Chapter 5

THE INTERNET

AS *COMMERCE* SYSTEM AND *MARKET* SPACE

Of all the applications emerging on the Internet infrastructure, Internet commerce will have the most profound impact...

Peter Drucker (1999)

From Communications to Commerce

When Dell began selling PCs over the Internet, and reorganizing its procurement and assembly activity through Web-based interactions with its suppliers and logistics partners, the PC maker was able to craft these innovations on the basis of an historical transformation similar to the breakthrough that had enabled Swift to recast the system of production and marketing in the beef industry a century earlier. Like Swift, Dell has seized upon a revolution in communications as a platform for reorganizing its competitive activity. Just as Swift deployed the railroad and telegraph at the center of its long-distance production and distribution network, Dell has succeeded in transforming its strategy and routines, along with its organizational structure and territorial reach for profit-making as a result of the revolution represented by the Internet. In both cases, new communications technology resulted in the development of *commerce systems* for producing, buying, and selling in fundamentally new ways.[1] This chapter examines how this transformation of the Internet from communications systems to commerce system occurred, and how this process of commercialization created the foundations for firms such as Dell to compete differently.

[1]One major difference, however, separates these two commerce systems. By the late 1870s, when Swift was just beginning to create his beef network, rails and telegraphy had already supplanted water and wagon conveyance as the dominant commerce system. By contrast, the Internet, as a commerce system and platform for Dell, is currently still in a stage of relative infancy. Nevertheless, Internet commerce, although a small percentage of overall business activity, is already transforming how firms produce, buy, and sell.

The Contours of Commercialization

At the time that Dell began experimenting with the Internet in 1996, the so-called network of networks had just passed through an initial period of "take-off" as an infrastructure for commerce supplementing its original role as a communications system (Reid, 1997). This progression from an essentially non-commercial, defense-oriented communications system, to a commerce-oriented infrastructure is one of the most compelling features of Internet development (Kenney and Curry, 2001: 45). Nevertheless, this pattern of commercialization is not unique to the Internet.

The history of the Internet shares certain features of creation and commercialization broadly similar to the pattern of earlier infrastructure systems.[2] This pattern is represented in its initial creation phase by a technical breakthrough associated with the phenomenon of "invention." Railroads, telegraphy, telephony, and the Internet all utilized breakthrough inventions for moving people, materials, and messages. Commercialization of breakthrough technologies, however, while involving numerous individuals and investor groups, occurs primarily through the efforts of two distinct types of firms. Firstly, commercialization begins when such technologies become sources of profit for firms involved in construction and build-out of infrastructure systems. Secondly, commercialization advances when these technologies become sources of profit for firms that put newly built infrastructure to uses in ways often unanticipated at the outset of infrastructure creation and construction. With the exception of the telegraph, in which profit-making activity for telegraph firms and profit-making activity for business users of telegraph systems followed only five years after initial demonstration of the new technology, a period of gestation separates initial technological breakthrough from the commercial period. With the Internet, this period of gestation actually lasted almost twenty-five years from initial demonstration in 1969 of packet-switching technology at the core of Internet communication, to a commercially oriented system by the early 1990s marked by profit-making in the build-out of the infrastructure, and profit

[2] In addition to Schumpeter's notion of invention and innovation (see Chapter 2), this paragraph takes advantage of the model of Hughes (1983: 7-17) revealing how infrastructure systems emerge from invention and grow through a process of technology transfer and "momentum" against "reverse salients."

opportunities in Internet use.

Thus, while the Internet has its own unique history in evolving from a communications system to a commerce system, it shares features of creation and commercialization with other infrastructure systems. Broadly conceived, the process of creation and commercialization has three primary elements: 1) invention of the core infrastructure technology; 2) transformation of the technology into a built system providing profit to infrastructure builders; and 3) exploitation of the built system as a source of profit to a broader group of business users largely unconnected to the creation and construction of the infrastructure. These three elements, in turn, incorporate several key themes: infrastructure expansion and interoperability; the creation of infrastructure standards; and the establishment of a legal and political rulemaking environment for infrastructure deployment and use. Although all three elements and the accompanying themes are critical in the commercialization of communications systems, it is infrastructure users such as Swift and Dell that are the key actors in this process.

Users as Innovators

These business users, though not directly involved in creation and construction of infrastructure, play a decisive role in providing momentum for the build-out of infrastructure systems, and transforming invention into the broader process of innovation and economic change. Users in effect, act as agents for diffusion of communications revolutions. As the economic viability of invention becomes clear, and as early investors along with technical experts promote initial expansion in the new infrastructure, certain business users experiment in an effort to incorporate the new infrastructure into their business models and change the way they operate. It is this process of experimentation and learning by business users of the new infrastructure that results in commercial uses not anticipated by infrastructure builders at the outset. The rail and telegraph system was no more envisioned as the agent for the long-distance movement of commodities when it first emerged in the early part of the nineteenth century, than was the Internet envisioned as a platform for buying and selling goods and services at the outset of the ARPANET in the

1960s. In this way, the experiments of users create momentum for greater system expansion and further experimentation by other users. In the process, these actors help shape trajectories of innovation and technological change.

Such business use of transport and communications infrastructure originates at what has been termed the "consumption junction" of new infrastructure technology systems (Fischer, 1992: 17). At this historical intersection, business users of transport and communications systems come in contact with the initial variants of new transport and communications technology. As these actors begin to experiment and deploy the newly created infrastructure for profit-making ventures in ways unforeseen by the inventors and early builders of the new infrastructure systems, these users become the *functional* source of innovation during communications revolutions (Von Hippel, 1988). Alongside the initial creators of the actual technology, users provide the agency through which invention spreads and assumes the transforming attributes of innovation (Lundvall, 1988). In this role as carriers of the innovation process, business users actually help shape the development of new infrastructure, defining the goals and aims of newly-deployed communications systems, while influencing the trajectory of subsequent infrastructure deployment (Cohen et al., 2000). These business users, in effect, provide momentum for build-out of new communications systems as commercial enterprises. In concert with the inventors and developers of new infrastructure, business users of communications systems enable the impacts of communications revolutions to spread and act as catalysts for innovation in the economy.

Expandability and Interoperability

In ascending to its commercial status in the early 1990s, the Internet had to pass through two critical historical developments. In the first place, the infrastructure had to expand. Secondly, the disparate pieces of the infrastructure had to interconnect and become interoperable. Expansion and interoperability, in turn, were interrelated.

Similar to the development of the rail and telegraph, geographical expansion was integral in the evolution of the Internet from communications system to commerce system. Such expansion, however, required that the various elements of the Internet system become interconnected and interoperable.[3] Like the railroad and telegraph, the Internet after its initial creation, developed as disparate communications networks which had to fit together and function as a system. And just as the disparate and often incompatible track gauges of the separate railroads, and the different chemical and electrical technologies of various telegraph firms were made to interconnect in creating a unified transport and communications system, so too has the Internet assumed its role as a commercial infrastructure in stages marked by the efforts of Internet builders and users to enhance the interoperability of the new infrastructure.

This process of expansion and interoperability, in turn, is further dependent upon two additional elements, *standards* for infrastructure compatibility, and *rules* for infrastructure deployment and use. Standards enable different elements of an infrastructure to function as a system while providing specifications around which new pieces can be added so the system can expand. Legal and political rules create the environment needed by businesses to participate in commercial ventures either in building or using the new infrastructure. Standards and rules, in effect provide momentum for new communications infrastructures to become more built-out and interoperable.[4]

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[3] Bar et al. (1995) point out that the notions of interconnection and interoperability, though commonly used interchangeably, actually differ. Interconnection is a prerequisite for interoperability and is binary – you are either connected or not – while interoperability can increase gradually. The idea of interconnection derives from older communications technologies such as the telegraph and telephone where the connection mechanism was a wire. Interoperability, however, presupposes a more complex level of compatibility needed for different systems to work across complex interfaces. The more complete the compatibility, the greater the level of interoperability (Bar et al., 1995).

[4] On the process of standard setting see David and Greenstein, 1990, and David, 1987. David makes a distinction between "standards agreements" that are negotiated and implemented by political authority, and "unsponsored standards" that arise de facto among firms themselves in competitive environments. While many of these unsponsored standards emerge as optimal solutions to specific technological problems, it is sometimes the case that sub-optimal standards, resulting from the specifications of a technology successfully deployed by a first mover, persist into the future despite the existence of a superior alternative developed subsequently. The most classic case is the QWERTY typewriter keyboard which emerged initially to slow down the very fast speeds of skilled typists so as to avoid key jams (David, 1985). Despite the existence of a much faster keyboard, the standard of QWERTY prevailed. Once such newly-deployed technologies become established, the standards embedded in these technologies create what is called the "lock-in" effect. Lock-in occurs because as standards diffuse, a shift to an alternative, even if it is superior, is costly. Such feedbacks promote path dependence as greater numbers of users, faced with the same choice of high switching costs, accommodate their activity to the existing standard (David, 1985; Shapiro and Varian, 1998; 1999).

Several metrics are commonly used to provide indications of Internet expansion and interoperability. These indicators include the number of Internet users, host computers, Internet domain name registrations, and even the amount of venture capital expended on start-up firms. Modest growth in these measures began during the mid to late 1980s.[5] The period of commercial take-off in the early to mid 1990s, however, reveals several dramatic departures from previous trends especially with respect to the number of users, the percentage of .com web sites, and venture capital outlays. It was during this time as expansion proceeded apace, that the Internet finally succumbed to what has been termed, Metcalfe's law. The basic idea of this principle is one of scale whereby the value and functionality of a network will increase exponentially with each additional user. Consequently, at a certain threshold of nodes, a network's value will exceed its costs so that the larger a network becomes in terms of the number of nodes and users, the more potential value it has to those users. Just as this principle drove expansion of earlier infrastructure systems such as the telegraph and telephone, so too is it also driving the expansion of the Internet (Moschella, 1997:106-107).

The Contingencies of Internet Commercialization

Despite historical precedent and similarities between the commercial development of the Internet and infrastructure systems of the past, the passage of the Internet from communications system to commerce system was not preordained. Contingent events, occurring as the Internet evolved, were critical in pushing the Internet away from its military roots, and creating the basis for an interoperable and commercially-viable communications infrastructure. Four crucial developments proved decisive in this transformation.

First was the decision by the defense establishment to split what was then the communications network of the Advanced Research Project Agency (ARPA) into two pieces. One piece was a military

[5] Internet statistics are notoriously inconsistent and must be approached with caution. Different sources report widely different numbers. They are useful only in time series as trend indicators rather than absolute measures.

network aimed at continuing the mission of ARPA to create a communications system capable of functioning in a nuclear war. The second piece resulting from this split, however, was a nonmilitary communications network envisioned to serve a community of university and academic researchers. Placed under the administrative responsibility of the National Science Foundation (NSF), this research-oriented communications network soon spawned numerous other civilian networks that together became the basis for the "network of networks" at the core of the Internet.

Secondly, was the transformation beginning in the mid-1980s of personal computers into devices that could interconnect and communicate, and the networking of these devices into local area networks (LANs). Although this development removed some of the individual autonomy of personal computers, it created the foundations for a networking infrastructure based not on mainframe or even minicomputers, but on devices with potential for widespread use. After the mid-1980s, as PCs and PC oriented workstations became interconnected mostly within firms, and as these local area networks proliferated, an expanding population of nonmilitary networks based on microcomputers created a new foundation for the Internet project. The networking of PCs and workstations was therefore a critical step in enabling the Internet to become widely accessible, as a mass-based communications infrastructure.

The third set of contingent events was the creation of two critical technological breakthroughs in the area of networking software -- the World Wide Web and the Internet browser -- that could be used in conjunction with personal computers. The most immediate impact of these two breakthroughs was to make the Internet far more accessible as a communications medium to both society and the business public. These tools, however, had an even greater impact in shaping a particular trajectory of growth and technological development. The creation of the Web and the Internet browser established a foundation -- a technological paradigm -- for an entirely new "ecology" of firms to emerge and develop myriad other Internet applications and products, from software, search engines and portals, to routers and broadband equipment, that facilitated ease of Internet use (Hunt and Aldrich, 1999; Kenney; 2001). Fueled by venture capital, this swarming phenomenon of new technologies, created primarily by start-ups along with incumbents such as America Online, promoted a dramatic expansion in new Internet users. In developing new tools for easy Internet access and use, these builder firms established an environment for a community of *business* users to emerge and experiment with the new Internet infrastructure as the communications element of a system for buying and selling goods and services. Dell Computer was among these early users.

The final element contributing to the transition of the Internet to an infrastructure for commerce was political. By 1994, policymakers, influenced by a deregulatory, free trade environment, provided the first signals that rules for deployment and use of the emerging Internet infrastructure would be market-driven and would follow the lead of businesses. Although these rules are still evolving, both infrastructure providers and business users had a reasonably clear picture that the Internet and commerce were evolving along the same pathway. Although commerce first appears as a phenomenon in 1995-96, the contours and contingencies producing this phenomenon begin in the 1960s with the advent of the Internet itself.

Internet Origins and Architecture[6]

The Internet is a communications network of a unique type. At its most basic level, it is a network of different communications networks. It connects millions of different computers and communications devices and represents the convergence of computer and communications technologies. Although the backbone for Internet traffic still utilizes existing telephone and cable television lines, the architecture of this network of networks represents a departure from earlier communications systems in which communication occurs over dedicated connections from one point to another through a central switch. The Internet, by contrast, is based on decentralized and distributed nodes of computers all connected without a centralized point.

[6] Numerous accounts of this history exist among them Hafner and Lyon (1996), Abbatte (1999), and Norberg and O'Neil (1996) but among the better short accounts written from a nontechnical perspective see Griffiths (2001).

This decentralized architecture derives from the Internet's origins within the U.S. defense establishment. The Defense Department and its allied institutions, notably the RAND Corporation, were intent on responding to the development of Soviet military technologies in the aftermath of the Sputnik launch. What concerned the military above all was Soviet nuclear capability. Underlying the design of decentralized and distributed nodes was the idea that such an architecture, unlike centralized switching, would be able to withstand a nuclear strike.[7]

Military involvement affected not only the architecture of the Internet as a communications network, but also the time lag that occurred between initial development of the packet switching technology, and eventual commercial use. Although the Internet was operating by 1969, it was only in the early 1990s that the network assumed its role as a system for mass communications and commerce. Prior to that time, it was a relatively obscure invention that, in its initial phase of expansion outside the defense establishment, was used by university researchers and not really commercialized in any significant way. Initial expansion and interoperability, however, gradually occurred in this environment.

ARPA and the Internet

As a first step in the Internet project, the Department of Defense created the Advanced Research Project Agency (ARPA) with a mandate to keep the United States ahead of the USSR in key defense and communications technologies. In 1962, ARPA formed the Information Processing Techniques Office (IPTO) to fund computer science research oriented toward promising military applications. By 1966 the director of ITPO, Bob Taylor had begun to work on the problem of how to connect different mainframe computer systems so that these systems could share data and thus communicate with one another. ARPA allocated $1 million to Taylor to find a solution to this problem (Hafner and Lyon, 1996: 12-13).

[7] Owing to these origins, the Internet was less the product of inventor-entrepreneurs and more of an institutionally driven technical breakthrough. Although certain individuals played key roles in the development of Internet technology, unlike the telegraph and the telephone, the Internet is not as easily traceable to individual inventor entrepreneurs such as Samuel Morse or Alexander Graham Bell.

A critical step in this effort emerged in 1967 when computer scientists working within ARPA developed the idea of inserting a sub-network of smaller computers between the host mainframes, a concept later known as Interface Message Processors or IMPs (Rosenzweig, 1998: 1532). Once this idea of a network within a network was in place, ARPA eventually awarded a $1-million contract in 1967 to the computer consulting company of Bolt, Beranek and Newman (BBN) to develop the initial architecture for the ARPA network or ARPANET.

The awarding of this contract, however, and the creation of the initial ARPA network had several other critical antecedents that enabled some of the most important conceptual foundations of the network to emerge in the first place (Rosenzweig, 1998). The most important contributions came from Paul Baran, an engineer at the Rand Corporation, and a British physicist, Donald Davies. In confronting the problem of how the U.S. government could maintain its communications capability following a nuclear exchange with the Soviet Union, Baran conceived of a communications network unlike telephony or even telegraphy that sent message traffic through dedicated physical lines. Critical to his concept was the idea of breaking communications messages into discrete "message blocks" that could be sent individually and reassembled at the reception point. He further proposed a system without centralized gateways in which the switching nodes are decentralized enabling messages to be rerouted in the event some nodes are incapacitated. Baran summarized his ideas in a document entitled "On Distributed Communications" (1964). Working independently of Baran, but along a similar technical path, Davies focused his concerns on interactive computing and increasing the number of users who could access information from mainframe computers. In pursuing this aim, he developed a similar concept to that of Baran on discrete messaging and gave Baran's "message blocks" the name of "packets." This idea of packet switching in which data traffic is broken into discrete pieces through digital technology, sent through multiple paths instead of dedicated lines between two points, and finally reassembled at an end point, is today the core idea of Internet technology (Rosenzweig, 1998: 1533).

The first phase of the IPTO project aimed at creating a network of users at ARPA-funded university sites based on the concept of packet switching. The firm of BBN was responsible for developing the Interface Message Processors to enable the packet switching to operate between the four initial sites chosen for the project. These sites included UCLA, University of California at Santa Barbara, Stanford Research Institute, and the University of Utah. By 1970, these sites were expanded to include MIT, Harvard and the University of Illinois. The following year, fifteen additional computer science centers funded by IPTO were connected to the ARPANET. This very modest pattern of growth in the number of host computers connected to ARPA continued throughout the decade so that by 1979 there were sixty-one such hosts (http://www.cnie.org/nle/st-36.html; Kenney (2001: 16).

By 1972, ARPA demonstrated the feasibility of packet switching as a communications technology while creating a nationally extended, though limited and little used network (Rosenzweig, 1998: 1536). An important dilemma, however, remained unresolved. As other communications networks emerged alongside and independent of the ARPANET, so-called local area networks, computer scientists at ARPA realized that they confronted a problem similar to what they had to overcome in 1967 with incompatible computers. This time the problem was how to connect incompatible *networks* – not just incompatible computers – to one another. From this challenge of "inter-networking" came the project that would launch the Internet (Rosenzweig, 1998: 1536).

Infrastructure Standards

Robert Kahn, a computer engineer who had moved from BBN to ARPA, spearheaded this "Internetting Project" to enable computers on different networks to communicate uniformly with one another and with the ARPA network (Hafner and Lyon, 1996: 223). Kahn relied upon another computer scientist, Vinton Cerf to help devise a standard language for packet-switching technology. In 1974, the two published their idea for such a language in an article entitled, "A Protocol for Packet Network Intercommunication." In this article, Cerf and Kahn pointed out how previous language protocols for packet switching had only addressed the problem of communication on the same network. Their paper introduced a protocol for communication on "different packet switching networks" (quoted in Zook, 2001: Appendix B). Their idea was the basis for a new standard called Transmission Control Protocol (TCP).

By 1977, ARPA began the first demonstration of TCP idea in linking the three packet switching networks of the ARPANET. One year later in 1978 the new inter-networking protocol was divided into two parts and renamed TCP/IP. TCP consisted of the host-to-host linkages, while IP, standing for "Internet Protocol," referred to the network-to-network links. A standard had developed for interconnection between computers operating on different networks.

One of the most critical developments in the ascendancy of TCP/IP as the standard for Internet communication was support for the new protocol by the U.S. Defense Department. When ARPA came under more direct control of the Defense Department through the Defense Communications Agency (DCA) in the mid-1970s, the need for a standard communications language was paramount. As a consequence, the Department of Defense adopted the TCP/IP standard in 1980. The following year the Defense Department required all ARPANET hosts to implement the TCP/IP standard. This standard, however, did not go unchallenged.

European telecommunications companies pushed an alternative standard to TCP/IP, the x.25. Nevertheless, support and funding by the Defense Department for TCP/IP enabled the American protocol to prevail over the European alternative in this "battle of standards" (Shapiro and Varian, 1998; David and Bunn, 1987). In March, 1981 the DCA provided an even more powerful incentive for adoption of the TCP/IP standard when it initiated the requirement that all ARPANET hosts implement the protocol by January, 1983 (Zook, 2001: Appendix B). The creation and adoption of the TCP/IP standard, and the requirement for its use by the DCA, provided a powerful catalyst for growth of the ARPA network since, with the new language, different networks could connect to it.[8]

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[8]This victory of TCP/IP as the standard language of internetworking is one of the reasons why the U.S. emerged as

One source of growth was computer science departments at non-ARPA funded universities that sought access to the ARPA network. As the number of university-based users increased, however, the DCA made the decision to separate military and academic users by splitting the ARPANET into two networks in October, 1983. One network, MILNET, was for the military. The other was a residual ARPANET oriented toward civilian users in which the National Science Foundation began to play a major role.[9] This civilian-oriented ARPANET attracted users from the second source of growth, the local area networks of business firms.

As personal computers expanded in workplaces during the mid-1980s, and as networking of PCs became practical in 1985 with the introduction of the Intel 80386 microprocessor, the number of local area business networks expanded and emerged as new source of demand for access to the ARPANET. Alongside LANs based on workstations, the growth of PC-based local area networks resulted in an increase in the number of networks connecting to the ARPANET. In 1982 the ARPANET consisted of fifteen networks. By 1986, the ARPANET included over four hundred networks (Zook 2001: Appendix).

This increase in the number of networks connected to the ARPANET was also reflected in a more dramatic increase in the number of network host computers. In 1984, host computers numbered slightly over one thousand but increased fivefold to a little over five thousand by the end of 1986 as new networks became connected to the ARPANET. The final years of the decade, however, witnessed the first growth spurt in the number of host connections as local area networks multiplied. By 1990, the Internet comprised roughly 313,000 host computers.

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the dominant force on the Internet (Rozenzweig, 1998: 1537).

[9]As part of this decision to split the ARPANET, the National Science Foundation established an Office of Advanced Computing in order to create centers of super computing throughout the nation. Only five centers, however, were actually funded. The locations for these centers included Cornell, Princeton, Pittsburgh, University of California (San Diego), and the University of Illinois (Champaign-Urbana). The center at the University of Illinois would later play a decisive role in helping transform the Internet into an infrastructure for mass communications and commerce for it was at this campus that the initial versions of the Mosaic Internet browser were developed.

Table V-1

Number of Host Computers Connected to the Internet (1982-90)

	1982	1984	1986	1988	1990
# of Hosts	235	1,024	5,089	56,000	313,000

Source: Internet Software Consortium, http://www.isc.org/ds/host-count-history.html

Nevertheless, while the number of Internet host computers was increasing and expanding the network, the number of actual users was still confined to a relatively obscure community of academics and research scientists. Besides the connections of certain local area networks, the Internet had no real commercial characteristics. The transformation of the Internet into a commercial space, as well as a space of mass use, still awaited two crucial developments -- the World Wide Web and the Mosaic and later Netscape Internet browser.

The Web, the Browser and Web Commerce

The breakthrough of the Web consisted of three critical Internet building blocks: hypertext markup language (HTML) to provide a format for Internet communication; hypertext transfer protocol (HTTP) to provide a guide for sending and receiving Internet communication; and the uniform resource locator (URL) to denote locations for finding information on the Internet. The creation in 1990 and release in 1992 of these elements was the work of computer scientists at the CERN European particle physics laboratory in Geneva under the direction of Tim Berners-Lee. Their efforts represented a first step in making the Internet accessible for widespread use beyond technological elites (Weintraut: 1997: xxic). The basic idea behind the Web and its relationship to the Internet, is perhaps still best captured by Berners-Lee himself.

The Web is an abstract, imaginary space of information. On the Net, you find computers. On the Web you find documents, sounds, video – information. On the Net, the connections are cables between computers. On the Web, connections are hypertext links. The Web exists because of programs which communicate between computers on the Net. The Web could not exist without the Net. The Web made the Net useful because people are really interested in information, not to mention knowledge and wisdom, and don't really want to have to know about computers and cables (taken from Griffiths, 2001).

Perhaps the most enduring contribution of the Web is that it provided the technical foundation for development of Web browsers, most notably Mosaic, and myriad other applications promoting both widespread use, and eventually commerce on the Internet.

The origins of the Mosaic browser derive from the NSF Supercomputing Center at the University of Illinois and two students working there, Marc Andreesen and Eric Bina, who began to explore ways of making the Web easier to navigate (Ceruzzi, 1999: 303). By the following year, they had written an early version of a browser program they called Mosaic, which simplified use of the Web, and the two circulated this browser software freely over the Web itself. As a result, thousands of copies came into use and the number of individual Internet users climbed dramatically, from roughly 100,000 individual users worldwide in 1993 to approximately three million in 1994.

In 1994, Jim Clark, the founder of the Silicon Graphics Company, approached Andreesen and the two founded the start-up known as Netscape Communications that successfully commercialized subsequent versions of the Mosaic browser. In concert with the Web, the Netscape browser opened a new pathway of access to the Internet. As a result, Internet activity which had expanded impressively after release of the Mosaic Browser in 1993, exhibited an explosive increase in the number of individual users, expanding from three million in 1994 to 26 million the following year. These increases would continue in the years following.

Table V-2

Estimated # of Individual Internet Users Worldwide (millions)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001
# of Internet Users	.1	3	26	45	69	129	185	423	513

Note: The number of users in 1993 comes from Department of Commerce (2000) but Zook believes the number to be higher than 100,000.
Source: Department of Commerce, 1998: 7; Department of Commerce, 2000: 5; www.zooknic.com

In addition to individual use, the Internet during these years was also becoming a magnet for institutional use. Such institutions included businesses, educational establishments, and myriad different organizations. As a result, the number of Internet domain name registrations increased dramatically paralleling the expansion pattern for individual users.

Table V-3

Internet Domain Name Registrations (000s)*

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
# of Registrations	5	10	46	120	488	1301	2154	7052	18,649	30,090

* Includes .com, .net, .org, and .edu domains.
Source: eMarketer (2001); www.zooknic.com/domains/counts.html

In the aftermath of the extremely successful introduction of the Netscape browser, which enabled the base of individual Internet users to expand, the Company began work on a series of applications intended as a bridge from the browser to business. Netscape called this orientation "Integrated Applications" (I-Apps). The company began to ship these new commerce-enabling tools in 1995.

The I-Apps, later renamed Commercial Applications, were among the first efforts at creating tools for Internet commerce (Reid, 1997: 48). They were developed to enable businesses to sell goods or services through an Internet-based communications and transaction system. Two of the initial I-Apps, the I-Store and the Merchant System, were designed to create catalogue-type purchasing environment including an on-line infrastructure for clearing credit card transactions. The difference between these applications and catalogs, however, was that instead of the mail or the telephone, the communications infrastructure for this type of buying and selling was the Web.

This concept of commerce enabled by the Internet held enormous promise owing to the Internet's strength as a "pulled" information channel (Reid, 1997: 48). This potential was based upon the perception of parallels between pulling information supplied from a source on the Internet, and buying goods sold by a vendor. If information could be pulled from the Web by Internet users, it seemed a short step to the idea first of substituting saleable goods for information, then replacing the concept of Internet "user" with the concept of "buyer," and finally changing the action of pulling information with a different type of action -- a *transaction*. The challenge was how to shift this process of buying and selling in the physical world onto the Web infrastructure. The foundations for such a transition, however, were already beginning to emerge by 1994-95 in terms of users, both individual and firms, and applications. Internet traffic was continuing its dramatic rise with millions of new users including businesses emerging on the Internet, taking advantage of an explosion of new Web portals, search engines and an array of Web-hosting services. Secondly, the proliferation of Web-based transaction applications being developed not only by Netscape but by numerous other software providers, provided tools for the Internet to become a business space for buying and selling (Kenney, 2001: 23-24).

Owing to these trends, the years of 1993-95 demarcate the early commercial phase of Internet development and separate it from the pre-commercial, so-called "B.C." (before commercialization) stage of the Internet (Weintraut, 1997: xxxv). During this period, tools in the form of commerce-enabling Web applications stemming from the breakthroughs of Netscape, created a more viable infrastructure for business activity and contributed to the overall build-out of the Internet infrastructure. These tools and the build-out of the Internet infrastructure enabled the burgeoning community of Internet users to orient to the Web in a commercial way. It is important to emphasize, however, that commercial use of the Internet and mass use did not evolve in opposition to one another. Both mass use and commercialization evolved more or less in tandem. In this environment, business firms, both start-ups and incumbents began to create web sites to take advantage of this business orientation of the Internet during this critical period of early commercialization. As a result, the number and percentage of .com web sites, which was very small in 1993, started to rise dramatically in the next couple of years. By the beginning of 1996, websites associated with business firms represented roughly half of the sites on the Web. This percentage would increase even more dramatically by the time the decade came to a close.

Table V-4

Growth in % of .com Web sites

Date	06/93	12/93	06/94	12/94	06/95	01/96
% of .com websites	1.5%	4.6%	13.5%	18.3%	31.3%	50.0%

Source: Mathew Gray, MIT http://www.mit.edu/people/mkgray/growth/

This period of 1993-95 represents a crucial demarcation point in the transition of the Internet as both a medium of mass communication, and as a commerce infrastructure. Two developments in this process were critical. In the first place, overall use of the Internet by individuals exhibited extraordinary growth from 1994-95. Such use was also paralleled by expansion in the number of hosts and domain names. Perhaps even more dramatic however, was the growth during this period of 1993-96 in the number and percentage of web sites connected to business firms. Web sites themselves began to grow rapidly after their initial appearance in 1993. As the number of websites on the Internet began to expand after 1993, so did the percentage of .com web sites representing business firms. From a negligible presence in 1993, .com web sites by January of 1996 constituted 50% of the sites on the Web – a percentage that would continue to climb throughout the remaining years of the 1990s.

This period of rapid expansion in 1993-96 marked the beginning of the critical build-out stage for the Internet as an infrastructure for business (Weintraut, 1997: xxxv). During this period of rapid build out, the number of domain name registrations (a different measure than web sites) in the .com, .net, and .org domains increased from roughly 10,000 in 1993 to 200,000 in 1995 to 1.5 million in 1997 (eMarketer, 2001). During this same time period the number of Internet host computers skyrocketed from 1.3 million in 1993 to 16.1 million by 1997.

Internet Commerce and Government Policy

While the various web-hosting and commerce enabling applications for the Web began to appear in the period of 1994-96 enabling the Internet to become viable as an infrastructure for commerce, and while early experiments in Internet buying and selling began to emerge by 1995, commerce on the Internet raised numerous legal and political issues for policymakers. If the phenomenon of Internet commerce was to become accepted with businesses and expand, it would require a rulemaking framework to set standards for the conduct of buying and selling on this infrastructure. Rules on such issues as intellectual property, privacy, content distribution, and taxation of Internet transactions, are still evolving as part of an ongoing process to create a uniform commercial code for Internet activity throughout the world.[10] Two early sources, however, provided signals for businesses on the direction of policymaking for the Internet. One source was the Telecommunications Act of 1996. The other was the position paper of 1997 released by the Clinton Administration entitled *Framework for Global Electronic Commerce.*[11]

Although the Telecommunications Act of 1996 aimed at governing construction and deployment of communications networks, and providing new rules for the conduct of firms involved in infrastructure build-out, its impacts on the Internet were far-reaching. The Act in many ways continued a trajectory begun in the 1960s acknowledging that the emerging world of data networking was different than telephone service and should be regulated differently (Bar et al., 1999: 2). The primary objectives of the 1996 Act were twofold.

Firstly it aimed to strengthen the already-evolving convergence of communications and computer networking technologies that was providing the catalyst for Internet development, and legitimize this convergence as public policy. Secondly, it sought to open competition for construction of the Internet infrastructure and to create open access to the network in contrast to the closed networks created by monopoly telephone companies. The pathway to these aims in terms of general policy was *deregulation.* The Act established a deregulatory environment for the telecommunications market allowing firms from myriad different sectors, many of which were formerly precluded from involvement in telecommunications activities, to compete in expanding the build-out and interoperability of the Internet infrastructure. While the law focused on the infrastructure, its impacts were just as critical to the emerging community of business users. For users, Internet-enabled commerce is dependent upon an Internet infrastructure that is interoperable, accessible, and universal. The legislation provided users with signals that the infrastructure would not operate haphazardly and arbitrarily but would expand in

[10] There are still significant differences between U.S. and European approaches to issues of Internet taxation and privacy.

[11] Although the 1996 Act and the *Framework* appeared *after* Internet commerce had already debuted, the content and policy direction of both had already been signaled by 1994 in policy forums throughout the world by U.S. government officials (U.S. Government Working Group on Electronic Commerce, 2000).

accordance with certain rules. If users were to conduct business over the Internet, they had to know that a framework was in place to promote the technologies enabling this infrastructure to extend its reach and become more interoperable. In a sense, the policy enabled users themselves to play a major role in driving the Internet revolution (Bar et al., 1999).

Similarly, the *Framework* document, authored primarily by Ira Magaziner, gave businesses signals not only that Internet commerce would be encouraged, but also that it would actually receive special dispensations such as tax relief. The document outlined five major principles in which the government affirmed its interest in providing a predictable legal environment for Internet commerce. Nevertheless, the *Framework* was careful to qualify its involvement in establishing this environment. It was to be one where government would not lead but would follow the practices and precedents – including the standards -- established by businesses. In many ways, the document followed in spirit the deregulatory emphasis of the Telecommunications Act. Government was going to implement a more market driven and less regulated competitive environment for the new activity. These principles were already the de facto policy of the Administration before the document was released.

The Internet Retail Space

As the foundations for an increasingly interoperable and commerce-enabled Internet infrastructure emerged in 1994-95, fueled by an explosion of venture capital investments in start-ups creating ever more applications and networking gear for the Internet, and as the signals for a favorable policy environment began to take shape more clearly during this period, business users began a process of experimentation in buying and selling on the Internet. Most of these early firms engaging in selling products and services on the Internet, were themselves venture-funded start-ups that began to sell a range of different consumer oriented items to retail customers. In the process these companies were pioneering new models of consumer-oriented Internet retailing. By far, the most compelling of these early experiments in Internet retailing emerged in the form of a Seattle-based bookseller. The firm was called Amazon.com.

Amazon and Internet Market Space

Amazon.com created the first large-scale business using the Internet as a communications infrastructure for retail transactions, initially selling books and later a wide array of different products to consumers. The firm established a website for Internet sales in July, 1995 and became a billion dollar seller of books over the Internet in a little over three years. During this period, Amazon succeeded in creating the most recognizable brand name in Internet commerce that rivaled the brand names of the world's largest firms (Dodge, 2001: 167). Its growth paralleled the growth of the Internet itself.

The sources for the business model of Amazon were twofold. The first source from which this business was built, was the enormous increase in the number of Internet users. The second platform exploited by Amazon was the availability of commerce-enabled Web tools developed by various software firms in the wake of Netscape's successful Web products. Company founder, Jeff Bezos provides a revealing admission of how he developed the idea for selling books over the Internet from these two sources. "Two years ago [1994] nobody knew how many people were on the World Wide Web," concedes Bezos, "but what *was* noticed was that Web usage was growing at 2,300 per cent a year."

> I started thinking about what kinds of opportunities are there going to be in this new Web space. It was clear that the Web technology, even though it was rudimentary, would support primitive interactive retailing. I thought that the content areas were going to be very crowded, and it wasn't clear what the revenue model was to make money off of content, so transactions-based business made sense to me (Southwick, 1996).

From this rapidly expanding population of Internet users, coupled with the new commerce-oriented web tools, Bezos successfully reconceived the notion of what is perhaps the most fundamental element in economic activity, the notion of a *market*. The challenge confronting Bezos and Amazon was how to use the Internet to sell in this market space, and how to generate a profit from this new method of sales.

The economic rationale for Bezos was that in reaching this market through the Internet and eliminating the costs of stores and employees, the process of selling could be made more efficient and hugely profitable. By taking customers' orders directly over the Internet, and by eliminating the overhead costs with physical retailing, Amazon aimed to undercut prices of retail bookstores by marking up book prices from publishing houses at a fraction of the normal markup rate for retail stories. In addition, Amazon counted on creating a more convenient and efficient sales channel to its customers through Internet communications.

Internet Efficiency, Internet Geography

The business model devised by Amazon took advantage of the Internet in two fundamental ways. In the first place, Amazon used the Internet to create market *efficiencies.* Secondly, the technology of the Internet enabled Amazon to reshape market *geographies.* It was the latter, however, that actually enabled the former.

In creating market efficiencies, Amazon used the communications capabilities of the Internet to accomplish two objectives. In the first place, Amazon used Internet communications to locate buyers for its product. In this way the firm relied on Internet technology to overcome one of the primary obstacles to efficient markets, the problem of incomplete information – the so-called problem of information asymmetry – in this case, incomplete information on the location of customers. Secondly, Amazon used the Internet as a transaction processing technology, enabling the firm to create greater levels of efficiency in the market by reducing its costs of transacting. Consequently, by using Internet communications to pioneer a more effective mechanism for matching buyers to Amazon as seller, and by using the Internet to process transactions from this newly-created base of buyers in a much more automated and less expensive way, Amazon actually created a more efficient *economic space*.

Perhaps more profound, however, was the way Amazon used the Internet not only as a route to efficiency, but also as a technology for reshaping the geographical space for economic activity. The business model of Amazon provided one of the earliest and most powerful lessons in the way commerce on the Internet began to change the concept of markets as territorial entities. This change in the geography of markets had profound consequences. In reshaping the geographical space of markets, as well as enhancing the efficiency of economic space, the Internet-driven business models of firms such as Amazon helped create a vastly different environment for profit-making.

Amazon and the book business provide a compelling illustration of this transformation in market geography, and how such territorial restructuring changes the profit-making environment for firms. A bookstore is traditionally a business with a market shaped most fundamentally by the concept of place. For the most part, customers of bookstores reside in the same geographical locale as the bookstore itself. While large bookstores might service long- distance customers and possess a more geographically dispersed customer base, in general the bookstore and its market share the same locality. Furthermore, in addition to bookstores, numerous types of businesses operate in this manner, their market and customer base conditioned by territorial boundaries.

What the Internet as a commerce system did for Amazon, as well as numerous other Internet firms, was to open the territorial boundaries that circumscribed, and even protected the markets of established businesses firms. At the same time, the Internet subjected incumbent stores to competition from Internet firms located outside the market area. Internet auto retailing, flower selling, even the Internet grocery business began to change the territorial shape of markets for certain types of economic activity.[12] Indeed, the Internet did not dissolve distance as a factor in producing and trading as many of its earliest disciples claimed it would. Internet merchants could not neglect the logistical challenge of delivering products to geographically dispersed customers and thus turned to the overnight package delivery industry, the "Airline of the Internet," to provide the fulfillment for delivering goods ordered through the new communications infrastructure (Lappin, 1996).[13] Nevertheless, despite the fact that Internet technology could not completely dissolve distance as a factor in business activity, this new

[12] In this sense, Internet retailing is little different than the innovation of mail order catalogs pioneered by Montgomery Ward and Sears Roebuck in the late nineteenth century. These mail order houses invaded the protected markets of retailers especially in rural areas and small towns, undercutting these local merchants with low prices achieved through enormous volumes and economies of scale. It is also interesting to note that organized opposition to Wards, Sears and other national mail order houses emerged during the early 1900s on the part of country retailers and wholesale jobbers during debate over legislation to extend parcel post service in rural America. See Chandler, 1977: 230-233.

[13] "We're on the fulfillment end of [Internet Commerce],"insists Federal Express CEO Fred Smith. "When the telegraph came along, there was a corresponding development of the rail system. The telegraph created the connections and the railroad allowed fulfillment. Well, today the Internet creates the connections, and we provide the fulfillment" (quoted in Lappin, 1996: 284, 286).

communications system, much like the technologies of earlier communications revolutions, did reshape the organization of territory for economic activity. By enabling firms to reach customers in geographically distant locales, the Internet created a new type of economic territory and market space.

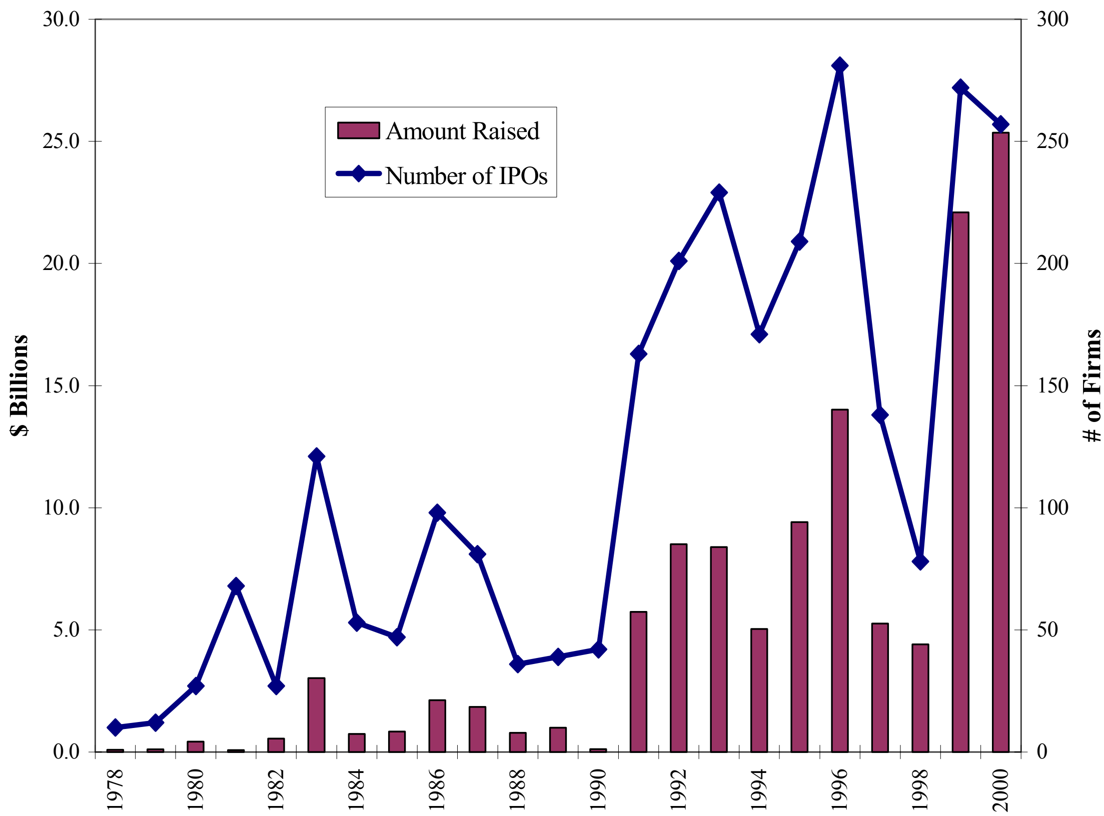
In addition to reshaping the market geography of buying and selling, the most enduring impact of Internet sellers such as Amazon, despite the inability of the firm to turn a profit, was to legitimize the viability of business models for transacting and selling over the Internet. Although these early Internet-based selling models emerged primarily in the retail channel where products moved from firms to consumers, forms of Internet retailing pioneered by firms such as Amazon also influenced the selling channels of non-retail businesses. Among the firms in this group, Cisco Systems was arguably the most pioneering. It began selling its networking equipment to its business customers over the Web beginning in the second half of 1996. By the end of the year, Cisco had booked $100 million in Internet sales which expanded to $1 billion in 1997 (Department of Commerce, 199: A3-11). Dell was also involved in these early efforts of manufacturers to develop Internet sales channels. By the late 1990s, numerous other firms whose customers were actually other businesses, began to follow the example of Cisco -- and Dell -- in developing the capacity to sell over the Internet.

This sales activity marked the beginning of a far more significant trend on the Internet, *interfirm* sales where businesses buy and sell among themselves in what is commonly referred to as the business-to-business space. It is in this space where most of the value in the economy gets created. It is also within the business-to-business space, where firms, especially manufacturers, confronted an enormous challenge as well as potential opportunity. This challenge focused on using the Internet to reorganize entire value chains from procurement of supplies, through manufacturing and assembly, and finally distribution.

Within a year after the initial explosion of Internet retailing firms in 1996-97, venture capitalists began financing companies with business models aimed at enhancing the efficiency of interfirm activity through Internet communications (Kenney, 2001: 36). As early as 1998, despite continued media attention on Internet retailing and firms such as Amazon, nearly 80% of Internet commerce was occurring between companies (Business Week, June 22, 1998: 130; Tedeschi, April 19, 1999). In the process, the business-to-business space had emerged as the next wave of commerce on the Internet.

Chart V-1

Number of Venture Backed IPOs and Amount Raised, 1978-2000



Source: Zook, 2001. Reprinted by permission.

The Internet Business-to-Business Space

While the business-to-business space on the Internet is distinct from Internet retailing, there are ways in which the precedents of Internet selling became models for reorganizing interfirm activity through the Web. The reason for this bridge between Internet retailing and the reorganization of interfirm value chains through Internet communications stems from the fact that efficiency in the value chains for manufacturing, and efficiency in retailing, despite obvious differences, share certain underlying similarities. Taken in its entirety, the value chain in manufacturing involves an enormous amount of transacting in order to connect the creation of products with their sale and consumption. Not only are there numerous transactions between different firms involved in this circuit from production to consumption. There are transactions within the boundaries of the same firm as part of the creation and distribution process. Transacting is therefore a fundamental element in economic life.

This shared characteristic between manufacturing and retailing involving the process of transacting, is what enabled Internet retailing to provide certain precedents for the idea of enhancing the manufacturing process through Internet communication. If retailing could be made more efficient through Internet communication as firms such as Amazon were seemingly demonstrating, it seemed logical that opportunities existed to render *interfirm* trade, that is, entire business-to-business supply chains and production networks, more efficient through the creation of Internet-based “E-Supply Chains” (Poirier and Bauer, 2000). Such Internet-driven forms of enterprise resource planning between firms represented a new frontier in supply chain management and Internet commerce (Anderson and Lee, 1998; Adhikari, 1998).

Table V-5

Estimated Levels of Internet Commerce

($ billions)

Year	1996	1997	1998	1999	2000	2001
B2C	.24	2.5	5.1	18.0	33.0	65.0
B2B	.51	8.0	17.1	52.9	226.2	448.9

Source: eMarketer (2001); Forrester Research; NUA Internet Surveys.

Indeed, certain manufacturers, notably Cisco Systems and General Electric as well as Dell Computer, began to experiment in 1996-97 not only with Internet sales channels but also with ideas for reconfiguring the supply chain component of their business (U.S. Department of Commerce, 1998). Such efforts at reorganizing the value chain in this more comprehensive way through Internet communication, however, posed much more complex operational and organizational challenges than using the Internet to recast retail sales channels. The reason for this complexity stems from the dominant role of interfirm activity in the economy itself. Roughly three quarters of the activity in the economy occurs along networks linking firms.[14] Reorganizing these linkages through Internet communications effectively involves changes throughout the entire system of interfirm relationships in the economy. This dominance of interfirm trade in the economy, and the potential efficiency gains from recasting this trade through the Internet, is what attracted the efforts of venture capitalists, start-up firms, and existing companies to develop Internet-based business models for supply chain activity. In the process, the business-to-business space became the most coveted area of Internet commerce. In order to understand these efforts, however, it is critical to examine the foundations of interfirm value chains themselves.

[14] The dominance of interfirm activity in the economy is reflected in the transactions tables of input-output analysis pioneered by Wassily Leontieff that reveal the extent to which intermediate trade between firms dwarfs final demand.

Interfirm Value Chains

The basic activities of firms in procuring, creating, and selling products and services, take place in networks known as *value chains* (Porter, 1985).[15] Each individual firm has its own value chain that defines the boundaries between it and other firms, and reveals how the economic activity in the network -- procurement, production, and selling -- is organized. The manner in which firms organize and perform these various functions within their value chains is the source of the firm's profitability and competitive advantage.

What occurs along these networks is a process of value creation whereby goods and services move between different firms, or between different units of the same firm, and in this process of movement, become transformed. Through the activities of initial concept, design, procurement, fabrication, marketing, distribution, and final sale, firms at these adjacent steps modify the attributes of goods and services, imbuing them with more value. Built into each of these activities, however, is not only human labor. The various steps in the value-creation process also include an element basic to labor itself, the element of knowledge-transfer or information-sharing, and communication. The economic activity in value chains is essentially an information and knowledge processing activity in which communication is fundamental (Bar, 2001: 36).[16] The interfirm (and intrafirm) networks along which value chain activity takes place are, in effect, information and communications networks.

Inputs added by firms to products or services to increase their value as they circulate within value chains are of two types.

One type of input occurs on the *production* side of value chain activity. This input changes the properties of goods and services and involves the addition to the product or service of new materials, or

[15]"Every firm is a collection of activities that are performed to design, produce, market, deliver, and support its product or service. All of these activities can be represented using a value chain,... the activities in a firm's value chain are linked to each other and to the activities of its suppliers, channels, and buyers..." (Porter, 1985: 34, 36).

[16]Admittedly, Bar does not link communications to value chains exactly in this way. Nevertheless, his point -- that market processes and market activities are information processing activities – is the source of inspiration for the connection between value chains and communications made here.

new knowledge and information. The other type of value-creating input occurs on the *circulation* side of the value chain. Often referred to as "the gains of trade," this type of input adds value to a product or service by facilitating how products or services move through the various steps in the value chain creating value from what geographers term, a change in *location*. Value on the circulation side is generated from information used to rationalize how products or services circulate from conception, to creation, to consumption.

Despite these distinctions, inputs whether on the production side of the value chain, or on the circulation side, share a common and fundamental characteristic. Both types of inputs add value to goods and services by imbuing them with new knowledge and information through a process of *communication.* On the production side, communication transmits information that gets embedded within products. On the circulation side, communications transmits information embedded within processes. As a result, communications-enhancing technologies provide a primary route for efficiency gains in the process of value creation. The Internet is currently providing such a pathway.

Internet Value Chains

In reconfiguring distances between economic actors and reshaping market geographies, the Internet is recasting efficiency in value chains, and enabling business firms to reorganize business models as a result of three primary attributes (Malone et al., 1994: 67-68). These attributes of the Internet are: 1) the digital *communication* effect which refers to the larger volume of information that can be exchanged between businesses in less time at less cost; 2) the digital *brokerage* effect referring to the number of alternative transactions that can be considered by firms in less time at less cost; and 3) the digital *integration* effect referring to changes in the organization of businesses processes occurring at the interface of adjacent value-added stages of the value chain.[17] All of these attributes enable firms to decrease the unit costs of coordination within value chains. These costs include the costs of information

[17]Although this model of Malone et al. describes the impacts of new information technology in general, it has an enormous amount of fluency in representing the effects on firms of the Internet itself.

processing and communication in such tasks as selecting and interacting with suppliers, settling contracts, scheduling and budgeting activities, and tracking flows of materials as they circulate from suppliers through production to final marketing. Although the savings to firms from these Internet effects are difficult to measure, they are estimated to range from 5-10 percent of sales (Business Week, June 22, 1998: 130).

On the basis of these attributes, two different business models deriving from two types of firms, emerged and began to recast interfirm value chains through Internet communication. The first model derived from the efforts of existing firms aiming to rationalize their procurement systems through Internet communication. In this business model, existing companies used the Internet to locate and negotiate with a far larger number of suppliers than was possible before Internet communication. The other business model that emerged in the Internet business-to-business space, resulted from the growth of an entirely new business phenomenon, the so-called Internet market maker. Taking advantage of the Internet's communications and brokerage effects, these start-ups created Web-based, on-line exchanges for aggregating and consolidating buyers and sellers in supply chains for entire industries or product groups (Business Week, March 13, 2000; Tedeschi, January 24, 2000). In what was perhaps a paradox, these market makers involved in creating on-line exchanges, emerged as new *intermediaries* aiming to reorganize interfirm buying and selling through the Internet and secure revenues from transactions.

Among the companies in the first category, General Electric was arguably the earliest and most pioneering in developing a Web-based business model for procurement. As early as 1996, GE had already developed a pilot Internet-based procurement system for its Lighting division using an extranet developed by GE Information Services (Business Week, August 5, 1996). One year later, eight of GE's operating divisions had implemented this online procurement system for some of their part and supply purchases (Department of Commerce, 1998). By the end of 1999, the company had managed to convert all twelve of its operating units to online purchasing. GE referred to its on-line procurement system as TPN or "Trading Process Network."

The goal of GE's Network was to create efficiencies in procurement by relying on the capacity of Internet communication to aggregate large numbers of suppliers through the digital communication effect, and create an auction environment with this extended group as a result of the digital brokerage effect. This process of market enlargement for supply sources, however, derived not only from the Internet's communications effect in reaching large numbers of suppliers simultaneously. Market enlargement for suppliers also stemmed from the Internet's capacity to store, duplicate and send information. These characteristics enabled GE to change the way it organized the work for sending out bid specifications thereby taking advantage of the Internet's digital integration effects. Bid specifications including blueprints that formerly had to be copied and processed individually and then distributed to eligible bidders, were able to be stored digitally and sent as web-based documents. Because the former process was complex and time consuming, GE normally sent out bid packages to only two or three suppliers at one time. Through the Web, this process of sending bid specifications to suppliers was simplified to the point where numerous suppliers were able to bid on GE projects. Suppliers registered to be on the Network enabling GE to reach this wider base of firms. This larger base of suppliers, in turn, provided GE with the opportunity to create on-line reverse auctions to drive down prices. The firm, in effect, was able to gain efficiencies in procurement by extending the market for suppliers, and using this extended market to obtain the lowest possible component prices. The Trading Process Network helped GE reduce the time required to identify suppliers, prepare bid requests, negotiate prices for parts, and award a procurement contract by 50 percent (Department of Commerce, 1998: A-3-27). By enlarging its market for suppliers, and by enabling the firm to change certain operations in the procurement process, the Internet, through its communications, brokerage and integration effects, has provided firms such as GE with cost savings in its supply chain.

In many ways, the aims of the independent exchanges established in the Internet business-to-business space by start-up firms are similar to the Trading Network created by GE. These exchanges seek to create cost savings and efficiencies for firms by aggregating and consolidating buyers and sellers through the Internet's communications and brokerage effects. The difference, however, between these exchanges and the Web-based Trading Network of GE is one of control. Whereas GE built an Internet business model in which it controls its own Internet procurement space, in the on-line exchanges, the business model and structure of control is different. With names such as e-steel.com, Chemdex.com, and PlasticsNet.com, these new firms created a business model based upon the idea of consolidating and aggregating buyers and sellers within industries, while seeking to exercise some control over the transactions between these actors in order to generate revenue (Economist, June 26, 1999: 23). Thus, while the element of efficiency through aggregation and consolidation runs through both models, the on-line exchange is based on the idea of an *intermediary* exercising control over the activity and generating revenue from transactions that it orchestrates.

In some ways, these intermediaries represented a type of gold rush in the business-to-business space of Internet commerce. Funded heavily by venture capital, these startups exhibited an explosive growth in number especially after 1998. There were an estimated 250 of these exchange sites in early 1999. By the beginning of 2000, the number of these exchange sites had expanded to roughly one thousand while the amount of venture capital in these new companies increased from $1.8 billion in 1998 to $23.4 billion in 2000 (eMarketer, 2001; Business Week, October 9, 2000).

Many of these exchanges operated in the same industry. Metalsite and e-steel competed against one another to organize transactions between steel-related firms. Other sites such as VerticalNet and FreeMarkets organized buying and selling between firms in a range of related industries. What was similar in these start-up sites was the fact that they aimed to attract established firms to their exchanges. Predictions about a massive migration of interfirm trade to these independent exchange sites, however, proved erroneous. Many of the existing firms, after initially experimenting with these exchanges, later abandoned them preferring to establish their own sites rather than relinquish control to an intermediary (Kenney, 2001: 37). Furthermore, these start-ups also suffered from the effects of the Internet downturn. After their extremely buoyant start in which over one thousand of these exchanges had emerged in the first quarter of 2000, by October of the same year, roughly 90% were out of business with the survivability of the remaining independent Internet exchanges very much in doubt (Business Week, October 9, 2000). Many firms that tried using them at the outset of the Internet boom realized that relinquishing control to an intermediary was not in their interests (Business, Week, December 4, 2000). Although Dell was among the existing manufacturing firms that experimented with independent Internet exchange sites such as FreeMarkets for procuring certain types of components, the PC maker largely abandoned these exchanges as a viable Internet supply chain strategy.

Dell had a far different idea of how it could use the Internet in its business model. Despite the success of models for Internet commerce developed by firms such as General Electric, which essentially duplicated the independent exchanges without relinquishing control, Dell rejected this brokerage-oriented approach to the Internet. Aggregations of myriad unknown firms through the Internet's brokerage effects, and transactions with such agents through markets supposedly made much more efficient and free through this process of aggregation, had little to offer the PC maker as a way of making its supply chain system more efficient. For Dell, it was the need for strategic *relationships* with supply chain partners that played the decisive role in how the firm would deploy the Internet in its procurement, production and distribution system. Dell would use the Internet as a mechanism to control these relationships, and shape the creation of efficiency and competitive advantage in its procurement, production and distribution network.