The Growth and Development of the Internet in the United States*

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OUTLINE

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Rarely does a new technology emerge that galvanizes a dramatic rethinking of the nature of commerce. The Internet is such a technology. At this early stage, it is difficult to appreciate fully the importance of the Internet, but some speculate it might be as momentous as the arrival of the telegraph (Cohen et al. 2000; Standage 1999). Radically new communication technologies such as the Internet have multiple applications and often become ubiquitous. As such, the adoption, diffusion, and development of this new technology provide an especially penetrating view of how different national innovation systems have responded to and shaped the commercial possibilities inherent in the Internet. Of course, such an assessment for an economy as large as that of the U.S. is difficult. It is further complicated by the peculiar way in which communications technologies permeate and facilitate connections and relationships. Often the action of such technologies is imperceptible to most of the actors involved and even to aggregate statistics; e.g., better information transfer between customers and suppliers is not manifested in the finished good, though it is embodied in the good in terms of lower cost and/or higher quality. Given the diffuse nature and the speed of the Internet's evolution, any analysis can only be tentative.

Descriptions of the U.S. national innovation system (NIS) have concentrated upon government funding and research conducted by the established Chandlerian corporations and universities (Lundvall 1992; Nelson 1993). The government and universities played vital roles in the gestation of the Internet in the pre-commercial and early commercialization phases. Many established firms were laggards in the early commercialization process, though ultimately they could become the greatest beneficiaries. The apparent ease of entry encouraged many startups.[1]

National exceptionalism is a difficult argument to advance and validate. Nevertheless, in the case of the commercialization of the Internet, certain unique characteristics of the U.S. political economy contributed to the head start that U.S. firms enjoyed, their ability to grow rapidly, and, after the 2000 NASDAQ decline, the large number of firm failures. With respect to commercialization, the U.S.

institution of venture capital played a central role in the rapid formation of new dedicated Internet firms that were established to define and occupy new economic spaces. With respect to the Internet, there were three advantageous features of the U.S. national system of innovation: a unique telecommunications infrastructure, an active government in funding university research, and a capable set of private sector institutions dedicated to funding new high-technology enterprises.

The enormity of the U.S. market and the variety of impacts and uses of the Internet dictate that this discussion must necessarily be a limited examination of the role of the NIS and the development of the Internet. For example, the significant impacts of intranets upon firm organization, internal information flow, and human resources practices, etc. are simply ignored, though they will surely be profound. Chapter XX examines the business-to-business (B-to-B) area in more detail, but this chapter only reflects upon B-to-B issues with respect to the role of the NIS in funding B-to-B startups. One of the most intriguing impacts or initiatives that has emerged from the Internet is not examined, namely the effort in a wide variety of industries to standardize descriptors of all parts of the value chain, so that commerce can be transacted entirely electronically.[2] Despite these and numerous other omissions, the pervasive nature of the Internet as a communications medium, and the wide variety of experiments underway that are aimed at exploiting the Internet, mean that the scope of this paper remains immense.

Setting the Stage

The commercialization of the Internet and the speed with which it became a medium for commerce depended upon the already extensive diffusion of the Internet's infrastructure and its noncommercial use. This section describes some of the organizational features that provided the preconditions for the U.S. commercialization process. Despite the formation of the European Union, the

[1] In certain respects, the commercialization of the Internet parallels the commercialization of university-based biology research in the late 1970s and early 1980s, which led to the formation of a biotechnology industry (Kenney 1986).

[2] For developments in the personal computer industry value chain, see Kenney and Curry (2001).

U.S. was (and remains) the largest single market united by common laws,[3] a common language, a common currency, and various features of a modern nation-state. A more prosaic, but nonetheless important, feature for the diffusion of the Internet was a well-developed telephone system with uniform rates and usage rules. Widespread credit card usage, and the large number of U.S. consumers who were comfortable using their credit cards for telephone and catalog sales, also helped ensure the rapid growth of Internet commerce.

In an entirely different vein, the U.S. had an enormous research university system with a number of global-class engineering and science departments that were among the largest and most lavishly funded in the world. This was complemented by a large number of global-class corporate research laboratories, led by AT&T/Lucent's Bell Laboratories, IBM's Yorktown Heights and San Jose Laboratories, and Xerox's Palo Alto Research Center, to name the most prominent. No other nation or, perhaps, even group of nations possessed institutions that could rival these as sources of technology and well-trained personnel. In terms of computers, computer firms, and resources dedicated to computing, the U.S. was the acknowledged global leader. The U.S. not only trained many engineers, but also had a liberal immigration policy that permitted qualified immigrants to enter, particularly for postgraduate education. These institutions and policies created an enormous pool of engineers and scientists.

The U.S. was the leader in developing and using computers in government, university, and industry. The importance of military spending in this process is well known (Flamm 1988), though often exaggerated. In the adoption of computers for commercial or general use, the U.S. was the world's leader.[4] The rapid adoption and large installed base created positive feedback loops, reinforcing the U.S. advantage. Though IBM was a global colossus, U.S. antitrust enforcement ensured a semblance of competition and fettered IBM's ability to throttle new entrants: witness Microsoft, DEC, or Sun

[3] It is worth noting that in the U.S., many different entities including state, county, and city governments can affect e-commerce. These jurisdictions have different taxation schemes and laws pertaining to retail sales, particularly with respect to tobacco, firearms, alcohol, and pornography. Despite these differences, it is accurate to call the U.S. a unified market.

[4] The U.S. lead was not always at the invention stage. Frequently, there was simultaneous invention in several nations, but nearly always the U.S. triumphed in the commercialization of the idea.

Microsystems. In most other nations, one national champion for computing and another for telecommunications equipment were chosen and subsidized by the national government; other entrants were discouraged. The evolution of the computer sector in the U.S. was characterized by repeated waves of new computing and data communications industry entrants, whose innovations were more capable and/or less expensive than those of the dominant vendors. Thus, there was continuing turbulence – a feature not as prevalent in Europe or Japan.

In technical terms, the Internet is the result of an evolutionary path that has been affected by two fundamental reconceptualizations of the architecture of computing. The first reconceptualization was distributed networked personal computers. The second reconceptualization was the connection of a wide variety of data processing devices via the Internet. At each step of this evolution, U.S.-based startups were the delivery mechanism and the beneficiaries of leaps in functionality caused by a set of technological trajectories (Dosi 1984).[5] The dominant tendency has been an evolution from centralized computing to distributed, networked computing. The distributed portion of this computing system consists of the millions of computers in workplaces and homes across the U.S. and the world. The networked portion refers to the various media, including radio waves, electrical pulses, and photons, that permit these computers to intercommunicate.

The adoption of the Internet and the WWW was predicated upon the earlier diffusion of personal computers at home and work in the form of local area networks (LANs) in institutional settings (von Burg 2001a) and modems on home PCs (Jimeniz and Greenstein 1998). When the WWW software was first released in 1992, the majority of adopters were in institutions, especially universities, where they utilized

[5] Four "technological trajectories" contributed to the rapid growth of these industries (Dosi 1984). The first is Moore's Law (named after one of the founders of Intel). It states that the cost of a transistor on a semiconductor will be halved every 18 months. The second is Metcalfe's Law (named by George Gilder after Robert Metcalfe, co-inventor of Ethernet and founder of 3Com) that postulates that the functionality of a network will increase exponentially with the addition of each user. The third law is Shugart's Law (coined by me for Al Shugart, founder of the hard disk drive firm Seagate Technology) and is based upon the observation that the price per bit of magnetic storage halves every 18 months. The importance of this law is ignored, but Web sites such as Yahoo!, Amazon, etc. require enormous amounts of data storage. The final law, which Gilder (2000) terms the Law of the Telecosm, observes that the price of transmitting a bit of data over the communications network is halved every 12 months.

a desktop computer connected to a LAN. These groups were already using their computers to access files through Gopher and communicating by email through systems such as Telnet. They were the early adopters that downloaded browsers to access the WWW.

Though not the initial adopters of the WWW, U.S. home users rapidly embraced the Web (see Table 1 WWW USERS). The earlier diffusion of online services such as AOL (which was venture capital-funded), Compuserve, Prodigy, and The Well had created a large, relatively sophisticated population of home users that were comfortable online (Jimeniz and Greenstein 1998). For the online services, the emergence of the WWW and the privatization of the Internet initially appeared to be a challenge, because their revenue was generated by per-minute access fees and further fees to use proprietary services. The no-cost Internet appeared threatening, but their response was to continue their proprietary online services that were inaccessible to non-members, while implementing flat monthly fees and converting themselves into Internet service providers (ISPs) that provided their home customers with email addresses and Internet access points globally (e.g., AOL).

Table 1: U.S. WWW Users in Millions, 1996-2000

Year	Home	Work	Total
1996	13	15	28
1997	20	20	40
1998	27	30	57
1999	35	45	80
2000*	42	60	102

* estimated
Source: http://www.computerworld.com/home/emmerce.NSF/All/pop

The U.S. had a far greater installed base of computers than any other country; moreover, many were already connected to a network. This can be seen in Table 2 GROWTH OF DOMAIN NAMES, which indicates that there were more domain names registered in the U.S. than in the rest of the world. This massive installed base and the large number of users experienced with computer networks meant that

the adoption of the Internet could advance at breakneck speed. The next section discusses the ways in which the unique U.S. regulatory regime encouraged the development of the data communications market.

Table 2: Growth of Domains in US and the World

	Com, Org, Net and Edu			Country Code Domains	Total	Percent of Total in U.S.
	US	World	% in US			
Jul-98	1,610,689	543,945	74.8%	1,127,483	3,282,117	49.07%
Jan-99	3,003,950	1,033,925	74.4%	1,466,276	5,504,151	54.58%
Jul 99	4,886,550	2,165,800	69.3%	2,045,716	9,098,066	53.71%
Jan-00	6,673,650	3,334,825	66.7%	3,393,973	13,402,448	49.79%
Jul-00	10,120,208	7,294,171	58.1%	6,450,232	23,864,611	42.41%

Source: Adapted from Matthew Zook 2000
http://socrates.berkeley.edu/~zook/domain_names/Domain

Regulatory Preconditions in the Telecommunications Sector

The low-cost and open U.S. telecommunications system was the outcome of a gradual evolution of the U.S. regulatory regime. As important as the contemporary regulatory environment, which is discussed in Chapter YAO, were a series of telecommunications policies that took effect before the birth of the Internet. These policies opened the telephone system to new entrants and accelerated the pace of innovation, encouraging the private sector to increase bandwidth and lower costs. U.S. government policy toward AT&T differed markedly from those of European and Asian governments toward their dominant telephone company. The result was that the U.S. had a more dynamic and open telecommunications system than did most other countries.

In nearly every other OECD nation, the telephone system was a government-operated monopoly, while in the U.S. AT&T was a private corporation regulated by federal and various independent state regulatory commissions. The roots of the U.S. telecommunications environment can be traced to a

marketplace struggle during the first two decades of the twentieth century that ended with the triumph of AT&T and the imposition of regulation. Beginning in 1893, when the central Bell patents expired, and ending about 1920, AT&T engaged in vicious competition with a large number of local (city-based) phone firms. AT&T's strategy was to offer low rates for local calls (i.e., where there was competition), while garnering its profits from the long-distance system that it alone controlled. The result was a brutal price competition, leading to a dramatic decrease in local rates, an increase in telephone penetration and usage,[6] overbuilding of the telephone infrastructure, and rapid adoption of new cost-saving technologies such as the Strowger mechanical switch. AT&T used its long-distance income, the ability to block access to its long-distance lines, and selective purchases of local telephone companies to defeat the locals and unify the entire system under monopoly control (Lipartito 1997). In the process of this competition, a flat-rate price for local calls and "universal service" became an accepted norm and was enshrined in the U.S. regulatory structure.[7] This arrangement was stable for the next 50 years, despite the fact that telecommunications technology continually improved. The flat rate for local calls would become an important factor in the adoption of online services and Internet penetration into the home.

With AT&T's triumph, the U.S. system now outwardly resembled the government-owned European situation, i.e., one entity controlled nearly the entire U.S. telephone system.[8] In most European countries, the government post office and telegraph monopolies quickly asserted control of the telephone system, and the cutthroat competition phase never occurred, so market penetration was retarded and there was no consideration of flat-rate local call pricing. Technology adoption also lagged, and service was the best an entrenched bureaucracy decided to deliver.[9] Moreover, the telephone service became a government revenue source and employer, so any deregulatory moves had budgetary and employment

[6] In 1900, there was one telephone per 60 Americans, one for every 115 Swedes, and one for every 1,216 Frenchmen (de Sola Pool 1977: 30).
[7] The term "universal service," when first coined by Theodore Vail, did not refer to every American having access to a telephone. It referred to the ability for anyone having an AT&T-provided phone being able to contact any other phone in the system (Dordick 1990: 230).
[8] In rural areas and some towns, independents survived and had interconnection agreements with AT&T.
[9] Few would argue that AT&T service was the best possible, but most would agree that in the 1950s and 1960s it was superior to service in other countries.

implications. Thus a different user profile, regulatory regime, and market structure distinguished the U.S. from other countries.

In the mid-1950s, AT&T owned and operated the entire phone system from the consumer handsets to the network – it was a classic case of vertical integration. The U.S. government had no vested interest in the system, however, and it was committed to encouraging competition. The opening of the AT&T monopoly to competition can be understood as a disintegration of telecommunications into the following independent market layers (Moore 1996):

1. Terminal equipment (e.g., phone-sets, extension cables, and switches).
2. Long-distance services (e.g., MCI and Sprint).
3. The local loop.
4. Encoding mechanisms (e.g., modems/multiplexing/protocols).
5. Value-added services (e.g., Tymnet, Telnet, and the Internet).

Each layer gradually was opened to competition. In parallel to this, though not directly related, was an inexorable increase in the volume of data versus voice transmission through telecommunications pipelines. Roberts (2001) estimated in August 2000 that the data transmitted the Internet protocol surpassed all other telecommunications combined. AT&T's near monopoly in the voice area forced new entrants to focus on the data transmission market – a fortuitous decision, as data transmission grew exponentially, while voice transmission grew incrementally.

The first move toward opening the telephone network was the 1956 Hush-a-Phone decision by the U.S. Court of Appeals, which permitted mechanical devices such as receivers to be connected to the network. The 1968 Federal Communications Commission (FCC) Carterphone ruling allowed the Carter Electronic Corporation to connect its mobile radio system to the AT&T telephone network. Thus the first liberalization occurred at the edge of the network, and created a market for telephones and subsequently for telephone answering devices, fax machines, and computer modems.

The next step in deregulation occurred in the area of transmission. In 1969 MCI received FCC permission to establish microwave service between St. Louis and Chicago. This permission was soon

extended to other markets, which enabled large long-distance users to bypass the AT&T network and extended competition closer to the center of the network. MCI and other specialized carriers soon undercut AT&T on the most lucrative routes, while AT&T's long-distance service was hobbled by its commitment and the regulatory requirement to serve less lucrative routes and provide highly regulated local service.[10] Moreover, the new entrants installed the newest and most up-to-date (and non-AT&T) equipment, thus providing a market for other equipment suppliers. Most important, though not recognized at the time, were FCC decisions separating data from voice communications, thereby permitting new entrants to specialize in data communications.[11]

The 1974 challenge from MCI to AT&T's right to maintain a monopoly over long-distance service set in motion antitrust proceedings against AT&T. These were settled in 1982, with the consent decree stipulating the conditions for the dismemberment of AT&T: long distance was separated from local phone service, and the six regional operating companies were created. Retaining the long-distance profit center appeared a brilliant decision; little did AT&T suspect that long distance would become a commodity, and that "ownership" of the consumer would become a critical control nexus.

This gradual deregulation of the AT&T monopoly was driven by a desire to accelerate competition and innovation. It would be tempting to attribute the process entirely to far-sighted government regulators and legislators, but it was entrepreneurs who pressed for deregulation, which, to their credit, government regulators and the courts did not strongly resist. The relationship of the U.S. government to the dominant telephone vendor made deregulation much easier and more gradual. This progressive deregulation allowed new firms to emerge in every aspect of telecommunications. Repeatedly, the new entrants ignited cutthroat competition, rapidly decreasing costs and/or increasing

[10] The value of the local loop would only come in the late 1990s, when the Regional Bell Operating Companies would benefit from their control of the customer.

[11], For AT&T, losing data communications did not appear serious in the 1970s, as it was such a small market. In fact, AT&T was uninterested in packet-switched data communications when it was first proposed. The result was that AT&T did not have the dominant role in the Internet data transmission business, and its equipment subsidiary, Western Electric, that became Lucent, fell behind in the data transmission equipment business (Hafner and Lyon 1996: 63-66).

functionality. The outcome of this gradual deregulation was a low-cost, relatively open market for telecommunications services.

The relatively open U.S. telecommunications market and the rapidly changing technologies created many new market opportunities. However, the conversion of opportunities into new firms required entrepreneurs, an encouraging environment, and a capital market willing to support these new ventures. In the decades since World War II, a set of institutions evolved in the U.S. that were centered on venture capital, which profits from converting such opportunities into successful firms.

Venture Capital – A Critical Component of the U.S. Innovation System

Venture capital was an institution largely confined to the U.S. until the mid-1980s, when Israel also developed a venture capital industry. The U.S. commercialization of the Internet cannot be understood without reference to venture capital and the complex of institutions for supporting entrepreneurship that have evolved with it. As we shall see, the largest concentration of firms commercializing the Internet are in the San Francisco Bay Area, which is also the center of the world's venture capital industry (Kenney and Florida 2000). Simply put, the willingness of venture capitalists to fund Internet startups was responsible for the U.S. pattern whereby startups rapidly commercialized the Internet.

The first venture capital firms were established after World War II with the express purpose of assisting in and profiting from the foundation and growth of entrepreneurial firms. During the following decades, venture capital gradually became a more formal institution, as the venture capitalists profited from and concentrated on investing in high technology, where they funded many of the defining firms of the late twentieth century. The rapidity of the increase is amazing -- total venture capital investments increased from $45 million in 1969 to $103 billion in 1999, with a dramatic increase in the last five years from $6 billion in 1995 (NVCA 2000b).

As the venture capital industry evolved in regions such as Silicon Valley and Route 128, there was also a co-evolution of a plethora of other organizations including law firms, accountants, employment

agencies, executive search firms, and investment banks; all of these services specialized in accelerating the growth of small firms (Kenney and von Burg 1999; Bahrami and Evans 2000). This ecosystem of organizations operates to lower entry barriers and accelerate a new firm's growth, thereby decreasing what Stinchcombe (1965) termed the "liability of newness." Curiously, for the constituents of the ecosystem, newness is not entirely a liability – it is also a desired attribute. Under normal conditions, usually the greatest single entry barrier for any fledgling firm is the lack of capital. Venture capital is the primary accelerant because it eliminates the need for new firms to grow slowly out of retained earnings and frees the founding team from a continual, time-consuming search for capital. The law firms are able to advise their small-firm clients on how best to structure their business, bargain with the venture capitalists, handle intellectual property issues, and assist with myriad other details necessary to establish a firm (Suchman 2000). Furthermore, there are a wide variety of consultants and firms capable of undertaking many corporate functions, allowing the small firm to postpone expenditures it otherwise would have to make immediately upon constitution, thereby freeing it to concentrate on product development and market introduction.

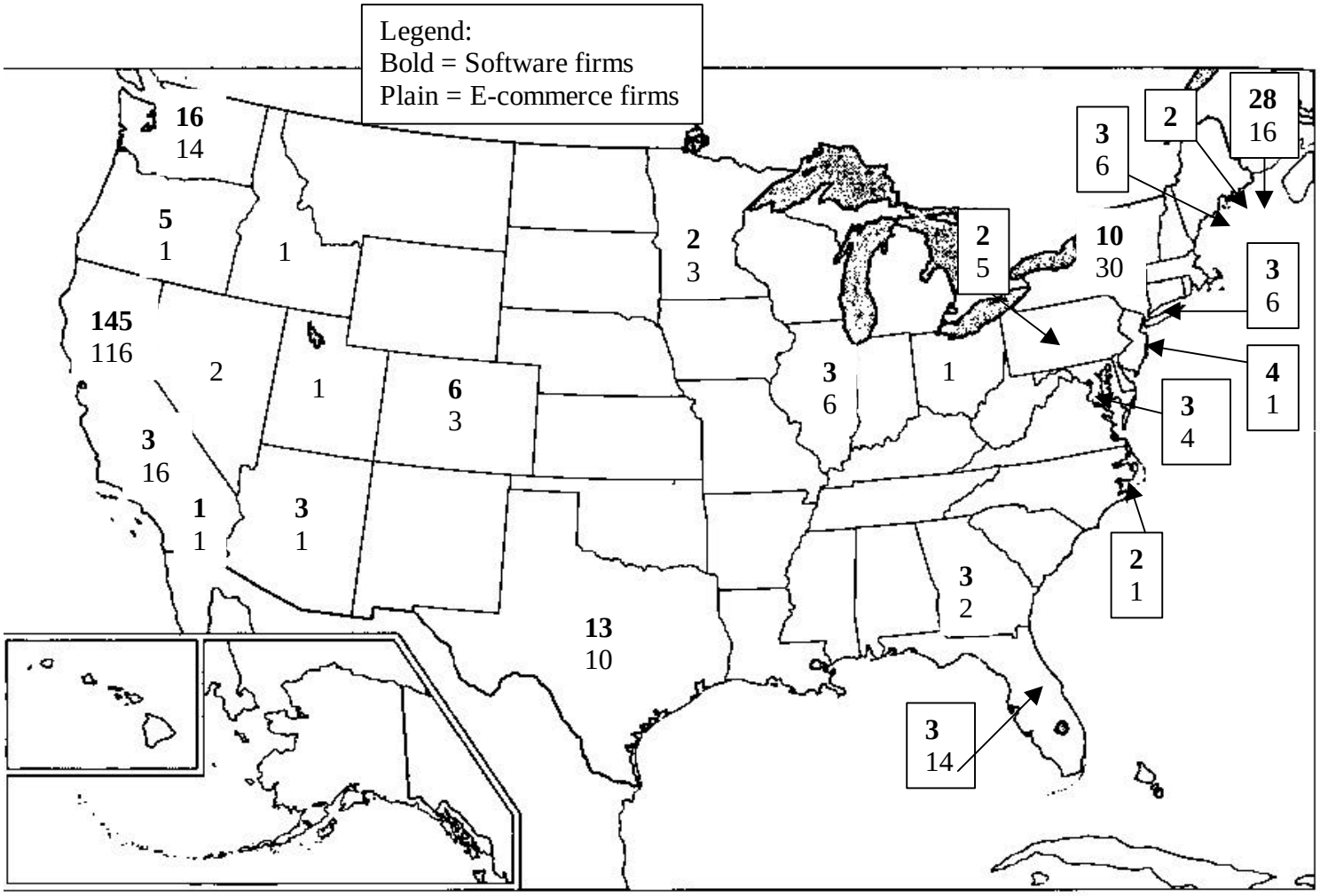
Another critical institution for this innovation system was the NASDAQ stock exchange, which gradually evolved to specialize in raising capital for fast-growing young firms as well as providing an exit strategy for the investors and entrepreneurs. It would be on the NASDAQ that the Internet stock bubble would be most pronounced and, after March 2000, where the decline in Internet stocks was the greatest.

In Silicon Valley, but also in other high-technology regions, entrepreneurs began establishing firms even before the Internet was officially privatized. Figure 1 MAP INTERNET STARTUPS shows that as of January 1999, Silicon Valley had many more significant Internet startups than any other U.S. region.[12] This is not surprising because the individuals making up Silicon Valley's institutions are constantly searching for new opportunities, and they were already active in data communications. The

[12] The definition of a "significant" startup was a firm that either had gone public or received funding from the top 20 venture capital firms. Thus the map is not exhaustive or necessarily complete; it is only illustrative.

potential of the Internet quickly attracted their interest, and the funding extended by venture capitalists provided the financial wherewithal for these startups to grow very rapidly.

Figure 1: Significant Venture Capital-funded Internet Startups as of January 1999*



* Compiled from initial public offerings and investments by first-tier venture capitalists. This likely overestimates Silicon Valley firms. However, it is indicative of where the main firm concentrations are and the regions with greater technology or e-commerce emphasis. Most important, Silicon Valley indicates high concentrations of both.

Source: Author's own compilation

The University – an Important Initial Repository of Capabilities

At the dawn of commercialization of the Internet, the single largest concentration of users (i.e., expertise) was to be found among university faculty, particularly computer science faculty, and their students . In the initial commercialization phase, students were as important or more important than faculty. Given this expertise, it is not surprising that universities were the source of several early startups. Firms tracing their origins to university computer science departments include the three major portals, Yahoo!, Excite, and Lycos, and the first important commercial browser firm, Netscape. Two of the most-used search engine firms, Inktomi and Google, had university roots (UC Berkeley and Stanford, respectively). An MIT faculty member established the Web-caching firm Akamai. The university was not only a source of knowledge and expertise; it was also a source of entrepreneurs.

Computer science students and faculty formed the vanguard, but soon students in other departments, particularly business school students, began launching e-commerce startups. The ensuing "dot.com" fever would make entrepreneurship an important career goal for students and faculty, and many ventures were first conceived and then launched from campus. During 1997-1999, the enthusiasm was infectious. Career goals for MBA students changed from joining an investment bank or consulting firm to establishing or joining a startup. Whether the changed goals are merely a short-term response to the increase of dot.com stock prices, or will persist for the longer term, is not clear. The early commercialization of the Internet was closely linked to the university.

From the Internet to E-commerce

The Internet began as a U.S. Department of Defense project for interlinking defense researchers at various universities and military research establishments (Abbate 1999). The first Internet server was installed at UCLA in September 1969. The next server computer went to the Stanford Research Institute, soon to be followed by servers at UC Santa Barbara and University of Utah. After this initial burst, further nodes proliferated slowly because only research sites funded by the Department of Defense were

allowed to connect to the ARPANet. So, by 1979 there were only 61 servers. On the network, email quickly became the compelling application, and soon other academic research groups clamored for email access. In the mid-1970s, the U.S. Department of Energy (DOE) inaugurated MFENet for its magnetic fusion energy researchers, and then DOE'S high-energy physicists built HEPNet. NASA's space physicists established their own network. In 1981 non-DARPA-funded computer scientists launched CSNET with funding from the National Science Foundation (NSF), and this spread quickly to more than 70 sites (Haffner and Lyon 1996: 244). Contemporaneously, AT&T's dissemination of the UNIX computer operating system spawned USENET, and then in 1981 BITNET was introduced to link academic mainframe computers and it offered a simple email program (Rogers 1998).[13] In 1985 DARPA transferred the ARPANet to the NSF. In an effort to increase usage, the NSFNET was open to all universities with the requirement that they must make a connection "available to all qualified users on campus" (quoted in Leiner et al. 2000). The NSFNET diffused email and file-sharing to the rest of academe, thereby enlarging the installed base and providing students with experience in using the Internet. In 1985, NSF also decreed that all NSF-related sites should use the TCP/IP protocol, and it became the dominant data transmission protocol. In the late 1980s, a lack of interest among AT&T and the other established firms in operating the NSF Internet backbones created market opportunities for startup Internet service providers such as UUNet and PSINet, both of which were funded by venture capitalists.

In March 1991, certain restrictions on commercial use of the NSFNET were loosened, providing an early indication that eventually the Internet would be privatized and opened fully to commercial use. In September 1994, NSF announced its intention to end subsidies for the Internet backbone by May 1995 (Ferguson 1999; Howe 2000). Even as NSF was moving in this direction, a national commercial online service began offering Internet access to its subscribers by opening an email service in July 1992 and then followed with full Internet service in November 1992.

[13] Contemporaneously, several firms introduced various networking technologies, such as DECNet and IBM's SNA, but these were all proprietary.

In 1992, the dominant program for using the Internet was Gopher, which had been written and released by University of Minnesota professors, but graphical browsers based on the WWW specifications would soon displace it. The technological breakthrough that dramatically increased the functionality of the Internet was the development and the 1990 release by Timothy Berners-Lee at the CERN high-energy physics laboratory in Switzerland of the software and specifications that would form the basis of the WWW. In May 1991, the first Web server was introduced at the Stanford Linear Accelerator. By the beginning of 1992 there were 26 servers, and the number began increasing exponentially. Berners-Lee released a Unix browser, but use of the WWW was still confined to a small number of academic and corporate researchers.

In February 1993, Marc Andreessen and Eric Bina, working at the University of Illinois National Center for Supercomputer Applications, wrote the Mosaic Web browser for the Microsoft Windows platform. Their user-friendly graphical browser simplified use of the WWW. Moreover, they made it freely available by posting it on the WWW, and as a result millions of copies were downloaded in a few months. This browser began the process of bringing the commercial potential of the Internet and WWW into focus. Moving to capitalize on the software, the University of Illinois licensed the Mosaic browser technology to the venture capital-funded firm Spyglass, and then later Microsoft. The creation of Mosaic, the connection of commercially operated networks to the old NSF Internet, and the withdrawal of NSF, signaled the end of the precommercialization phase. The rapidity with which the terms "Internet" and "WWW" merged in the public mind is remarkable. For example, the 1994 book The Internet Unleashed contained 62 chapters devoted to various issues surrounding the Internet, but only one chapter was devoted to the WWW and another to Mosaic. The other chapters largely ignored the WWW. In the index, there were 42 headings from Gopher, 25 for Telnet, and only 21 for the WWW (Sams Publishing 1994).

The commercialization of the WWW bears a certain resemblance to the Oklahoma Land Rush memorialized in the 1934 movie Cimmaron (Kenney and Curry 1999).[14] The Web created a new, rich

[14] A salient expression of this was the individuals who rushed to occupy various URLs with no intention of using them. They then offered to sell the URLs. To translate this into the Land Rush metaphor, they "staked a claim" to

interactive experience and a spatial-like feeling for cyberspace. A new universe of fast and inexpensive "virtual" applications promised to allow commercial transactions that would be far less costly and/or more convenient than those in the physical world. Because this new economic space is simply software constructions, there would be enormous opportunities to experiment and create novel applications. Many processes conducted in physical space could be modeled in software and manipulated in cyberspace.

The WWW transmits information not only through sound or words, but also through graphics, thereby creating enormous flexibility and bandwidth. The old adage "a picture is worth a thousand words" applies well. Like a phone conversation, the WWW is interactive: it allows a form of dialogue to occur between the user and the Web site. Because the interaction is digitized, it can be informated (Zuboff 1988). The removal of humans from the interaction means that if the demand for a product or service increases, then the site can be rapidly scaled-up or turned-off. The intense pace of WWW developments is the result of an interaction between the telephone-like speed, the ease of reproduction and transmission, and omniaccessibility (Curry and Kenney 2000). All of this is facilitated by the Internet's ease of use. In combination this made the Internet an attractive medium for commerce.

By early 1993, the technology was ready, and a few existing firms and several startups were experimenting with harnessing the technology to commercial purposes. However, for the most part industry and entrepreneurs were more interested in the implications of interactive television delivered through the cable system. In most respects, the Internet was still a university-driven technology, and for the users it was free. From the perspective of hardheaded businesspersons, the Internet was attractive, but it was difficult to decide whether there was a valid business model for its commercialization. The first significant report to the general public about the commercial implications of the Internet was the December 8, 1993 New York Times article by John Markoff entitled "A Free and Simple Computer Link." Markoff described how firms were putting documentation online, preparing online magazines, and thinking about advertising applications. Online sales were not mentioned.

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an address in cyberspace. One response to this was legislation forbidding “cybersquatting,” a reference to the registration by entrepreneurs of addresses that were trademarks and/or established firms’ names.

E-commerce

The U.S.'s advantages for an early start commercializing the Internet were substantial and multidimensional. Both U.S. startups and established firms moved quickly to establish an Internet presence. The strength of the U.S. firms is best illustrated in Table 3 MEDIA METRIX DIGITAL PROPERTIES, which indicates that Microsoft, Yahoo!, and AOL were the world's leading Internet sites on the basis of unique visitors. The strongest European site is Lycos, which was purchased by the Spanish telecommunications firm, Telefonica. Research on the Internet in Mexico found that many of the most popular "Mexican" e-commerce sites were actually hosted on computers in the U.S. (Curry, Contreras, and Kenney 2001). Thus, to some degree the statistics might understate the centrality of U.S. industry to the Internet. In the following sections we briefly detail the responses of established firms to the Internet. This is followed by four short subsections discussing the actions of the startups and the responses of the established firms in four areas: portals and other miscellaneous sites, business-to-consumer (B-to-C) e-commerce, B-to-B e-commerce, and software tools. One salient feature of these sections is the sheer volume of entrants and rivals in each area and the proliferation of niches within those areas.

Table 3: Media Metrix Global Top 50 Web & Digital Media Properties for October 2000

Rank	Top Web & Digital Media Properties	Unique Visitors (000)
	All Digital Media	**148,089**
1	Microsoft Sites*	90,597
2	Yahoo!*	87,504
3	AOL Network*-Proprietary & WWW	85,186
4	Lycos (Spanish acquired)*	50,144
5	Excite Network*	38,141
6	About The Human Internet*	25,493
7	Go Network*	24,170
8	CNET Networks Digital*	22,818
9	Amazon*	19,760
10	AltaVista Network*	19,756
11	Real.com Network*	17,958
12	NBC Internet Sites*	17,548
13	eBay*	17,330
14	FortuneCity Network*	16,638
15	Time Warner Online*	15,016
16	Ask Jeeves*	14,248
17	Infospace Impressions*	14,202
18	LookSmart*	14,140
19	Sony Online (Japan)*	13,877
20	Nifty Sites (Japan)	10,815

* Aggregated from a variety of sites.
Source: www.mediametrix.com November 2000.

Existing Firms and the Internet

The responses by existing firms varied widely in type and rapidity. At the initial stage of commercialization, full comprehension of the impact of the Internet was not easy. For example, it was only on May 16, 1995, with the release of Bill Gates' memo entitled "The Internet Tidal Wave," that Microsoft demonstrated it grasped the implications of the Internet (Ferguson 1999). Given Microsoft's comparative tardiness, it is no surprise that in the period from 1995 to 1997 most non-technology firms had little appreciation of the possible impacts of the Internet on their businesses.

Among the first established firms to understand the Internet's potential were Silicon Valley firms such as Cisco, Sun Microsystems, and Oracle, all of which had been financed by venture capitalists in the 1980s. Cisco was particularly advantaged: it produced the routers and switches that directed much of the Internet traffic, so it became aware of the Internet's implications almost immediately. Sun, with its roots in the engineering and networking community, also saw the potential, and its servers would become the standard for large Web sites. Sun also introduced the Java programming language. Oracle's database software became the platform upon which most Web sites operated. These firms became critical Internet infrastructure firms.

Other technology firms such as IBM and Hewlett Packard also responded, though they both lagged behind Sun and Oracle. Other firms such as DEC were less successful. In the case of DEC, this is particularly surprising because it was the owner of Altavista, which was one of the most successful early search engines. DEC might have been able to create a successful portal and become a rival to startups such as Yahoo!. A comparison of the rival PC makers Dell and Compaq also illustrates that the Internet did not necessarily lead to commercial advantage. Dell rapidly transferred its build-to-order model to the Internet and was rewarded with lowered costs and increased sales. In contrast, Compaq, dependent as it was upon its retail channels, found it difficult to convert its operations to the Internet. For Dell the Internet was a competitive weapon, while for Compaq the Internet proved to be a difficult media to use effectively (Kenney and Curry 2001). Although the Internet was a benefit for most technology firms, it also created difficulties for firms whose business model could not easily integrate the Internet.

For existing firms, the WWW enabled the provision of new services to their customers. For example, Federal Express first provided a one-way information service that enabled customers to track the location and arrival times of shipments (Lappin 1996; Grant 1997). The positive customer response to this experiment spurred Federal Express to develop yet other Internet services. Based on its experience with the tracking service, an application was developed to permit customers to use the Internet for all their shipping functions. The features now available include scheduling pick-ups and obtaining detailed maps for all their drop-off locations, rate charts, and other information such as international customs

regulations. FedEx also provided free downloadable software capable of automating shipment by allowing the user to create an address book, maintain a shipping history log, and create and print labels (FedEx.com 2001). In other words, FedEx and other package shippers quickly integrated the WWW into their business.

For every FedEx and Dell, there were many established firms that initially were oblivious to the possible impact of the WWW. Whereas FedEx and Dell began integrating the Internet into their operations in 1995, most firms only recognized the possibilities and dangers posed by the Internet in late 1996 and 1997. The store-based retail industry was especially slow in responding, and established Web sites after 1998. Catalog-based firms such as REI, Eddie Bauer, and Land's End moved more rapidly. The response of manufacturers was more variable. For example, Cisco and Intel began online customer service in 1995 and 1996, respectively. From these beginnings, the early adopters gradually deepened the functionality of their site. In 2000, Cisco had online sales of over $12 billion and resolved over 70 percent of its support requests over the Internet (Cisco Systems, Inc. 2000).

The safest generalizations about the established firms is that the more technologically sophisticated they were, the closer they were to computer networking, and the more entrepreneurial they were, the more likely they were to begin experimenting with the Internet and the WWW. However, many established firms were largely oblivious to the Internet's possibilities until startups actually entered their market with the threat of disintermediating them (if they were retail operations) or reorganizing the value chain (if they were manufacturers). Either way the strategic threats from the startups soon forced every established firm to consider the implications of the Internet for their business.

The Startups

The role of startups in the commercialization of the Internet did not begin with the WWW. As mentioned earlier, the Internet data communications firms PSINet and UUNet were funded by venture

capitalists in the late 1980s.[15] It is accurate to say that outside of these firms, there were only a few startups and fewer investments until 1994. This was a function of the time it took for entrepreneurs to comprehend the opportunities that the WWW represented, and the slightly more time for venture capitalists to be convinced that the Internet presented a valuable investment opportunity; however, the lag was not long, particularly in Silicon Valley. By early 1994, venture capitalists began receiving business plans from entrepreneurs with ideas about how to exploit the WWW. Given the greater venture capital resources and large numbers of entrepreneurs, Silicon Valley quickly became the center for Internet startups.

With the release of Mosaic, a few existing small firms and some startups began developing browsers. A few of these were funded by venture capitalists, but most were self-financed. The first major startup to attract venture capital and become a firm dedicated to exploiting the WWW was Netscape. It was established in April 1994 by Jim Clark, an ex-Stanford professor and founder of Silicon Graphics Inc., and Marc Andreessen, a former faculty member of the University of Illinois and leader of the team that created Mosaic. After hiring the others on the Mosaic team, they rewrote Mosaic and rapidly captured the browser market (Cusumano and Yoffie 1998). Netscape went public in August 1995 at a price that gave it a valuation of nearly one billion. This alerted every venture capitalist to the capital gains one might reap in the Internet field. By March 9, 2000, more than 370 self-identified Internet firms had gone public and their total valuation was $1.5 trillion, though they had only $40 billion in sales (Perkins 2000).

As the number of users grew rapidly and new business ideas proliferated, the Internet became an economic space that continually expanded, providing yet further commercial opportunities. The greater the number of users, the more reason there was to create Web pages, which meant there was more content. The result was a virtuous circle of increasing returns. This provided opportunities for still other startups to develop new software and Web-based services. There was an explosion of software tools

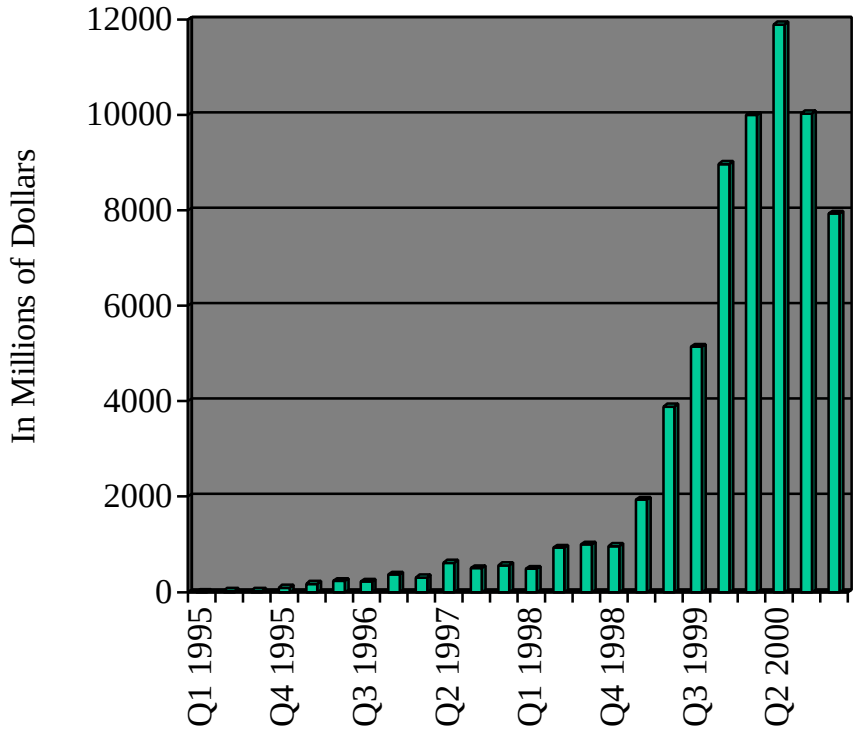
[15] Venture capitalists had funded AOL in the 1980s as an online service; at the time its operations were unrelated to the Internet.

firms, Web-hosting services, etc. For example, businesses could be built on searching and cataloging the other sites. The earliest examples of these catalogues and search engines were created in universities, but they were soon transformed into for-profit firms, such as Yahoo!, Excite, and Lycos. Each success attracted still more entrepreneurs experimenting with other business models.

The chaotic but rapidly growing user base, reinforced by the high valuations that Internet-related startups commanded in the stock market, unleashed a frenzy of venture investing. Naturally, this willingness to fund experiments encouraged ever greater experimentation. Moreover, during the stock market boom, all of these experiments could be listed on the stock market for massive capital gains. One example of a failure was "push" technology, which enabled WWW content providers to automatically send information to users. In 1997 pundits hailed push as a killer application, but by 1999 it became clear that it was only a niche market, at best. Venture capitalists had funded many firms to exploit push technology, but there was only a limited market, and the firms either limped along, were acquired, or ceased operations.

Despite the scattered failures, overall the Internet sector burgeoned and more firms entered the space. The investments in the pioneers returned excellent results as firms went public. From 1995 through March 2000, the willingness of public markets to purchase the shares of newly formed Internet firms fluctuated, but in general the market was very positive and small firms were able to raise large amounts of capital. For example, eBay went public at a split-adjusted price of $7.64 per share in September 1999 and rose as high as $121 per share before falling to about $45 per share in February 2001. This illustrates how by mid-1999 there was what might be termed a full-scale investment panic as public investors drove the price of new issues skyward. As a result, some venture capital funds reported annualized returns of one hundred percent or greater. In 1999, the **average** return for early stage funds was 91.2 percent, the highest in history (NVCA 2000a).[16] As FIGURE 2 INTERNET-RELATED VENTURE CAPITAL BY QUARTER indicates, the amount of venture capital invested in Internet-related firms grew from a nearly negligible $12 million in the first quarter of 1995 to nearly $49 billion in

Figure 2: Internet-related Investments by Venture Capitalists by Quarter, 1995 – Q4, 2000



the fourth quarter of 1999 (NVCA 2000b). In percentage terms, the increase was equally dramatic, growing from a negligible percentage in 1995 to over 60 percent of total investment in the fourth quarter of 1999.

In this bubble, massive sums were committed to multiple firms intent on entering the same business segment, even when it was likely that only one firm could survive. However, if these investments are thought of as being experiments, it means that the U.S. launched an enormous number of experiments. This large number, even if accompanied by foolishness and even stupidity, increased the probability of having made a correct investment; indeed, some of the startups have become global leaders. As important, this feverish investment alerted established firms to the potential of the WWW and forced

[16] The three-year compounded average annual return was a more modest 47.9 percent!

them to react. In effect, these investments both created new firms and changed the environmental conditions for established firms. Finally, the concentration of these firms in Silicon Valley meant that they were able to benefit from the knowledge gained from previous startup attempts and from access to advanced users providing insight into other opportunities to create new firms (von Hippel 1988).

An intense emphasis on speed is a central attribute of the U.S. venture capital-driven commercialization process. Speed is vital because usually there are other startups seeking to occupy the same space, and because it is necessary to reach critical mass before larger established firms enter the market. The fuel for this growth is sufficient capital and the ability to offer new employees equity that might quickly appreciate in value. Combined with the head start, this emphasis on rapid execution meant that the U.S. would repeatedly have the earliest and then the largest firms in nearly every Internet segment. Moreover, since a number of these sectors exhibit winner-take-all characteristics, the earliest entrants to grow to substantial size often acquire an insurmountable first-mover advantage.

The genesis of the Internet in the U.S., the large number of U.S. and English-language users, and the preponderance of English-language content were all advantages for U.S. firms establishing Internet firms. U.S. firms quickly established dominance in English-language Web sites, and foreign Web sites had to cede their own national English-language market. Moreover, soon they were faced with established U.S. firms trying to capture their local language market.

The success of U.S. firms in other countries was not assured, however, for a variety of reasons. Customization for a local market was not so simple. Different cultures might appreciate different layouts, designs, and logics. Beyond this are the individual national idiosyncrasies and legal regimes. Thus the English-language Yahoo! auction site was sued in French courts for allowing Nazi paraphernalia to be offered to the French. The technology opens the world to the user, but national governments continue to enforce their local laws. Examples such as the Yahoo! case indicate that the emergence of dominant global players is not a foregone conclusion.

The transformation of cyberspace into an economic space was characterized by a construction process in which commercial entities were formed at various levels.[17] The uppermost level is the location of actual sites, such as Amazon, Yahoo!, Chemdex, and eBay, which the user visits. At this level, the diversity of sites is almost infinite. The level below encompasses the various software toolmakers and services. At this level, there are established firms, such as IBM, Oracle, and SAP, and also a large number of startups, such as Viant, Scient, Ariba, CommerceOne, and Microstrategy, to name only a few. The firms at the next level provide services much closer to the network, including Web-hosting firms such as Exodus and those providing network software such as Inktomi and Akamai. At the infrastructural level are the firms actually owning the data pipelines of all types. Then there are the firms providing the infrastructure equipment including routers, fiber optics-related components, DSL equipment, cable modems, etc. In the infrastructure sector both established firms and startups competed, and in most of these areas the competition was between established U.S. firms such as Cisco, Lucent, and 3Com; established non-U.S. firms such as Ericsson (Sweden), Nortel (Canada), Alcatel (France), Siemens (Germany), and NEC (Japan); and many startups. In other words, at every level U.S. startups became competitors, most of them funded by venture capital and the majority of them located in California.

Deciding the boundaries for a discussion of the Internet is complicated indeed. In fact, when Hunt and Aldrich (1998) described the organizational ecology of the Internet, they included firms ranging from AT&T to the newest startup. For the purposes of this paper such a definition would be too inclusive. Therefore, my discussion concentrates upon only two levels: the Web sites and the software and services directly related to creating and delivering those sites. To accomplish this, the sites are parsed into general commercial Web sites and software and services. Among the general Web sites, two genres, the B-to-C and B-to-B sites, are described in separate subsections. This division is somewhat artificial, but given the number of sites and the proliferation of activities on the Web, it provides a certain order and structure.

[17] The richness of this economic space is based on a small number of universally agreed-upon open protocols. The most important are HTML, HTTP, TCP/IP, etc. A metaphor for this is the richness of life being based on the DNA

Portals, Communities, Auctions, and More

The sheer diversity of WWW-based commercial activities is remarkable. Many of these businesses simply would not exist if it were not for the WWW. For example, portals and search engines such as Yahoo!, Excite (now part of Excite@home), and Google are only possible because of the WWW. It is impossible to even categorize all the experiments in creating new businesses that the Internet has sparked. One way to think about this is that a cyberspace is being "settled" and people are building economic activities in the space. Some of these activities are directly analogous to those in physical space, i.e., B-to-C and B-to-B commerce (discussed below), but others are unique to cyberspace.

Portals are important because they have established themselves as central destinations for Web users. The dominant portals were established during the earliest days of commercialization. Due to the U.S. head start, nearly all of the dominant global portals such as Yahoo!, Excite, Altavista, and Infoseek were U.S.-based.[18] These U.S. portals have successfully penetrated foreign markets. In November 2000, Yahoo! operated 23 overseas properties (Yahoo's term). In the most important markets, such as France, Germany, the United Kingdom, and Japan, Yahoo! is either the first or second most-visited site. In France and Germany, it is second only to the sites established by the dominant telecom providers, Deutsche Telecom and France Telecom. The strength of the U.S.-based portals is predicated on a number of advantages. The precocity of the U.S. market and its large size meant that the vast preponderance of sites continue to be in English. Not surprisingly, this is an advantage to the U.S. portals, not only in terms of content, but also in terms of an ability to increase content and services that could be distributed over more users. They also had an advantage because they had more technological and marketing experience. Their early growth allowed them to establish global brand names, before other sites could compete in the English-language market. In other countries, indigenous portals were forced to defend their language

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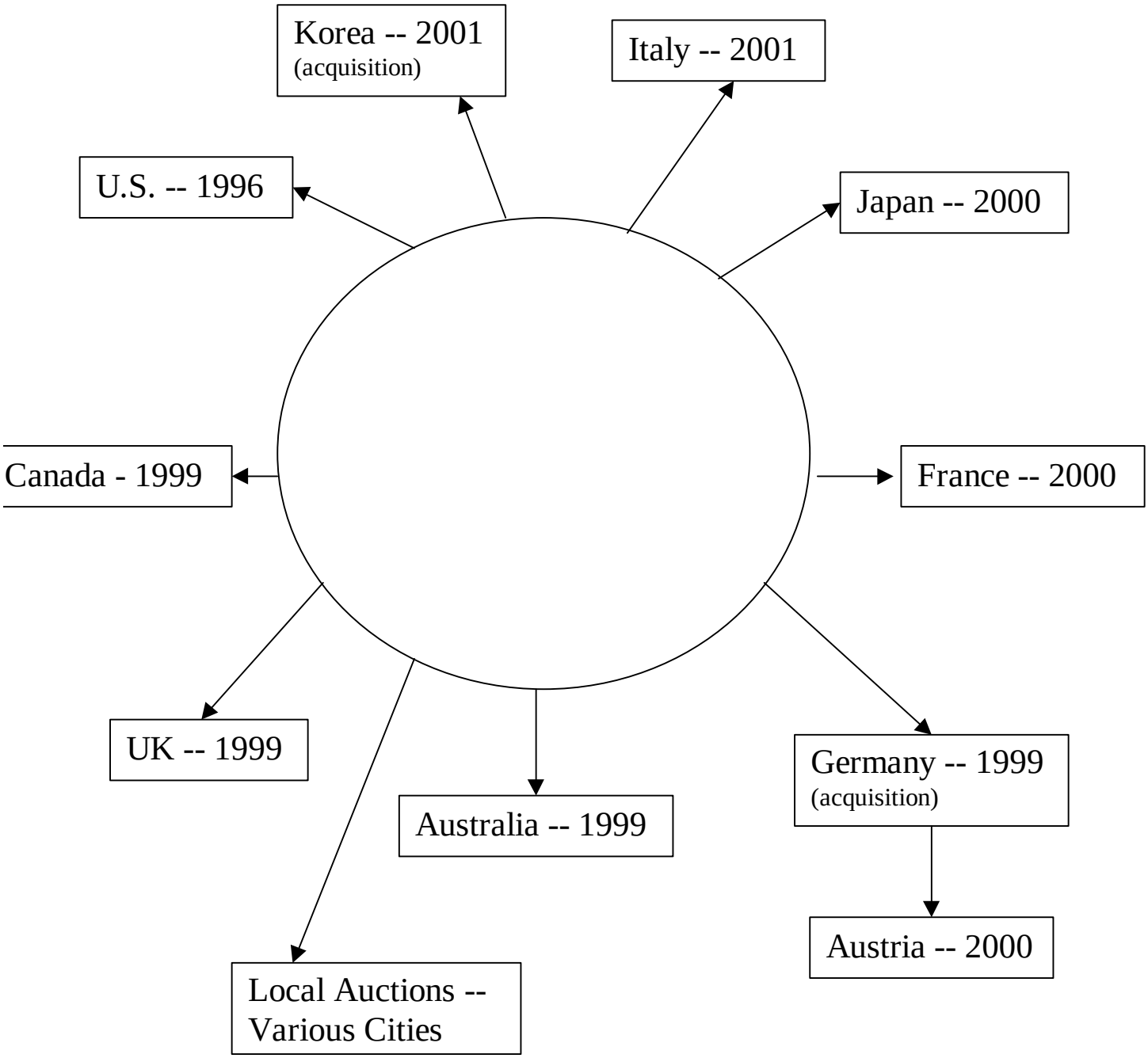
molecule, which operates on the basis of quite simple protocols.

[18] Microsoft and AOL are also leading destinations. AOL is successful because it has its captive audience of AOL subscribers. Microsoft attracts visitors for many reasons; for instance, it is the default option on the Internet Explorer browser, and users need software assistance, etc.

market from the U.S. portals, which had already captured their English-language traffic. However, the U.S. portals also translated their sites into foreign languages, while leveraging their underlying architecture, software, server farms, and technical talent.

Another group of sites are those involved in consumer-to-consumer (C-to-C) e-commerce. This category refers to Web sites that connect consumers. Since C-to-C sites are not based on direct sales, their profits come from other revenue sources such as advertising, commissions, referral fees, etc. The premier example is the auction site eBay. eBay was established in September 1995 and grew rapidly to be the largest C-to-C auction site on the Internet, with revenue of $431 million in 2000 with a profit of $48 million. In 1998, it expanded overseas by establishing a subsidiary in the UK. In June 1999, it purchased Alando.de, the largest C-to-C German auction site. In February 2000, it launched a joint venture with NEC for the Japanese market. eBay claims that it is the leading C-to-C auction site in Australia, Canada, Germany, and the U.K. (FIGURE 3 EBAY GLOBAL AUCTION SITES). It expects to operate in 10 countries by the year-end of 2001 and plans to expand to 25 countries by 2006 (eBay 2001). Whether eBay can successively translate its model for each of these national markets is difficult to predict; however, it now has critical mass, brand awareness, significant technical advantages, and a strong financial base.

Figure 3: eBay's Global Auctions



There are many other examples of C-to-C sites. For example, a number of sites allow users to engage each other in games. There are community sites such as Geocities, which was purchased by Yahoo! for more than $4 billion. Firms such as Napster provide software downloads that allow registered users to trade various digital content such as MP3 files. There are online services that provide notification, registration, and verification through the Internet for meetings. These are only examples of the enormous variety of services created to exploit the Internet.

For students of technology, the development of C-to-C business is fascinating because it did not simply translate existing commerce online; rather, it was a field for experimentation with extremely wide parameters of possibility. Of course, such experimentation was under way in other countries, but there can be little doubt that the U.S. undertook a far greater number of experiments than any other single country.[19]

Business-to-Consumer E-commerce

From late 1995 through late 1998, great attention was focused on the proliferation of startups in the B-to-C sector. These startups meant to replace physical stores (bricks and mortar) with online sales. Put differently, the online operations would disintermediate the traditional retailers, because virtual storefronts on the Internet would substitute for physical storefronts. One idea was to create e-malls, i.e., retail sites that, like physical-world shopping malls, would be where retailers would "locate" their various shops. The proposition was that these B-to-C sites would attract consumers because of the convenience of having a centralized "shopping center" online. This was a flawed vision and these malls failed, though interestingly the portals and other heavily visited sites then set up shopping sites that resembled the mall idea.

The theory underlying B-to-C e-commerce was that the elimination of the costs of stores and sales employees and the use of a more efficient supply chain due to taking customers' orders directly

should allow online retailers to sell at a discount. The proponents of online retailing were predicting nothing short of revolution – there would be a massive shift of purchasing to the Internet. There is precedent for such shifts in retailing. For example, the "category killers" such Wal-Mart, Home Depot, Walden Books, Office Depot, Rite Aid, etc. transformed retailing and thereby devastated both small independent stores and the department stores. The Internet appeared to be an opportunity to galvanize a shift in consumer purchasing habits that could have transformative consequences for retailing.

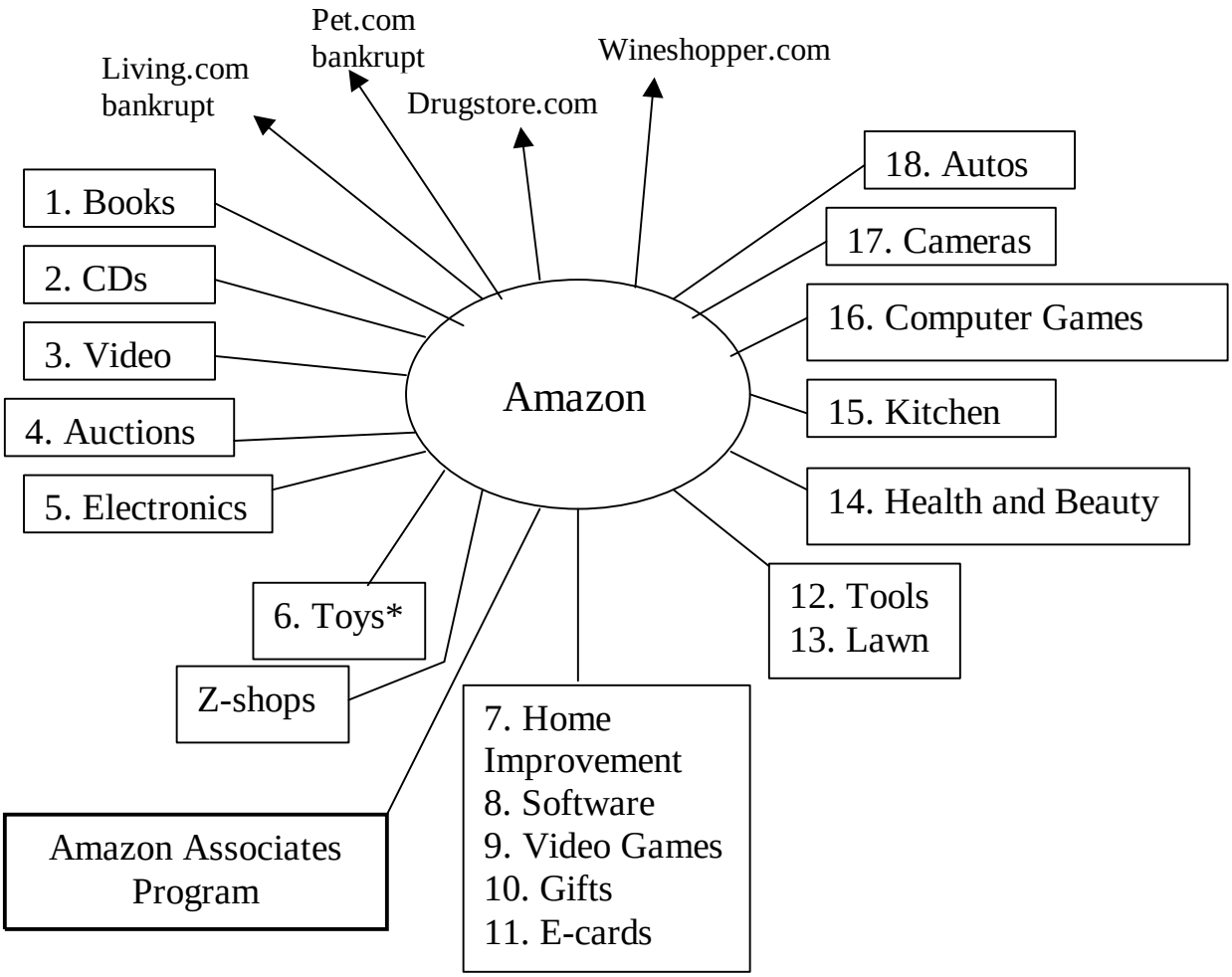
With any new technology there are two ideal-typical possibilities. New entrants displace the existing firms, or the incumbents fend off the threat either by adopting the entrant's model or by reinforcing their own advantages, thereby undercutting the entrant's advantages. In B-to-C e-commerce the incumbents were caught unawares by the startups, which mushroomed seemingly overnight. Moreover, many, but certainly not all, of the early efforts by the incumbents to develop Web-based businesses failed. For example, both Wal-Mart and Levi's created Web sites that proved to be disasters. Retailers that had substantial mail order businesses were generally far more successful in switching to Web-based operations.[20]

In July 1994, only a few months after the establishment of Netscape and Yahoo!, Amazon was established, and its online bookstore opened in July 1995. Amazon's founder, Jeff Bezos, was not particularly attracted to books; rather, he was searching for a retail sector that would be easy to penetrate. Books were chosen because they are an easy-to-ship, undifferentiated product. Moreover, there was an existing set of distributors that could be used for fulfillment. But, most critical, from its inception Amazon aimed to expand from books to other items, with the eventual goal of becoming a multiproduct retailer – in other words, Wal-Mart was the real target (FIGURE 4 Amazon's Growing Empire). As indicated on Figure 4, by 2001 parts of Amazon's empire had gone bankrupt. Even though Amazon consistently lost money, and it did not have the advantage of being the first online bookstore, it was able

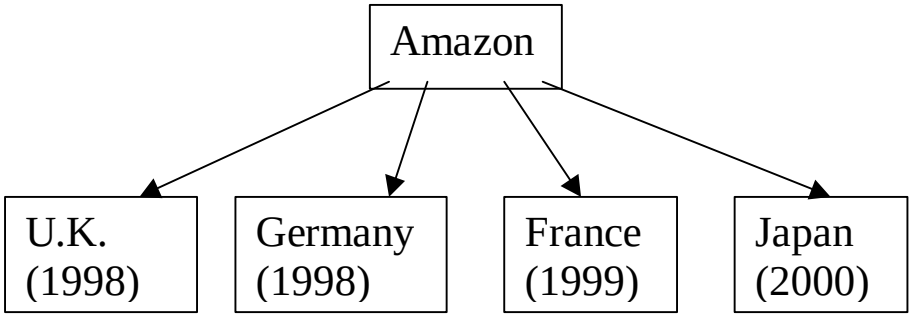
[19] Entrepreneurs and venture capitalists in other countries often simply observed the experiments in the U.S. and then reproduced them in their own countries. This was the case for the German auction site Alando.com and numerous Asian sites. The Japanese firm Softbank adopted this as its strategy for creating Japanese sites.
[20] For Dell see Curry and Kenney (1999).

to grow rapidly because of the venture capital backing it received in June 1996. As of May 2001, Amazon was not yet profitable, but management promised pro forma profitability in the last quarter of 2001.

Figure 4: Amazon's Growing Empire



Amazon's International Operations:



* In 2000 became joint venture with Toys 'R" Us.
Source: Author's compilation from various sources.

The early investments in the B-to-C space by venture capitalists and the successful listing of Amazon on the NASDAQ ignited a frenzy of investment in online retail startups. Very soon there were specialized sites selling groceries, pet supplies, air travel, vitamins, pharmaceutical prescriptions, stocks, CDs, electronics, PCs, home improvement supplies, and nearly every other commonly consumed item. In this investment frenzy often four or five online firms were established in each product category. At times these firms would have different business models, but for the most part they were simply clones. For example, in January 2000 Upside magazine listed six dedicated online cosmetic startups: Eve.com, Gloss.com, Sephora.com, Beauty.com, Beautyscene.com, and Beautyjungle.com (Garner 2000). Similarly, there was a plethora of online toy stores launched by startups and traditional players. However, by the end of 2000, all of them had failed or were consolidated (Table 4 Toy Stores). Many of those that had gone public were by early 2001 in the process of being delisted by the NASDAQ. Even more odd was the proliferation of high-visibility online pet stores that rapidly disappeared taking millions of investor dollars with them. When the IPO boom ended in early 2000, many of these e-retailers still had not gone public and were not profitable. With no exit opportunity, their backers rejected entreaties for more funds, sparking a wave of distress mergers and bankruptcies.

Table 4: The Status of Most Important Online Toy Stores in 2000

Firm	**Status**	**Investors**
Toysmart.com	Closed 2000	Disney
Toytime	Closed 2000	Unavailable
RedRocket.com	Closed 2000	Viacom
KB Kids.com	For sale	Consolidated Stores
EToys	Since going public down 95%	Idealab (public investors)
SmarterKids.com	Since going public down 90%	Venture capitalists (public investors)
Toys "R" Us	Merged website with Amazon	Toys "R" Us
Amazon.com	Merged website with Toys "R" Us	Venture capitalists (public investors)

Sources: Wall Street Journal (2000) and author's research

After establishing a Web site, these e-tailors discovered that simply posting an image of an item online and booking an order did not remove the need to deliver the purchases to the customer. Managing the delivery logistics would be as important as booking a sale. In Christmas 1999, many e-tailers were simply not prepared for the volume of Internet purchases, and their systems were overwhelmed. As a result, many purchases were not delivered in time for Christmas. Finally, the online retailers discovered what offline retailers had always known: predicting demand is one of the most difficult skills in retailing. For example, Amazon discovered that it had purchased the wrong toys and after Christmas had to write-off $35 million in unsold inventory. In response to these problems, in August 2000 Amazon.com came to an arrangement with Toysrus.com in which Toysrus would be responsible for buying and managing the inventory, while Amazon would operate the Web site development, order fulfillment, and customer service for a new joint site. The inventory for both companies would be housed in Amazon's warehouses (Farmer and Junnarkar 2000). In effect, Amazon conceded that it did not have the expertise to predict toy demand effectively, while Toysrus conceded that it was not so successful in interfacing with Internet buyers and handling fulfillment.

Traditional retailers such as Macy’s and Penneys found it difficult to establish online operations. The world's largest retailer, Wal-Mart, launched its first Web site in late 1996, but it generated minimal sales. Simultaneously, Amazon extended its product offerings beyond books and CDs, presaging a possible competitive threat. In 1999, Amazon hired 15 of Wal-Mart’s logistics and retailing executives to strengthen its logistics operations, making the threat more palpable. In January 2000, believing that its own site operating from corporate headquarters in Bentonville, Arkansas, was not successful, Wal-Mart established a joint-venture agreement with a venture capital firm to re-establish walmart.com, with headquarters in Palo Alto. Effectively, Wal-Mart decided that it had to develop an organization entirely separate from its Arkansas headquarters (Waxer 2000). This is not surprising, as selling in the online world was very different from selling from stores.

Without venture capital, there could not have been such a proliferation of B-to-C startups. While creating possible competitors, it also alerted U.S. retailers to the threats and opportunities this new

method of interacting with customers posed. The startups discovered the difficulties of fulfillment, inventory control, and handling of returns. In general, the firms most successful in launching online operations were those that had strong order fulfillment operations already in place. These firms already fulfilled remote orders, so for them it was a matter of switching their incoming order stream from voice and catalog to the Internet.

It is too early to judge the ultimate result of the willingness to risk hundreds of millions of dollars in e-tailing. What is certain, even if most of these investments are lost, is that the U.S. retail system will have been forced to become more efficient than ever. Further, there is the possibility that a number of the startups such as Amazon will survive and create an entirely new channel that has a global reach. Given the estimate that as much as one-quarter of Amazon's sales originate from outside the U.S., Amazon has already become a global brand. As of 2001, there were mixed signals about the ability of U.S. firms to compete globally: firms such as eToys closed their overseas subsidiaries while eBay and others continued to compete globally.

Business-to-Business E-commerce

Only six months to one year after the establishment of the first B-to-C firms, venture capitalists began funding entrepreneurs to establish Web sites aimed at becoming online marketplaces where businesses could buy and sell, i.e., business-to business (B-to-B) sites. The B-to-B market quickly outstripped B-to-C in sales. In Chapter XXX, MacDuffie examines this phenomenon in more detail. Here these sites are examined as the result of the venture capital-led commercialization process. By mid-1998, independent marketplaces had been established for nearly every business imaginable (for a few examples, see Helper and MacDuffie 2001; Kinsey 2001).

A 1999 report by a Robertson Coleman analyst listed 253 separate B-to-B sites (Upin 1999). VerticalNet was one of the first independent B-to-B sites. In October 1995 it established the first vertical trading community, and by November 2000, VerticalNet operated over sixty separate industry sites (VerticalNet 2001). The Plastics Network, which was launched in September 1995, and relaunched in

1999 with funding from Internet Capital Group (ICG), was another early site. In fact, ICG was a publicly listed firm established in 1996 with the express purpose of investing in fledgling B-to-B startups. ICG's investments were an indicator of the growth in interest in B-to-B e-commerce. In 1996 ICG committed only $14 million, and by 1999 this had increased to $572 million. Moreover, it expected to commit in excess of $1 billion in 2000, though this has been dramatically reduced due to the collapse of ICG's stock price. ICG was not alone. Beginning in 1997, there was a rising tide of investment in B-to-B startups (Internet Capital Group.com 2001). For example, Chemdex Corporation was funded by several venture capital funds in September 1997. The receptivity of the public market to B-to-B stock offerings in 1998 and 1999 led to a plethora of new firms funded by both traditional venture capital and the new publicly held venture capital firms such as ICG and CMGI.

The establishment of B-to-B sites was initially uncontested by existing firms and industries. In this respect, the B-to-B marketplace resembled that of the B-to-C sector, because the first movers were startups funded by venture capital. These startups aimed to attract established firms to their sites. This was easiest when there was no dominant firm or set of firms in the value chain. However, if the value chain contained oligopolists, be they suppliers or purchasers, often they exerted significant power over adjacent segments at the least and perhaps even over the entire chain. In such markets, success in moving the chain onto the startup's platform was predicated upon attracting these oligopolists. For the oligopolists there was no compelling reason to join any specific platform. Though the potential efficiencies were substantial and could not be ignored indefinitely, joining a marketplace controlled by another firm would create vulnerability and permit the other firm to reap the benefits.

Hesitant to join marketplaces owned by others, larger firms soon decided to create their own Web sites. The problem was that each oligopolist created his or her own unique site. This reintroduced an inefficiency because it divided the market; i.e., it forced suppliers to adapt to different sites, and thereby limited any efficiency gains. Thus, if the oligopolists all created their own sites, then the threat of a market organized by an independent firm remained. The independent could divide and conquer the market, because the independent could offer incentives, such as a preferential position, equity, or lower

trading costs, to a few oligopolists that were willing to break ranks and join the independent site. Then the late movers would be the losers, because after the site gained momentum they would be compelled to join the site under unfavorable bargaining conditions. The oligopolists responded to this threat by creating consortia to own the platforms they joined. However, in 2001 the largest B-to-B sites are those operated by a focal firm such as Cisco, Dell, IBM, or Intel for their suppliers and/or customers.

In terms of commercialization, the B-to-B space also exhibited characteristics similar to those in the B-to-C area. Entrepreneurs quickly entered the field, and there was a proliferation of sites in each category as venture capitalists funded many "me-too" firms. After a significant lag, the established firms reacted by creating their own Web sites. In contrast to B-to-C e-commerce, in which many established firms have had difficulty appealing to consumers, the power of the oligopolists to coerce their suppliers and customers to use their site could easily lead to an outcome favorable to the incumbents.

Software Tools and Internet Services

The early and rapid development of e-commerce, the large number of leading-edge users, and an already strong position in software provided significant advantages to U.S. firms intent upon developing software tools for Internet users. As von Hippel (1999) pointed out, the needs of cutting-edge users can alert toolmakers to marketable improvements, or what could be termed "learning from lead customers." Further, the needs of customers such as Yahoo!, Amazon, and/or eBay meant that software and services would be severely tested, thereby exposing limitations and problems. The intense competition among the users as they sought technological advantages meant that software innovators had a ready market. A symbiosis between software designers and leading-edge users developed. This created a virtuous circle in which improved tools accelerated the development of the Web sites and vice versa.

For established software firms such as Microsoft, Oracle, and Seibel Systems, the startups were both competitors and potential acquisition targets. U.S. firms quickly grasped the importance of the WWW and rewrote their software to operate on the Internet. In contrast, the German firm SAP did not grasp the movement to the WWW as quickly, and by the time it became conscious of its significance it

had lost ground to aggressive U.S. competitors. In contrast, Oracle rapidly reengineered its database software to be WWW compatible and captured market share from its competitors.

Rationalizing and transferring business processes and B-to-B e-commerce to the Web-based protocols created significant new demand for software, and many startups were funded by venture capitalists to meet this new demand. Venture capital-funded startups such as CommerceOne, Ariba, E.phiphany, and Kana Communications, to name only a few, became global competitors, and very often the U.S. firms (and, most often, these had roots in Silicon Valley) were competing globally against each other. In the Internet services arena, U.S. startups such as Exodus Communications became global leaders in corporate web-hosting. Other firms offered to manage corporate Web sites, email, and a wide variety of other Internet-related functions. Other software firms such as Inktomi and Akamai developed software used for Internet infrastructure.

U.S. firms have occupied nearly every important Internet-related software niche. These firms have rapidly expanded their businesses into other countries, either by establishing offices or using their stock to purchase the much smaller national competitors. Whether American or foreign, most Web sites operate on U.S. software and hardware. Regardless of the outcome of international competition concerning portals or e-commerce, or the different privacy issues and government policies, it will be U.S. software toolmakers and service providers that will become the dominant vendors. Judging from the current situation, there will be fewer significant European and Asian firms. The exception will be if mobile phones become a dominant Internet access device – a dubious proposition.

Regardless of what happens to the e-commerce startups, in the arena of WWW software tools the U.S. firms have important first-mover advantages. Whether the bulk of the sector will be captured by existing firms such as Oracle or Seibel or by the startups such as Ariba and Kana is not as important as the fact that most of the tools will be provided by U.S. firms. This tools industry, which is centered in Silicon Valley, also makes it likely that U.S. firms will be able to benefit from the further evolution of the Internet infrastructure. The one possible exception to this scenario would be if wireless applications were to become dominant, requiring a set of competencies that U.S. firms lack at present.

Conclusion

In summary, the speed with which the U.S. NSI reacted to the commercial possibilities inherent in the Internet was remarkable and, perhaps, unprecedented. In nearly every facet of the Internet, from the infrastructure and equipment to e-commerce, U.S. firms became global leaders with the possible exception of two fields: wireless Internet and optical switching. It would be simplistic to attribute the achievement of such dominance to any single variable; rather, it was the result of a confluence of factors.

The first bundle of factors that favored U.S. industry was the unique political economy of the telecommunications system. Early and gradual (though thoroughgoing) deregulation made the U.S. the leading economy for innovation. In sharp contrast, in most of Europe and Asia the dominant government-owned monopolist (even in 2000) exerted undue influence. The flat-rate tariff structure for local phone calls was remarkably important for the diffusion of online services and the uptake of the Internet in the home market. The macro-level deregulation created a powerful competition that drove bandwidth costs down, encouraging ever-greater use of the telecommunications system and the Internet.

A second bundle of factors involved the willingness of Americans to order remotely. U.S. consumers already had ample experience using their credit cards to purchase through a catalog or over the phone. Thus they were comfortable purchasing from a Web site. Similarly, U.S. firms were already using Electronic Data Interchange (EDI) systems, so they were willing to consider Internet-based trading systems, particularly because they believed such systems would be less expensive and easier to use. Moreover, U.S. firms were under intense price competition from foreign and domestic producers, so the idea of a potentially more convenient, easier to operate, and cost-effective system was attractive. Many leading firms such as Intel, Cisco, and Dell quickly moved to implement Web-based systems because of these advantages.

The third and probably the most unusual bundle of factors centered upon a unique feature of the U.S. economy, the infrastructure centered upon venture capital meant to support high-technology entrepreneurship. Earlier this infrastructure had supported the establishment of critical e-commerce and

Internet infrastructure firms such as Sun Microsystems, Oracle, and Cisco Systems. With the successful public offerings of Netscape, Yahoo!, and Amazon, venture capitalists were eager to fund Internet-related investments of all types. From one perspective, the massive outpouring of capital was spectacularly wasteful, but from another perspective, it created a large number of experiments to be winnowed out by a Darwinian selection process. This infrastructure not only funded these experiments, it also attracted many of the society's best managers and technologists to these startups.

When the preparation of this article began, Internet firms were still the toast of Wall Street, and there was a perception that the venture capital-funded Internet boom was contributing to a fundamental transformation of the economy. In 2001, the situation appeared very different. A powerful shakeout was under way among public and private startups as firms were delisted and venture capitalists refused to provide further support for many of these firms. Undoubtedly, billions of dollars will have disappeared. Nevertheless, the Internet has become an almost taken-for-granted utility. Entrepreneurs and established firms alike are deploying the Internet to reorganize the way commerce is conducted. In retail commerce, it is an important new sales and information channel. For interbusiness commerce in the U.S., it is becoming the accepted medium. An observation made on other technological changes will likely be proven true again: in the short-run the impact was overhyped, but in the long run the change will have much greater impact than anyone imagined.

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