THE DIGITAL SOCIETY

What is the Digital Society?

It is a global society based on a new infrastructure emerging from the convergence of energy, telecommunication, Internet, and electronic commerce. The digital society represents a new era of economics and social experience driven by technological changes that are producing new ways of working, new means of communicating, new goods and services, new transaction processes, and new forms of community.

The digital society is driven mainly by the digital economy—which is enabling commerce in the 21st Century using technology that is microprocessor-based. In recent years the economy of the United States and much of the developed world has performed beyond expectations. Some observers believe that the digital economy, supported by advances in information technology (IT) and the growth of the Internet, made the largest contribution to creating this healthier-than-expected economy. According to U.S. Department of Commerce data, GDP grew an average of 4.32 percent per year between 1996 and 2000, while one element of the digital economy, Internet-based business, grew by 174.5 percent and created 1.2 million jobs alone.

In testimony to Congress, Federal Reserve Board Chairman Alan Greenspan noted that "…our nation has been experiencing a higher growth rate of productivity output per hour worked in recent years. The dramatic improvements in computing power and communication and information technology appear to have been a major force behind this beneficial trend."[1]

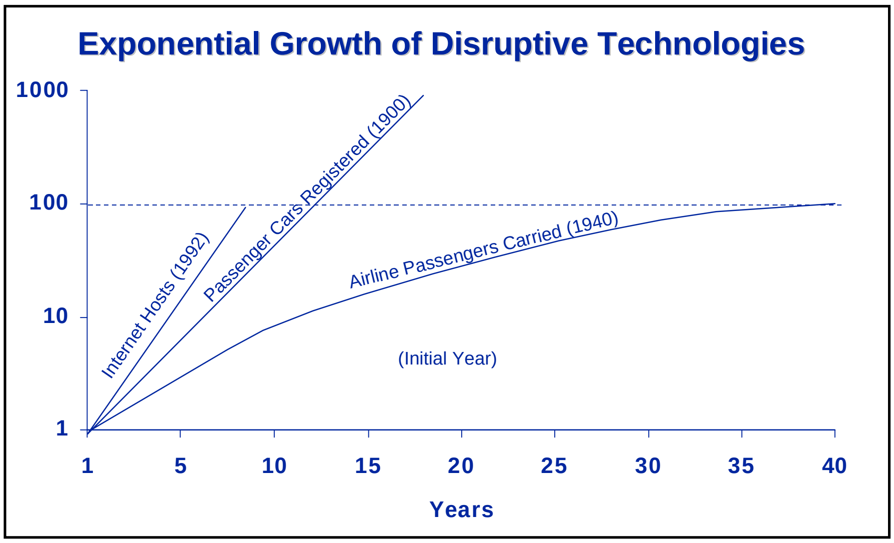
Along with these benefits, the proliferation of power-sensitive digital technology presents serious new challenges to the planners and operators of power systems: how to provide enough electricity to meet increasing demand, and at the high quality and reliability levels needed to serve a microprocessor-based economy.

Driver to Digitization: Transformative Technologies and their Impact on Economy
History provides compelling examples of new technologies driving economic growth and social change. There have only been a few times in a century where "enabling sectors" of technology and the economy emerge that are so profound in their impact that they transform *all other* sectors of the economy. There are typically a few key "disruptive" technologies that underpin these sectors and promote the creation of new economic structures. For example, the steam engine and telegraph transformed the 19th century through the creation of new transportation and communication networks. In the 20th century, electricity transformed every aspect of society by providing more precise and efficient energy, plus practical access to the electromagnetic spectrum (e.g., IR, UV, X-

[1] "Monetary Policy Testimony and Report to the Congress." Testimony of Alan Greenspan, Chairman, Federal Reserve Board. February 24, 1998. Http://www.bog.frb.fed.us/boarddocs/HH/

ray, and microwave). For these reasons, the National Academy of Engineering recently ranked electrification as the greatest engineering achievement of the 20th century.

However, disruptive technologies by themselves cannot fully transform the society without a catalyst. In this case, the catalyst is societal acceptance. Today's society has become more receptive to new technologies. For example, the Internet's pace of adoption eclipses all other technologies that preceded it. Radio was in existence for 38 years before 50 million people tuned in: TV took 13 years to reach 50 million users. Sixteen years after the first PC kit came out, 50 million people were using one.[2] The Internet, once it was opened to the general public, crossed the 50 million line in four years.[3] Together, societal acceptance and the advancement of technologies fuel the exponential growth of disruptive technologies that drive today's digital society.



[2] Meeker, Mary and Pearson, Sharon. *Morgan Stanley U.S. Investment Research: Internet Retail.* Morgan Stanley. May 28, 1997. pp.2-2, 2-6. Notes: Data for TV and other media are U.S. figures. PC figures reflect worldwide users. Morgan Stanley uses the launch of HBO in 1976 as their estimate for the beginning of cable. "Though cable technology was developed in the late 1940's, its initial use was primarily for the improvement of reception in remote areas. It was not until HBO began to distribute its pay-TV movie service via satellite in 1976 that the medium became a distinct content and advertising alternative to broadcast television."

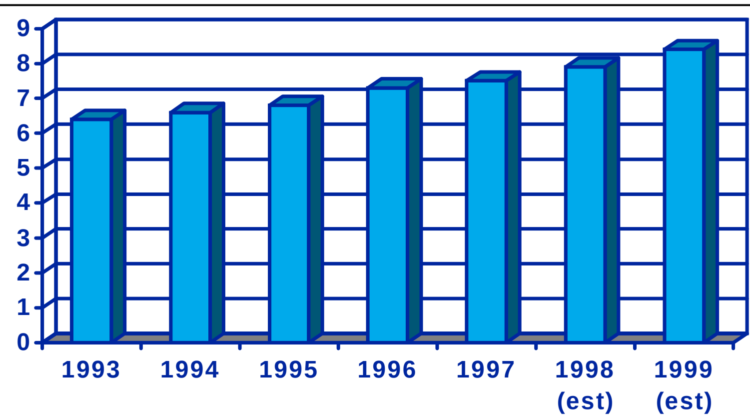
[3] In 1989, the World Wide Web (WWW) protocols for transferring hypertext via the Internet were first used in experimental form at the European Center for Particle Research (CERN) in Switzerland. In 1991, the National Science Foundation lifted the restrictions on the commercial use of the Internet. That same year, the World Wide Web (WWW) was released by CERN. In 1993, the alpha version of Mosaic, the graphical user interface to the WWW, was released, giving non-technical users the ability to navigate the Internet. This report uses 1993 as the date when the Internet became truly open to the public. See: Cerf, Vint. "The Internet Phenomenon." National Science Foundation Web page. Http://www.cise.nsf.gov/general/compsci/net/cerf.html

No exact figures exist on Internet usage worldwide, but different sources point to 1997 as the year when Internet usage approaches/crosses the 50 million mark. For instance, NUA, an Internet consultancy and developer, compiles figures from different research analysts and finds the following ranges of Internet usage: 1995: 8-30 million, 1996: 28-40 million, 1997: >100 million. (Note: some research groups report U.S. figures only. Global figures for 1995 and 1996 were derived from NUA estimates on U.S. Internet usage as a percent of global Internet usage.) http://www.nua.com/surveys/how_many_online/index.html

The digitization of the global economy has proceeded in three phases. First came computers, which revolutionized information processing and fundamentally transformed the way most businesses operate. Next, as the cost of microprocessors plunged, individual silicon chips began to appear in all sorts of applications—from industrial process equipment and medical instrumentation to office machines and home appliances. This embedded-processor phase of digitization has progressed to the point that for every chip in a computer, 30 more are deployed in stand-alone applications.[4]

Now, in phase three, computers and microprocessors are being linked into networks, a trend seen most clearly in the explosive growth of electronic commerce. There are currently more than a million web sites on the Internet, potentially available to some 200 million computers around the world. As a result, Internet-based commerce already represents about 2% of the American gross domestic product, and by the end of next year the revenues from e-commerce are expected to exceed those of the entire U.S. electric power industry.

One of the most notable economic developments in recent years has been the rapid increase in the networked information technology sector's (computing and communications) share of investment activity and of the GDP. It grew from 4.9 percent of the economy in 1985 to 6.1 percent by 1990 as the PC began to penetrate homes and offices. The next spurt started in 1993, with the burst of commercial activity driven by the Internet. From 1993 to 1998, the IT share of the economy will have risen from 6.4 percent to an estimated 8.2 percent. With such rapid expansion, IT's share of total nominal GDP growth has been running almost double its share of the economy, at close to 15 percent.



Source: ESA estimates derived from BEA and Census data for 1993–1996. ESA estimates for 1997–1999 derived using DOC's "Industry and Trade Outlook '99".

IT systems are believed to be exerting a highly leveraged influence on U.S. productivity growth as well. The United States has invested more than $1 trillion in IT equipment in the past 5 years, a period in which U.S. productivity surged after 30 years of subpar growth (about 1% a year). While productivity growth is still highly concentrated in the

[4] Gwennap, Linley. "Birth of a Chip." *BYT*E. December 1996. Network Solutions, Inc. Private communication received February 1998.

information industries, it is expected to continue to spread to other parts of the economy. For example, Fed Chairman Greenspan believes that the efficiency gains of electronic commerce could lead to a drop in overall product inventories of $250 billion to $300 billion a year—a reduction of as much as 40% in the country's inventory levels. A member of EPRI's Advisory Council has even suggested that digital technology advances will create a long-term boom[5] that will take the economy to new heights over the next quarter century.

While the full economic impact of information technology has not been precisely evaluated, its impact is significant. There has been no conclusive study to demonstrate that investments in IT have substantially raised productivity in many non-IT industries.[6] IT industries continue to grow at more than double the rate of the overall economy. Investments in IT now represent over 45 percent of all business equipment investment. Declining prices for IT products have lowered overall inflation.[7]

Driver to Digitization: Getting Connected

The digital revolution is just beginning. Growth could accelerate in the coming years not only in the IT sector itself, but across all sectors of the economy as the number of people connected to the Internet multiplies and as its commercial use grows. In addition to horizontal growth, vertical growth of the Internet is also a formidable force. New applications and technologies that exploit the Internet offers new business or transaction opportunities - in essence, the ingredients that make up the "revolution" in digital revolution. The key drivers to growth of the Internet are as follows:

Building out the Internet**:** Some experts believe that one billion people may be connected to the Internet by 2005.[8] This expansion is driving dramatic increases in computer, software, services and communications investments.

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[5] Schwartz, Peter and Leyden, Peter. "The Long Boom: A History of the Future, 1980-2020." *Wire*d. Issue 5.07. July 1997. Http://www.wired.com/wired/5.07/longboom.html

[6] There is an ongoing debate on IT's contribution to productivity. Some believe that IT has had a positive impact on productivity, yet it does not show up in government data because of inadequate measurement techniques. Others believe that IT has not had a measurable impact on productivity because businesses have not yet reorganized their operations in order to take advantage of information technology. They note that the lag between investments and their full payoff generally takes many years.

[7] The Emerging Digital Economy: U.S. Department of Commerce, 1999

[8] Nicholas Negroponte, founder and director of the MIT Media Lab, estimates that 1 billion people will use the Internet as early as 2000. See: "The Third Shall Be First: The Net leverages latecomers in the developing world." *Wired.* January 1998. In his book, *Digital Econom*y, Don Tapscott cites the New Paradigm Learning Corporation when he estimates that there should be well over 1 billion Internet users by 2000. Others feel that 2000 may be too optimistic, as much of the developing world does not even have a basic telecommunications infrastructure. As new investments in fiber, satellite, wireless and cable are made, more of the world will be connected to the Internet. One billion people on the Internet by 2005 could therefore be possible.

Key Enabling Technologies

One reason for the optimism surrounding the digital society is the remarkable pace of progress in the key enabling technologies.

- **The Microchip.** The computing power of microchips continues to double about every 18 months (Moore's Law),[9] and there is no end in sight. Silicon microchips are now 1 billion times smaller, cheaper and more powerful than their predecessors in 1950. And looking ahead, Nobel prize winner and Lucent VP Arno Penzias foresees that "we can expect a million-fold increase in the power of microprocessors in the next few decades, yielding computers more powerful than today's workstations for about the price of a postage stamp and in postage stamp quantities." Low-end, single function microprocessors are already referred to as "jelly beans" in the trade because they can be produced as easily and cheaply as gumdrops, and will be embedded into every appliance, tool and product. The billions of microchips in operation in the world today will likely grow to trillions within a few decades.
- **Network Dynamics.** A network is made up of two components: nodes and connections. A network's value grows in squared proportion to the number of nodes and their interconnections - specifically, value of the network equals the square of the number of users (Metcalfe's Law). In the case of the digital network such as the Internet, intranets and virtual private networks, the individual nodes – the microprocessors -- are shrinking in size and expanding in power at an exponential rate, while the interconnections – both wired and wireless – are exploding in terms of connectivity, speed, and capacity. The process is now accelerating at such a rate that over the next few decades we will effectively be "connecting everything to everything."
- **Internet.** Starting from scratch in the early 1990s, there are now an estimated 300 million users of the Internet, most of them concentrated in the high-tech regions of the world. But global Internet traffic is doubling about every 3 months. As a result, by 2025, more than 3 billion people (nearly half the planet), are expected to be communicating and doing business via the web. [10]
- **Broad-Band Communications.** The capability for interconnection and communication among microprocessors and computers is growing at least as fast, if not faster, than computing power itself. The total bandwidth[11] of communications systems is expected to triple every 12 months (Gilder's Law). While voice traffic in the world was 1000 times greater than data traffic in 1998, it is expected to be only 1/10th that of global data traffic by 2005. Some analysts are predicting that by 2008, 2/3 of all U.S. households will have high-speed data capacity.

Where advances in telecommunications and computing largely occurred side-by-side in the past, today, they converge in the Internet. Soon, virtually all information technology investment will be part of interlinked communications systems, whether internal to a business, between businesses, between individuals and businesses, or between individuals.

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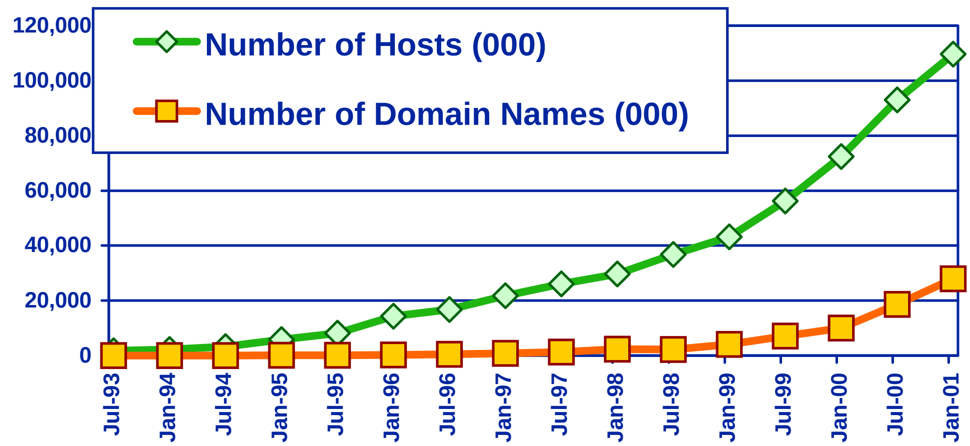
[9] Moore, Gordon. "The Continuing Silicon Technology Evolution inside the PC Platform." Intel archives. http://www.intel.com/update/archive/issue2/feature.htm

[10] Inktomi Corporation White Paper. 1997. Paper cites data from UUNET, one of the largest Internet backbone providers. Traffic is measured as the total amount of information - - bits - - going across the network.

[11] Bandwidth determines the speed at which data can flow through computer and communications systems without interference. In the early days of the Internet, most messages were simple text that did not require large amounts of bandwidth. Bandwidth requirements have increased as people began to send images, sound, software, video and voice over the Internet.

The number of names registered in the domain name system grew from 26,000 in July 1993 to 1.3 million in four years. The number of hosts connected to the Internet has skyrocketed. [12]



* Internet host refers to a computer that is connected to the Internet that has a unique Internet Protocol (IP) address. A domain name represents a record within the Domain Name System.

Source:The Internet Software Consortium, http://www.isc.org, and Matthew Zook, UC Berkeley, http://socrates.berkeley.edu/~zook/domain_names/Domains/counts.html

Making the Internet Faster and More Accessible: Households usually connect to the Internet through a PC and a telephone line. Since less than half of U.S. households have PCs, most households do not have Internet access.[13] It also means that most Internet connections from the home are probably slow.[14] It takes 46 minutes to download a 3.5-minute video using a 28.8 kbps (thousand bits per second) modem, the modem most commonly used by households today.

Telephone companies, satellite companies, cable service providers and others are working to create faster Internet connections and expand access to the Internet. New technologies such as DSL (Asynchronous Digital Subscriber Line) enable copper

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[12] NetNames Statistics 12/28/1999

[13] Consumer Electronics Manufacturers Association (CEMA). “U.S. Consumer Electronics Industry Today.” June 1997. pp. 50-52. CEMA reports that 40 percent of U.S. households own PCs. A more recent analysis by IDC/Link estimates that the penetration rate has now reached 43 percent.

[14] While high-speed optical fiber lines are used for long-distance communications, most U.S. homes connect to these lines via lower-bandwidth copper wire. Integrated Services Digital Network (ISDN) connections have become widely available to households and businesses, but a very small percentage of Internet subscribers use them.

telephone lines to send data at speeds up to 8 million bits per second (mbps). At this speed, that same 3.5-minute video takes 10 seconds to download.[15]

PC manufacturers and software developers are also taking steps to make home computers cheaper[16] and faster as well. Some PCs can now be purchased for less than $1,000. New network computers are expected to be introduced at prices of a few hundred dollars. As semiconductor chips become faster and cheaper exponentially, surpassing even Moore's Law predictions, computers are operating at speeds not seen imagined a few years ago. At the same time, new and enhanced software programs will make the PC and the Internet easier to use and thereby able to reach a broader community of consumers.

Soon, many Americans may be using their televisions to access the Internet. Available in nearly every household, TVs are easy to operate and require little or no maintenance. Digital broadcasting services (high-definition television, or HDTV) are now available in some markets, and broadcasters are expected to make the transition to digital broadcasting by 2006.[17] With digital broadcasting, TV viewers will be able to interact with their televisions and surf the Web, pay bills, plan a trip, or make hotel reservations. Already, satellite dishes and signals carried over cable television lines enable consumers to receive data from the Internet through their TVs and television through their personal computers. At speeds of 10 million bits per second, a household connected to the Internet via a cable modem can download a 3.5-minute video in 8 seconds.[18] In most cases today, however, the outgoing communication (the speed at which the Internet receives the commands by the user) is still limited to the fastest modem speeds that copper telephone wires will support.

E-Commerce: Businesses in virtually every sector of the economy are using the Internet to cut the cost of purchasing, manage supplier relationships, streamline logistics and inventory, plan production, and reach new and existing customers more effectively. They are motivated by the need to increase consumer choice and improve consumer convenience. On the next level, businesses are increasingly using the Internet to offer e-collaboration with their customers in order to create the exact products needed, thus reducing wastes in materials and time.

The Internet makes electronic commerce affordable to even the smallest home office. Companies of all sizes can now communicate with each other electronically, through the

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[15] Federal Communications Commission (FCC). “Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming.” CS Docket No. 96-496. January 2, 1997. pp.58-59. Http://www.fcc.gov/Bureaus/Cable/Reports/fcc97423.html

[16] From January 1997 to January 1998, the average selling price of a home PC dropped 30 percent, to $1,169. By Christmas 1998, analysts expect top PC makers to offer $600 machines. At this price, analysts predict that PCs could find their way into 60 percent of U.S. homes by 2002. Source: Burrows, Peter et al. “Cheap PC’s.” *Business Week*, March 23, 1998.

[17] Shankar, Bhawani. “Digital TV on home run.” *Telecommunications*. December 1997.

[18] FCC, CS Docket No. 96-496, 1997, p.58. Because access to the cable network is shared, speeds may be overstated.

public Internet, networks for company-use only (intranets) or for use by a company and its business partners (extranets), and private value-added networks.

With the proliferation of PCs and Internet access, increasing demands on leisure time and the improvement of overnight and second-day delivery services that spurred the growth of catalog shopping in the 1980s and 1990s, more consumers are migrating to online channels to make purchases[19], especially for products such as electronics, books, and music. However, despite the hype, retail e-commerce or B2C e-commerce make up of only less then 1 percent ($15 billion) of all retail sales activities and less then 10 percent of all e-commerce activities in the U.S. in 1999.[20] Compared to B2B e-commerce, which Forrester Research predicts will hit $1.3 trillion by 2003, retail e-commerce is predicted to reach $80 billion by 2002 - nonethless, still a five-fold increase from $15 billion.[21]

Digital delivery of goods and services: Software programs, newspapers, and music CDs no longer need to be packaged and delivered to stores, homes or news kiosks. They can be delivered electronically over the Internet. Airline tickets and securities transactions over the Internet already occur in large numbers. Other industries such as consulting services, entertainment, banking and insurance, education and health care face some hurdles but are also beginning to use the Internet to change the way they do business. Over time, the sale and transmission of goods and services electronically is likely to be the largest and most visible driver of the new digital economy.

Software, CDs, magazine articles, news broadcasts, stocks, airline tickets and insurance policies are all intangible goods whose value does not rely on a physical form. Much of today's intellectual property is produced, packaged, stored somewhere and then physically delivered to its final destination. The technology exists (or soon will exist) to transfer the content of these products in digital form over the Internet.[22]

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[19] CommerceNet/Nielsen. *Internet Demographic Study*. CommerceNet/Nielsen. Vol. 1 & 2. Spring 1997. The Fall 1997 statistics were provided by CommerceNet/Nielsen representatives. See also: CommerceNet. "Electronic Commerce on the Rise According to CommerceNet/Nielsen Media Research Survey" Press Release. December 11, 1997. http://www.commerce.net/news/press/121197.html

[20] E-Stats1999 from the Economic and Statistics Administration, U.S. Census Bureau. www.census.gov/estats

[21] Forrester Research, numerous business executives. Morgan Stanley estimates 46 million U.S. Internet users in 1997. See: Meeker, Mary and Pearson, Sharon. *Morgan Stanley U.S. Investment Research: Internet Retail*. Morgan Stanley, May 1997. CommerceNet Nielsen estimates 62.8 million Web users in the United States and Canada for the six months ending September 1997. Statistics provided by CommerceNet/Nielsen representatives. IntelliQuest estimates 62 million online in the United States in the 4 th quarter 1997. See: IntelliQuest. "Latest IntelliQuest Survey Reports 62 Million American Adults Access the Internet/Online services." IntelliQuest Press Release. February 4, 1998.

[22] In a packet-switched system, a message is broken into chunks and each chunk or "packet" is individually addressed and individually routed across the network to its destination. At the destination, the message is reassembled. Packets that do not arrive at the destination are retransmitted. As Vint Cerf, one of the inventors of the Internet, describes it: Packet switching is conceptually similar to the way the postal service works. That is, each letter or postcard is individually addressed and moves geographically from point-to-point as it travels towards its destination. Two postcards mailed from a post office in San Francisco may take different routes to New York, but once they arrive at the New York City post office, they are assembled with the other mail going to the destination address and delivered. Each "packet" is like a postcard and network routers are like the mail stops along the way.

Some Implications of the Networked Digital Economy

The network economy holds a number of implications for the future:

- **The dominance of electronic commerce.** Electronic commerce is still in its infancy. Last year, it represented about 1% of U.S. GDP. This year, it is estimated to grow to just under $200 billion, about 2% of GDP, and nearly as large as the electricity industry. By 2002, it will be pushing the $500 billion mark. Chairman Greenspan believes that the efficiency gains through electronic commerce could lead to "a reduction in overall inventories of $250-300 billion/year, or a 20-30% reduction in US inventory level."
- **Faster productivity growth.** The exponential growth of information technology (IT) network capacity is exerting highly leveraged influence on the economy as a whole. IT already accounts for about one-third of U.S. economic growth, and as much as 2/3 of all the <u>growth</u> in U.S. capital spending. In the last 5 years, US business has invested more than $1 trillion on IT equipment, and the cumulative impact has been a recent surge in US productivity after nearly 30 years of sub-par growth (about 1%/year). Productivity growth is, however, still highly concentrated in the information industries, where it exceeds 10%/year, but is expected to continue to spread to other parts of the economy.
- **Death of distance.** In the industrial age, geographic distance was a major driver of transaction costs. Increased computer processing power and increasing bandwidth will make distance and political-economic boundaries around the world increasingly irrelevant to commerce.
- **Magnet for talent.** High-tech industries are now drawing the best and the brightest into their fold, by paying on average 80% more than the comparable industrial wage, and holding out the prospect of rapid wealth. With the global network, talent will be increasingly found and assimilated everywhere in the world, and networked in real-time for immediate projects or for longer-term, creative undertakings. In a manner of speaking, there will be a "virtual emigration" onto the web for qualified job seekers all over the world. They can remain in the home culture, yet work elsewhere.
- **Growth of immaterial assets.** IT's influence is accelerating the trend toward the "dematerialization" of the economy. Immaterial assets, from software to intellectual property (IP) to brand equity, represent a growing share of national wealth. The US GDP, for example, grew more than 200 fold in real dollars from 1900 to 2000, while the physical weight of the goods and services produced remained about the same. In terms of the labor force, the people making tangible things is slowly decreasing, while those engaged in the immaterial world of services and network commerce is growing – 15% in the last decade alone. By 2025, just a few percent of the U.S. labor force will be engaged in actual manufacturing, following a similar path set by agriculture nearly a century earlier.
- **Sustainable economic growth.** Increasing demand for sustainable global development will encourage the worldwide propagation of electronic commerce. The Electricity Technology Roadmap suggests that productivity improvements across the board – in agricultural yield, industrial output, emissions reduction, energy efficiency, decarbonization of energy, etc – must advance at 2%/year, or better, over much of the century to allow needed economic expansion supporting 10 billion people, while sparing the earth. Global electrification and instantaneous communication are the prerequisites, with the need to reach at least 100 million more people each year.

ELECTRICAL NEEDS OF THE DIGITAL SOCIETY

Increase in Demand for Electricity

As inevitable as the emerging digital future seems, its success depends on the reliability of its power supply backbone. The proliferation of networked digital technology poses two challenges for those who must supply the necessary electric power—quantity and quality.

Together, microprocessors and the equipment they control have helped stimulate growth in electricity demand well beyond previous expectations. Information technology itself now accounts for an estimated 13% of electricity consumption in the United States, and some industry observers believe the IT share may grow to as much as 50% by 2020. Even given the uncertainty in this extreme estimate, it is clear that IT related electricity use is growing rapidly and could conceivably eclipse analog power needs in a few years.

Moreover, the amount of electricity used directly for computers and other digital devices represents only the tip of the iceberg: all of the commercial and industrial equipment controlled by microprocessors also requires electricity. Thus, digitization has increased the electrification of the economy. More than 80% of the growth in total U.S. energy demand since 1990 has been met by electric power and within 25 years electricity is expected to account for more than half of the energy consumed in most industrial nations.

- Given the growth in the Internet's direct and indirect usage of electricity, the equivalent of 30%-50% of today's U.S. power production will be needed to serve the needs of the booming digital society within the next decade or two.
- Power demand in Silicon Valley is indicative of the future of the digital society. For example, total demand growth in the valley is currently running at about 5% per year, much of it due to high-tech expansion. This is more than twice the national average. It is quickly absorbing capacity margins for both generation and power delivery and racing well ahead of capital spending by utilities.
- This demand growth is coming primarily from new end-users; particularly data centers and co-location facility providers, data storage providers, cellular, PCS and radio tower operators, and the optical components industry.

The Need for Digital-Quality Power

The digital economy depends upon a server and fiber-optic based network whose power demands necessitate an extremely high level of reliability and quality. The growth in Internet-based commerce fundamentally depends on the reliability of its power supply backbone.

Realistically speaking, most of the electricity delivered in the U.S. has a reliability of about 99.9% (based on average annual outage duration), with a variety of disturbances, which reduce overall quality to something less. That is just not good enough for a digital society. Interruptions and disturbances measuring less than one cycle (less than $1/60^{th}$ of one second) are enough to crash servers, computers, intensive care and life support machines, automated equipment, and other microprocessor-based devices. For example, power disturbances around the world cause more than 17,000 computer disruptions every second, ranging from annoying frozen cursors to serious disruptions of equipment and products.

What is digital-quality power? On an annual basis, it means electricity must be available to the microprocessor 99.9999999% of the time – "9-nines reliability" as it is sometimes called. Many of the measures required to achieve 9-nines entail devices that are on the customer's side of the meter, but linked in seamless fashion to the power supply system. Economics is the primary driver.

For example:

- Information technology companies require ultra high-quality electrical power and are willing to pay for it. Oracle has pointed out that their power costs could triple and not impact their product cost, whereas an outage carries heavy and growing costs. An Oracle spokesperson brought the point home. "What is self-sufficiency [to ensure power quality] worth to us? Millions of dollars per hour. It is so important that you can't calculate the value to us and our customers."

- One result is that a power conditioning industry is quickly emerging. Bank of America Securities recently issued a report showing the demand for Internet-quality power increasing at a compound rate of 17%/year through at least 2010, roughly in line with shipments of high-end servers. Coupled to this is an emerging "energy technology" industry, focused on the use of power conditioning, uninterruptible power systems (UPS), and distributed power resources that can provide ultra high-quality power for the Internet. This "silicon powerplant" industry is expected to grow from a few billion dollars in sales today to $50 billion/year by 2005, to $100 billion/year by 2010.

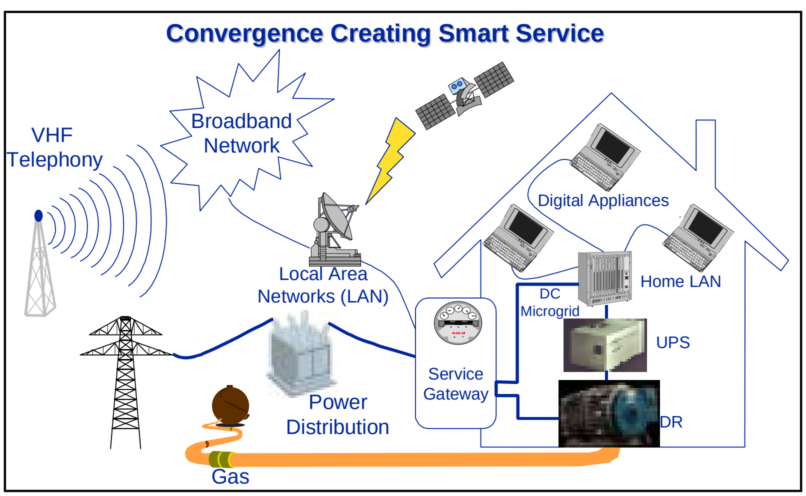
THE FUTURE OF DIGITAL SOCIETY

Infrastructure Convergence

Four forces are creating convergent trends in the networked utility industries: digital information technology, energy utility economics, deregulation, and consumer demand.

- Near term, this involves convergence in electricity and gas services and infrastructure, the convergence of different communications technologies, and the convergence of electricity and telecommunications.
- Longer term, this network may, in turn, incorporate other urban infrastructure, financial and information services, and even high-speed transportation networks into one inclusive "mega-infrastructure" that reaches, and interconnects, all ultimate consumers – billions of individuals and the trillions of microchips that will operate on their behalf.
- Ultimately, a fully integrated infrastructure can, for example, set the stage for a bottoms-up (self-organizing) approach to urban and industrial design based on ecological principles, where the waste from one process becomes the feedstock for another.

The Consumer Energy Council of America's recent forum on convergence recognized that, "the potential of a nationwide broadband network and all of its advanced capabilities will be bringing together some of the largest communication concerns in the world as telephone, cable, satellite and wireless converge to transform the information superhighway into a high-speed communications vehicle delivering advanced Internet applications. For those who have access to the network, broadband technology promises to drastically alter and enhance the way people live their lives and how the nation's business is conducted."



- VHF - very high frequency
- DC - direct current
- UPS - uninterruptible power supply
- DR - distributed resources

The Morgan Stanley Dean Witter Global Electricity Team has concluded that "In our view, a natural union exists between electric utilities and telecom industries due to electrics' existing infrastructure, primarily related to their rights of way (ROW) and internal communication systems…Specifically, by using these assets, the utilities' average network construction costs are 14% below those of new entrants and 58% below private market purchases of ROW access. Achieving even a 0.1% share of the long-haul telecom market would increase annual revenue by $100 million."

In the digital society, consumers will likely purchase energy as part of an integrated service package. Currently, consumers have an electric meter, a gas meter and pay for gasoline at a metered pump. In the future, consumers will be able to pay for all energy and other essential community services with a single identification number, regardless of the point source of the energy or resource. Delivery of power and information (telecommunications) will become completely interwoven. Finally, just as telecommunications are delivered in a two-way setting, power will increasingly be delivered two-way, as households and industrial enterprises are increasingly able to sell power back to the grid.

Transforming the Use of Energy

Computers, the Internet, fiber optics, and wireless communications—just some of the technologies underlying the digital revolution—will also transform the use of electricity in the new millennium. Advances will include self-diagnosing and self-repairing equipment, real-time off-site process control, advanced automated manufacturing, Web-connected household appliances, and smart houses.

In the digital economy, there will be a new level of involvement in energy markets. Customers will have access to a network of information on energy availability, prices, and assets. Digital connections will enable all market players to be linked through instantaneous communications, opening up the possibility for new and more creative relationships between buyers and sellers. Consumers will use the Internet to select and pay for customized energy services in the new deregulated energy markets.[23]

Powering the Digital Society

The importance of enabling and sustaining the digital economy and consequent growth in productivity (and thus economic prosperity and opportunity) cannot be overstated. Simply put, the digital economy is the engine that provides the motive force for economic and social progress, and this engine runs on electricity. Although it is likely that biotechnology, nanotechnology, and other not-yet-envisioned technologies will eventually eclipse the digital society, much as the digital society has begun to eclipse the industrial society, our nation's best strategy for meeting the needs of society for the

[23] Allison, David. "Using the Computer: Episodes across 50 Years." Smithsonian Institution. February 14, 1996. http://www.si.edu/resource/tours/comphist/eniac.pdf

foreseeable future is facilitating, nurturing and enabling the growth of the digital economy.

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