if they continued to underinvest in information technology.[49]

Steadily increasing from previous decades, dramatically so after the 1974 to 1975 recession, U.S. corporate outlays for information processing and related equipment moved ahead of factory machinery and mobile equipment to become by the mid-1980s the largest single category of U.S. capital equipment spending.[50] Between 1970 and 1996, indeed, the percentage of all U.S. corporate capital investment allocated to information technology climbed steeply, from 7 percent to around 45 percent (and with additional growth expected).[51] Investment in computers and software by 1995 comprised three-quarters of the overall increase in corporate capital investment,[52] while two years later software itself became America's third-largest manufacturing industry.[53] Inclusive of computing and telecommunications, information technology was proclaimed (by the

American Electronics Association) the United States' largest industry.[54] Domestic information technology hardware expenditures alone totaled $282 billion—17 percent more than U.S. purchases of new motor vehicles and parts, 49 percent more than outlays for new homes, and 168 percent more than commercial and industrial construction. There was evidence, claimed *Business Week*, "that high tech may now have a larger multiplier effect in the U.S. than traditional manufacturing industries such as autos."[55] Business analysts began to write of a "new business cycle"—a new alternation of boom and bust, with attendant novel vulnerabilities—based no longer on housing and autos but on information technology.[56] Information technology investment, finally, and network applications in particular, comprised the pivot of a restructuring of big capital—both industrial and financial.

Corporate Mobilization of Internet Technology

Corporate applications of Internet technology—intracorporate and business-to-business—comprise the true fulcrum of Internet system development. Corporate networks are the guiding hand of technical experimentation within cyberspace and comprise the leading site of its creative ferment.

Intranets, which apply Internet technology inhouse, are the latest manifestation of some thirty years of mounting corporate investment in proprietary information systems. An estimated nine-tenths of Fortune 500 companies launched intranet projects in 1997, at a cost of billions of dollars.[57] Indeed, sales of the server software that was needed to "publish" material on the Web indicated that inhouse intranet development "will significantly outpace Internet growth."[58] Growth of intranet applications helped to propel unexpectedly large increases in corporate demand for dedicated, high-capacity (1.54 Mbps) T1 circuits, priced at several thousand dollars a month; in the United States, the number of T1 lines in use was projected to more than double between 1994 and 1998 from 850,000 to nearly 2 million.[59]

Protected by "firewalls" that employ both hardware and network security software, intranets may either permit access to the open Internet or be cordoned off from it. Even when they allow employees to access Internet resources, however, intranets refuse or strictly limit reciprocal access to

corporate computer systems by open Internet users. But intranets were rapidly extended to form *extranets,* which allow corporations to expand their shielded activities by linking up with collaborators. Cutting-edge network applications (voice and video) were also expedited within these inhouse corporate systems, ahead of their appearance on the open Internet.

The Internet decisively increased corporate abilities to widen the sphere of information exchange. From the beginning, military computer networks attempted to neutralize the disadvantages of incompatible computer systems. Arthur L. Norberg and Judy E. O'Neill show persuasively that the Arpanet—which pioneered the packet-switching technology on which the Internet was subsequently to build—began as what its military sponsors called "a fundamental attack on the problem of hardware and software incompatibility."[60] Incompatibility in turn was deemed a problem by military agencies because disparate computer systems prevented far-flung computer researchers, addressing common tasks, from sharing data, programs, techniques, and knowledge about computing.[61] From that day to this, advances in the technology of networking have steadily increased the ability of computer users to work together by sharing hardware and software resources.

During the early stages of network development, the leading computer vendors succeeded in locking in business, as well as military, clients to incompatible hardware and software systems. Local-area networks and distributed data-processing systems, which were established by companies during the 1980s and early 1990s, admittedly constituted a critical advance over their precursors, the mighty but highly specialized standalone systems configured around mainframes. They dramatically deepened the process of workplace computerization by permitting office employees to share resources of various kinds: both hardware tools—such as printers—and software files (programs and data).

Yet these *legacy systems* had only a limited ability to interconnect with each other and with the greater telecommunications network. The practical range of so-called *groupware,* for example—which is used for sharing information across an office or a department—was substantially restricted by the exigencies of operating distinct local-area networks. Man-

agers thus began to perceive that their existing networks both imposed extra costs and resulted in significant practical limitations.

Intranets were promoted as an encompassing alternative to legacy systems and, in fact, comprised a further step in the tradition of extending the sweep of collaborative work processes among dispersed employees. They held out the promise of a considerable increase in the scope of computer-mediated interaction among groups of workers. The goal of networking remained, however, "to connect computing systems, and through the systems the . . . [employees], so that . . . duplication of effort [could be] avoided through the sharing of resources and improved communication" and so that new kinds of collective labor could be applied to business processes.[62] *Collaboration software,* sold by vendors to facilitate anything from real-time coordination of complex projects to group presentations and training, quickly became a booming corporate Internet market.[63] Intranets harmonized and expanded inhouse access to information that was stored on multiple corporate networks, thus permitting corporate information systems managers "to cut across the proprietary polyglot of systems and networks that they must manage."[64]

Via these proprietary systems, corporate databases were made more generally available (on server computers) to employees within a single building, on campus, or, through a further extension, across the world. Groupware applications were given added flexibility to accommodate rapidly shifting organizational imperatives: monthly sales figures, benefits packages, video seminars and training programs, phone books, blueprints, compliance data, and other corporate information resources were posted online; information was available to larger pools of staffers, while managers also gained new abilities to monitor their work.[65]

Intranets did not entail any wholesale leveling of corporate hierarchies. To the contrary, different classes of employees were typically assigned distinct levels of access to shared corporate databases. Companies thus devoted growing energy to managing intranet content and controlling intranet access. Bankers Trust, a $9.6 billion holding company, was hardly unique in warning employees that management monitors all Internet communications (including email, as is widely customary) and that any visit they make to an external Web site using the bank's system may be tracked.[66]

As islands of corporate activity were linked, considerable cost savings sometimes resulted, even while the work that went into existing business functions was strategically reorganized. Motorola, under project deadline pressure, posted high-resolution images of a new product (a cable modem) on an intranet. Step-by-step instructions for assembly, testing, packing, and shipping were thereby made available on the factory floor of its Mansfield, Massachusetts, plant. This intranet application was both faster and measurably cheaper than the company's earlier paper documentation system.[67] (This local willingness to innovate, however, did not forestall Motorola's economic reverses and fall from investor grace in 1997 and 1998.) British Telecom's intranet granted its staff immediate access to information needed to handle customer inquiries more promptly. Around half its employees, some 65,000 people, made use of the system, which was said to have saved the company 740 million pounds in 1997—comprising "the single most successful systems investment the company has ever made."[68] At Microsoft, by spring 1997 almost every employee had found reasons to use the company's intranet, MSWeb—which published more than 690,000 corporate documents for use by some 20,000 workers.[69]

By extending its intranet, Holiday Inn gave customers online access to its reservations network.[70] Benefits were thereby derived by its newly self-serve customers, and the hotel chain decreased paid employee labor. Offloading paid employee labor onto suppliers and customers became a characteristic tendency of extranets that further extended the operational range of corporate information systems.[71]

Many companies already leased point-to-point lines to connect to a limited number of external parties, typically customers or suppliers. Extranets functionally resembled these private wide-area networks, but they were held to be more efficient. Extranets were heralded for eliminating the need to purchase dedicated lines between particular sites, as they depended instead on already shared facilities within carrier networks.[72]

But their potential impact was much greater. Because extranets ran on general Internet protocols, they again extended the reach of sponsoring companies. Both the market posture and the organizational basis of such enterprises depended, as Moschella relates, on this movement toward

"external forms of automation, using computers to reach customers, suppliers, investors, and other key third parties."[73]

With extranets, authorized outside partners thus gained access to internal corporate data via the Internet using their normal Web browsers rather than proprietary software. This in turn meant that a given company could invite as many collaborators as it chose, while the cost of setting up the new link remained relatively small—because each partner was typically already accessing the Net. Security issues remained considerable; standardization of encryption and directory services was far from fully satisfactory.[74] Nor was the U.S. government easily able to reconcile corporate demands for free commercial access to state-of-the-art encryption systems with demands by the FBI and other enforcer agencies that encryption should remain a responsibility vested in themselves. *Virtual private networks,* however, used *tunneling* protocols to transform the open Internet into a more secure channel, access to which was further delimited via deployment of user-authentication software.

Ford's system connected 120,000 workstations at offices and factories worldwide to thousands of proprietary Web sites with information regarding markets, competitors, and part-suppliers' efficiency. As a product-development system, Ford selectively opened its intranet so as to "let[] engineers, designers, and suppliers work from the same data" and updated that data hourly. Ford hoped to link its 15,000 dealers to its intranet and to move toward building cars on demand, thereby saving billions of dollars in inventory costs.[75] Some 90 percent of the transportation conglomerate CSX's customers likewise already dealt with the company over the Internet.[76] Caterpillar, a manufacturer of agricultural machinery, hoped to compress product-development time on design projects by asking outside experts and employees to use collaborative engineering techniques within carefully demarcated areas of its corporate information system. Sharing of real-time computer-aided design and manufacturing applications, videoconferencing, and common consultations with historical data files were among the prospective applications.[77] ITT, a large industrial conglomerate, deployed networks to turn 600 engineers in twenty locations around the world into a design group capable of working on projects almost around the clock.[78]

Intranets and extranets together comprised the leading edge of business-to-business *electronic commerce,* which in turn easily outshone other applications of the Net in the mind's eye of corporate America. Companies linked up on the Internet, among other things, "to streamline their supply chains and automate run-of-the-mill sourcing functions."[79] Costly printing and mailing of industrial catalogs were supplanted by corporate Web sites featuring descriptions, color pictures, and even sounds. Often, business buyers could purchase goods immediately by making only a few keystrokes to send information directly to a vendor's computer, thereby eliminating what one writer calls "whole layers of workers."[80] For more than a decade, business-to-business trading systems had already existed as proprietary (Electronic Data Interchange) networks that allowed buyers and suppliers to exchange purchase orders or invoices electronically. The existing industry, however, "has now turned to the Internet to extend its reach and make it easier and cheaper for small firms to use." The French retailer Carrefour, for example, tested an extranet developed by a U.S. company to permit its Italian buyers to select from among dozens of competitive suppliers of more than 1,000 products (stock control units) for its stores worldwide.[81] Companies such as Ford Motor, Home Depot, and American Express likewise pioneered use of an electronic purchasing system called *open buying* that aimed to standardize the transmission of purchasing data and thereby eliminate a vast array of dedicated machines and special phone lines. Fully one-third of the $6 billion in annual sales garnered by network-equipment producer Cisco Systems, in a widely cited example, came through the Internet. By adding credit checking, production scheduling, product support, and customer-service operations onto the Net, Cisco boasted that it would be able to handle a 50 percent growth in sales without adding a single employee to its 150-member sales staff.[82] Cisco also advertised on the Net to recruit prospective employees from around the world.[83]

Again, electronic commerce was not limited to any one sector. In addition to manufacturers and retailers, finance capital jumped on the cyber-bandwagon. The number of online accounts at brokerage firms and mutual fund companies doubled between 1996 and 1997, with a further surge during early 1998 to 192,000 a day. The share of individual investor trading comprised of online transactions grew to as high as 25

percent during 1998.[84] In addition to Charles Schwab, the well-known brokerage firm that commanded a significant proportion of current online accounts,[85] numerous specialized online trading services sprung up. E*Trade, for example, vaulted into Internet stock trading via high-visibility television advertising.[86] Giant banks also rapidly moved to implement Internet services. Wholly circumventing brick and mortar branches, Citibank moved to introduce Web banking in Britain—to those with annual incomes of at least $49,000.[87] Morgan Stanley, Dean Witter, Discover (a diversified financial services complex) contemplated an all-out attack on traditional commercial banking by establishing a direct banking business over the Internet, using its Discover brand name. Discover had 48 million credit-card holders, as well as an Internet stock-brokerage service.[88] A huge pool of financial information sites spread onto the Web to provide well-heeled Netizens with advice on speculative investments.[89]

On this terrain, Internet vendors of every kind vied to gain competitive advantage. Netscape, for example, by its CEO's admission, garnered the vast proportion of its revenue—as much as 75 to 80 percent—from business users.[90] And information technology spending as a whole was dominated by corporations, which collectively accounted for an estimated 88 percent of the domestic total in 1997.[91]

Taken together, the growth of these corporate systems and applications signified that, as one trade journal announced in summer 1997, "the Internet is becoming the primary platform for the essential business activities of computing, communications, and commerce." Internet business consultancies boomed, while soothsayers declared that, within just a few years, business-to-business electronic commerce was destined to account for hundreds of billions of dollars in sales.[92] In turn, initiatives that aimed to transform more limited legacy systems into integrated enterprisewide networks showed that corporate networks and the open Internet were becoming "inextricably intertwined."[93]

Underway throughout diversified corporations, in fact, was a multisectoral effort to utilize the Internet as the basis of a new, decentralized, global information infrastructure. Only a thoroughgoing modernization of underlying telecommunications systems could sustain such a comprehensive, economywide move into electronic commerce. But this in turn

would require a broader and more drastic political-economic change than we have chronicled so far. The liberalized zone of market-driven network development, which had already begun to encroach on the world's telecommunications systems, would have to become primary.

The Internet and the Telecommunications Infrastructure

By the late 1990s, telecommunications companies had spent some forty years retrofitting themselves to carry computer data. A host of specialized equipment and services—first in switching and network management and then beyond—testified to the carriers' integral reliance on computers. As regulatory liberalization gave them incentive to do so, carriers had long since also begun to move beyond the sole activity of transporting voice calls. Multifunctionality across the network became an operational reality: faxes and computer data comprised a large and growing share of carrier traffic volume. Indeed the Internet itself was largely laid over the telecommunications network, and, as the Net expanded, it placed increasing demands on this established infrastructure.

The Internet, however, concurrently disrupted these processes of gradual transition. Established telecommunications carriers, which were often the largest organizations in their home countries, received a series of nasty jolts.

Telecommunications Systems at Risk

It became plain that the Internet would comprise a progressively more important channel for the full range of established telecommunications services, including conventional voice service, the carriers' traditional bread-and-butter market. The titans of telecommunications, which had spent two decades crafting their own strategic plans for data carriage, unexpectedly had to jump atop the Internet bandwagon. With its decentralized structure, its unfamiliar data-traffic patterns, and, above all, its independent economic basis, the Internet posed grave problems of assimilation.

Some experts believed that the Internet's unrestrained growth would eventually lead to a system crash of biblical proportion. Network dependence among major corporations had grown acute, and—when a single

line of incorrect software code could accidentally trigger a ramifying failure of electronic switching systems—portents of catastrophe were easy enough to find. When AT&T's specialized, high-speed business-data network went down for a day in April 1998, for example, credit cards became useless and electronic inventory systems failed at half of Wal-Mart's 2,400 U.S. stores, Southwest Airlines lost control of cargo tracking, and 1,200 Wells, Fargo ATMs shut down.[94] The very next month, a paralyzed communications satellite knocked out much of the nation's pager network. Technicians redirected some 25,000 U.S. satellite dishes so that they could again pick up signals transmitted via a replacement satellite.[95] Signaling recognition of its mounting vulnerability to such network failures, General Motors disclosed that it expected to spend a staggering $360 million to fix its year 2000 problems—so named, because existing software has been written in a way that might cause it to misread *2000* as *1900,* triggering prospectively crippling malfunctions in factories, engineering labs, and offices across the world. Citicorp reported that its costs for year 2000 corrections might total $600 million,[96] and U.S. firms expected to spend the almost incomprehensible sum of $50 billion fixing year 2000 glitches.[97] A top-level presidential commission pondered how to counteract potential deliberate attacks mounted against "critical infrastructures" linked by networks in energy, banking, transportation, human services, and telecommunications.[98]

The undoubted fact of such vulnerabilities notwithstanding, the Internet's surging growth suggested a deeper, if perhaps a less easily grasped, societal danger: the terms on which Internet development has been predicated directly threatened the operating principles, and the vast sunk costs, incarnated in the carriers' existing networks.

According to a report cited by then-FCC chairman Reed Hundt, by September 1997 the construction of new network capacity aimed at Internet traffic was outstripping that for voice channels by a ratio of three to one. MCI and Sprint each already carried more data than voice traffic.[99] Just three years before, 85 percent of traffic carried by undersea cables had been voice, and 15 percent was data; by late 1997, it was a fifty-fifty split.[100] Studies submitted to the FCC by local U.S. telephone companies suggested that some 5 to 10 percent of the minutes on the public, switched telephone network represented Internet traffic and that

that proportion was destined to increase rapidly and overtake residential voice traffic within just a few years. As Internet traffic surged, indeed, some said that data transmission was likely to account for no less than 95 percent of the traffic on public networks by 2005.[101] In Europe, likewise, it was projected that corporate network data traffic would be five times greater than corporate voice traffic by 2003.[102]

The Internet's legion of applications placed the existing telecommunications industry at immediate risk.[103] Internet fax-service comprised the first significant usurpation. WorldCom's UUNet, for example, deployed its global Internet backbone network to support a high-security fax service, with prices at 35 to 55 percent below those charged by the traditional voice carriers.[104] GTE and MCI soon matched the offering.[105]

Internet telephony portended a far more substantial danger. Though only recently quite poor, the quality of *voice over IP* services was rapidly improved on the open Internet. By 1997, it had become nearly indistinguishable from that of conventional telephony in some specialized contexts. Business users, who accounted for a disproportionate share of overall telecommunications demand, were the first to turn to IP telephony, adding it to their existing internal data networks primarily to realize cost savings.[106] Startup companies selling Internet telephony packages aimed at this emerging corporate market linked up with major vendors such as IBM.[107] One writer mused that Microsoft or Netscape might even choose to add Internet telephony capabilities to future versions of their office software packages. In any case, by 1998, AT&T, British Telecom, and Deutsche Telekom were experimenting with voice over IP.[108]

Catering to corporate demand, and extending it selectively into the consumer market, was a flock of telecommunications companies sporting unfamiliar names. Qwest Communications International (which joined the ranks of major carriers when it acquired LCI International in 1998 for $4.4 billion), ICG, IDT, and Level 3 were among the vendors that sought to broker IP telephone services at cut rates to individual consumers.[109] At a cost of billions of dollars, some of these retail suppliers (most notably Qwest) built freestanding networks using Internet technology; thus they were also able to act as wholesalers. Lacking immediate access to Internet "backbone" networks, in turn, some major telecommunica-

tions carriers attempted to act as subcontractors for these specialized vendors.[110]

The goliaths were only beginning to collect appreciable sums from the Net. AT&T showed Internet and other online revenue of $79 million in the first quarter of 1998, when GTE posted Internet sales of $172 million; while MCI and WorldCom (which, as a condition of their 1998 merger, had to sell off MCI's Internet operation) together claimed Internet revenues of $475 million.[111] But Internet traffic was growing furiously, and Internet telephony alone seemed certain to steal an increasing share of PTN traffic.[112] "If you don't control network assets from voice to Internet in the future, you don't have a prayer of being a significant global player," became the new industry wisdom.[113] Big carriers, led by long-distance vendors, in turn began to move at full throttle during 1997 and 1998 to integrate forward into Internet services.[114] Overseas, selected public telecommunications operators—Deutsche Telekom was at the forefront—likewise moved to integrate Internet technology.[115]

As the flexible and capacious Internet was adapted for messages traditionally carried over conventional telecommunications networks, dramatic and contentious shifts began to occur in the political economy of telecommunications provision. "Packet-switched networks," thundered erstwhile FCC Chairman Reed Hundt, "will soon carry most of the country's bits, and that will change the economics, the structure, and just about everything else about the telecommunications industry."[116] It remained unclear, however, whether the Internet would swallow the existing telephone system—or vice versa. On the one hand, significant augmentation of the Internet's underlying technical architecture—packet switching—would be needed before all the service offerings afforded by circuit-switched networks could be integrated. On the other hand, leading telecommunications companies already were assimilating key elements of Internet technology into their existing networks.[117] Both competitive rivalry and consolidation through diversification therefore became typical. This dynamic and complicated process meant that the Internet's potential collision with the existing telecommunications industry was often exaggerated.

The goal was clear: higher-speed (*broadband*) data-traffic systems would accommodate existing voice services with video as well as data

and would be offered first within and between big corporate computer networks and subsequently within the greater public telecommunication system. Let us begin our assessment of this metamorphosis by looking more carefully at how and why established telecommunications providers (Public Telecommunication Operators) began to supply Internet systems and services.

If You Can't Beat Them, Join Them

Across virtually all market segments, the logic of network system development was similar. Smaller companies that specialized in what were initially niche markets at the frontier of the liberalization process worked the new territory. When they succeeded, major traditional suppliers either snapped them up or rushed to develop comparable applications on their own. Actions by major telecommunications equipment manufacturers—Lucent had $26.4 billion in 1997 revenues, and Northern Telecom had around $15 billion—were illustrative of this general course.

Routers are the specialized machines that direct and manage network traffic, while *switches* encode signals and establish connections between network locations. Scrambling to find points of entry in the white-hot Internet market during 1997, four of the world's top five telecommunications equipment manufacturers bankrolled Juniper Networks. Juniper's ambition was to develop a qualitatively faster router switch—in competition with Cisco Systems (which had 60 percent of the router market and $6.4 billion in 1997 sales), as well as smaller vendors such as Bay Networks, Cabletron, and 3Com—to sell to the network operators that provide Internet "backbone" circuits.[118] For this same purpose, Lucent also acquired data-equipment supplier Yurie Systems for $1 billion (after having purchased Ethernet switch maker Prominet to pursue the market for inhouse corporate networks).[119] Northern Telecom placed an even bigger bet through its $7.27 billion takeover of Bay Networks. Yet another top traditional equipment manufacturer, France's Alcatel Alsthom (which became prominent following its acquisition of IT&T's extensive international facilities), sought to enlarge its presence in the U.S. market by purchasing DSC Communications for $4.4 billion.[120]

A second expression of the telecommunications industry's rapidly escalating involvement with the Internet was its concerted move into *systems*

integration. Systems integrators are companies that contract to set up and manage business computer networks on an outsource basis. They patch together diverse network technologies and service offerings. Seeking maximum cost efficiency, they simultaneously contract to lease services from outside vendors, while also relying both on their own facilities and on network components owned by customers and installed on their premises. Systems integrators have thrived during the past decade of global merger fever; the U.S. market for these network management services was estimated at $27 billion in 1997, with further spirited growth projected. The increasing significance of system integrators offers evidence of an underlying shift in market orientation that I have already sketched. Carriers are unmistakably focused less on providing basic services to residential users and more on assembling and managing the specialized network capabilities demanded by sophisticated corporate users—including, preeminently, intranets.

As systems integrators were called "to resolve the increasing chaos caused by internet-working enterprises,"[121] the traditional carriers came into increasingly direct competition with a spate of outside rivals. Catering to the systems-integration market were specialized companies like EDS, consulting and accounting firms like Arthur Andersen, and computer vendors like IBM.[122] So carriers themselves decided that they had to give the systems-integration market top-level strategic attention. MCI entered the field by acquiring Canada's SHL Systemhouse at a cost of $1 billion in late 1995.[123] British Telecom inaugurated its Syntegra unit for the same purpose. Sprint paid $425 million in 1997 to acquire another specialized systems integrator, called Paranet.[124] AT&T in 1995 set up an internal network consulting and computer-outsourcing subsidiary to target this new market; this subsidiary, AT&T Solutions, had $218 million in revenues in the year ended 15 April 1998.[125] To boost its credibility with clients, AT&T Solutions said it would maintain its own parent company's voice, data, and image networking, network computing, and data processing—a system that included 120,000 desktop computers, as well as a massive mainframe operation.[126] Lucent, diversifying from equipment supply into systems integration, not only created a network-management service for corporate customers that owned so-

phisticated voice and data networks but went on to open a huge network-management center for phone-company clients as well.[127]

Yet another important channel of consolidation lay in direct forward integration by telecommunications suppliers into Internet service provision. Leading carriers' enormous annual investments in their networks (AT&T's capital spending comes to over $8 billion a year)[128] were reoriented to accommodate this strategic imperative. Beginning with marketing alliances with existing service providers,[129] carriers went on to supply Internet services themselves in two chief ways: as retailers and as wholesalers. Each is considered briefly below.

Internet service providers (ISPs) manage the retail link with Internet customers, providing connection to the system for a subscription fee and offering various other services. This market was worth around $6.5 billion in the United States by early 1998 and around $2.3 billion in Europe.[130] ISPs range in scope and orientation from huge local telephone companies like Bell Atlantic (and like the commercial online service AOL, which functioned more precisely as an intranet), to local, not-for-profit organizations; the average number of subscribers per ISP, though increasing, was still scarcely 3,000 in mid-1997.[131] Within this wider field lay a variety of carrier ventures, such as AT&T's online service startup. AT&T's WorldNet offered Internet access with an aggressive pricing strategy (since modified) that garnered 1.1 million customers by early 1998.[132] Through a deal with Internet search-service Lycos, AT&T also hoped to lure Internet users looking for telephone numbers to click through to its automatic dialing service.[133] EarthLink-Sprint combined Sprint's 130,000 Internet service subscribers with EarthLink's 445,000.[134]

Local telephone carriers' forward moves into retail Internet services, on the other hand, were initially sporadic and defensive. From spring 1996 to August 1997, the number of ISPs existing in the United States more than doubled to some 4,000.[135] This increase expressed something more than a simple effort to catch the coat tails of a high-growth market. Companies that chose to enter the ISP market (and their subscribers) were privileged—in the United States—to do so without having to pay anything like the full cost of doing business.[136] This vital point requires further explication.

Under federal regulation, U.S. ISPs had been classed as providers of an *enhanced* service. This designation conferred on ISPs a characteristically privileged status within the liberalized zone of network development. It exempted them from the interconnection, or *access,* charges levied on other systems that tie in with local telephone networks; it also meant that ISPs did not have to pay into the government's *universal service fund,* which provided subsidies to support telephone access in low-income and rural areas. As a result of this sustained federal policy, ISPs enjoyed a substantial cross-subsidy, which was borne by ordinary voice users of the local telecommunications network. Local telecommunications companies were in the forefront of those seeking to protest this arrangement because these local exchange carriers had to supply the vast majority of the circuits used to link personal computers with the Internet on what they believed were inequitable financial terms.

The effects of this ISP subsidy policy were not limited to the pocketbooks of the local carriers. As Nathan Newman has detailed, through this subsidy the Internet effectively cannibalized "past and present investments in the local phone infrastructure":

> Local phone users, mostly lower-income users without a computer in the home, are seeing investments diverted to industry and higher-income Internet users that could have been targeted for upgrading the overall network or delivering new technology for schools, hospitals, or other public places serving the whole public. Instead, the specific private subsidies for the Internet industry have helped fracture planning for the overall local phone system and blocked the general upgrading of data traffic.[137]

The inequity of these arrangements extended even beyond the fact that publicly supported local telephone networks subsidized yuppie Netizens. Internet users displayed markedly different behavior than voice telephone users. Whereas ordinary voice telephone calls averaged just a few minutes in duration, Internet hook-ups tended to last at least three times as long, and heavy users left their computer connections to the Net on all day (or all night). Data carriage thus placed a strain on a telephone system engineered for voice calls, as local networks were filled to bursting with incompletely compensated Internet data traffic.

Exhibiting the same favoritism to new competitors that has typified the liberalization process over the course of its forty-year development,

recent legislation—specifically, Section 251(c) of the Telecommunications Act of 1996—imposed yet a further onerous requirement. It mandated that local telephone companies that chose to modernize their networks in hopes of supplying customers with broadband Internet access had to make these new facilities available to would-be rivals at cut-rate wholesale prices.[138] Not surprisingly, under the circumstances, the local carriers were not exactly quick to enter Internet and other broadband service provision. Outside North America, in contrast, where local carrier charges continued to factor as a major item in Internet service pricing (an average of around two-thirds of total charges in OECD countries), existing carriers rapidly claimed a central role in furnishing such access. Deutsche Telekom's online service—Europe's largest—already claimed around 1.4 million subscribers in mid-1997, for example.[139]

The strain caused by these domestic U.S. policies increased further as ISPs began using the Internet to transmit voice calls.[140] Local exchange carriers' own primary service markets now stood to take a direct hit from arbitrarily privileged rivals. In April 1998, the FCC signaled what the *Wall Street Journal*—an organ of neoliberal policies—labeled "a terribly significant and unfortunate shift" by suggesting that it might begin to impose universal service fees on those ISPs that provided Internet telephony services.[141] The FCC's trial balloon changed little; its hands-off policy persisted. Local exchange carriers such as Bell Atlantic, however, accelerated their plans to offer more widespread access to high-speed data transmission services,[142] a point we return to in chapter 3.

This brings us to the other major means by which carriers sought to diversify into Internet services. The relationship between layered Internet services and underlying network backbones is indirect, as established transmission facilities—dedicated circuits and switches—are souped up with specialized routers and other instrumentation. Following the NSF spinoff of the backbone network in 1995, a growing number of companies entered the market to provide wholesale Internet distribution services. They did so by interconnecting with each other at the Internet's officially designated network access points (NAPs) (and increasingly as well at privately arranged NAP sites). In the United States, thirty network service providers (NSPs) carried the traffic of the thousands of smaller ISPs.

There existed, however, a sharp differential between the leading wholesalers and the rest; a bare handful of companies dominated this market. *All* of the five leading backbone suppliers, which together handled perhaps 80 percent of U.S. Internet traffic (the rest being accounted for by twenty-five smaller companies) were, in fact, by mid-1997 owned by major telecommunications carriers. Some, such as internetMCI or Sprint IP Services, were developed inhouse concurrent with the growth of the Internet. Others became acquisitions: GTE Internetworking was the fruit of GTE's takeover of BBN, while WorldCom's UUNet—itself already a leading backbone in its own right—acquired what had previously been the fifth major wholesaler, ANS (which had operated as a captive unit of America Online). During its negotiations to purchase MCI, WorldCom sold the former's Internet operation to an overseas carrier, Cable and Wireless, even as the merged MCI-WorldCom remained a major provider of wholesale network service, not only in the United States but also in Europe.[143] A laggard in this area though still the leading U.S. carrier, AT&T confirmed its importance in 1997 by announcing that it would begin offering its 10 million corporate customers access to a high-speed Internet backbone, at some 580 points around the United States. AT&T experienced pressure to introduce its own backbone, when BBN—with which it had previously contracted to host a majority of its 2,000 corporate Internet customers—was acquired by GTE.[144]

Thus the Internet positively seethed with strategic potential. By mid-1998, the established telecommunications industry was certain to enter a widening range of additional Internet markets, including billing, domain name registration, directory, and other services.[145] Telecommunications carriers looked to their ISP relationships with millions of customers, as well as to their growing control over underlying facilities—physical lines and switches, and the specialized routers and software that logically define the Internet, as well as private network access points—as sources of leverage over future system development.

Not long ago, interconnecting backbone networks used to exchange messages at NAPs via unbilled *peering* arrangements, whereby the different vendors simply agreed to allow each others' traffic to transit their own networks. Peering arrangements of this kind contributed greatly to

the Net's vaunted open culture. Today, in contrast, some major backbone operators will interconnect only with other operators who, like themselves, also interconnect at all of the system's major network access points. That is, they are beginning to choose—and to refuse—to peer, in light of their own strategic and economic considerations. And might not network service providers likewise begin to insist on levying new fees on interconnecting Internet service providers as their wholesale market power concentrates down into just a handful of carriers? One authority on the economics of the Internet notes that these major backbone providers "are in a position to declare themselves the Internet, and it could mean the costs of access are going to go up sharply."[146] If the backbone suppliers successfully impose new costs on Internet service providers, in turn, the latters' ranks are likely to thin rapidly—in one projection, to fewer than 100 within five years. Similar moves by telecommunications carriers were also evident in Europe, where pricing pressures and costly technology upgrades put the squeeze on "Internet small fry."[147]

I do not seek to imply, however, that the established leaders of the telecommunications industry will simply extend to the Internet their traditional domination over voice services. On one hand, shakeups, conflicts, and new strategic openings render any such outcome uncertain. Little-known WorldCom's 1996 takeover of MFS Communications, which in turn had just acquired another leading Internet wholesaler and service provider, UUNet Technologies, transformed WorldCom into one of the biggest supranational suppliers of advanced data services, with hundreds of local access points worldwide at which businesses might connect directly to its network. WorldCom's subsequent takeover of MCI vaulted this recently obscure company to the very topmost rank.[148] The third-largest U.S. long-distance carrier, meanwhile—Sprint—announced a much-ballyhooed remodel of its national network. A $2 billion system that deployed Internet technology to integrate voice, video, and data traffic now became the company's strategic centerpiece.[149]

There were wild cards, as well. Qwest staged a multibillion-dollar foray into data services.[150] Its equally well-capitalized rivals included a nationwide pipeline operator, Williams Companies, and other unfamiliar new entrants—Level 3, IXC Communications—as the attempt to profit from

new-built national and global IP networks diffused.[151] Then there was SITA, which spun off its international managed data network—the world's largest, supplying services to 420 airlines in 220 countries—offering managed data services to multinational companies outside the airline and aerospace industries.[152] These *green-field* providers, working out of the liberalized sector of network development, possessed advantages that continued to be denied to incumbents. Above all, they could realize the lowered costs of market entry afforded by new technologies, while eschewing from the start the legacy of universal-service provision with which established operators were burdened.[153]

Yet it cannot be emphasized sufficiently that this ongoing shakeup of the supply end of the telecommunications industry comprised a strategic response to a profound shift in demand. Corporate users of Internet systems and services never lost their primacy within the wider metamorphosis. It was essentially on their behalf that the carriers were impelled to increase their efforts to mesh unlike technologies and to roll out new IP networks, so as to offer comprehensive service packages with high-end features for preferred customers. By 1998, for example, MCI had gone further than most rivals in integrating its packet-switched data network and its circuit-switched voice network.[154] Its intention was to develop "pricing structures, technical solutions, and business arrangements to provide more robust and reliable service for applications that require it, and for users willing to pay higher fees."[155] Corporate demand to lock in predictable levels of service, with priority access to network bandwidth, meanwhile, increased for good reason.[156] In part, business users were looking for improved guarantees that underlying networks wouldn't seize up and crash and thereby prevent "mission critical" corporate data from continuing to slide serenely across the globe.

The open Internet remained largely a U.S. system. Some 60 percent of the Internet's host computers in early 1997 were located in the United States;[157] the Net relied on English as its lingua franca; and its very architecture still forced *intra*-Asian traffic to transit to network exchange points located in the United States before being routed back to Asian destinations.[158] Its system of bestowing the top-level domain names needed to give users workable Internet addresses was likewise still

dominated by the United States. Despite these decided skews, however, the Net's supranational orientation was deepening with each passing month. We are now in a position to see that its increasingly transnational orientation placed the Internet suddenly at the forefront of the more encompassing neoliberal policy trend that swept through global telecommunications.