Information Technology

ABSTRACT: The information technology (IT) industry represents a vital interest of the United States. The IT industry fuels the information revolution that is transforming the U.S. economy while significantly altering social interactions, domestic and international political relationships, and military capabilities. IT serves as a catalyst for innovation, communication, economic growth, and political and economic liberalization everywhere that it is embraced. Unfortunately, American society's growing reliance on IT also creates a vulnerability that governments and the private sector must solve together. Correcting this vulnerability and maintaining world leadership in the IT industry are crucial to maintaining a competitive advantage for the United States across all instruments of national power: economic, military, diplomatic, and informational.

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> *"Conventional wisdom holds that the world is in a period of profound economic transformation. The movement into an information based economy is likely to have as deep and lasting an effect on society, trade, the individual and the nation state as did the agricultural and industrial revolutions that proceeded it. The nations that best adapt to these changing conditions are likely to benefit materially in the area of National Security."*[1]

I. Definition of the industry

Information technology includes all forms of technology used to store, exchange, and use information. Americans use IT to transform and transport data for an infinite variety of purposes, encompassing virtually every aspect of society. Effective use of IT facilitates improved productivity through more efficient use of resources; IT conveys competitive advantage by enabling knowledge-based decision-making; IT makes e-commerce and e-government possible; and IT enriches lives with increasingly less expensive and more accessible information and entertainment content. The "Information Age," ushered in with the advent of IT, is creating a world where individuals, organizations, businesses, and governments share vast amounts of information and interact among themselves within a borderless, global IT network.

The IT industry includes firms that manufacture products and firms that deliver IT services. The major IT sectors are: the computer hardware sector (computers, peripherals, calculating and office machines, magnetic and optical recording media, semiconductors, industrial manufacturing instruments); the communications equipment sector (telephone and telegraph equipment, radio and TV equipment, satellite communications equipment, cable, fiber optics, network switching); the software/services sector (programming services, prepackaged software, computer integrated system design, information processing and retrieval, computer services management, web hosting); and the communications services sector (telephone and telegraph communications, cable and broadcast TV services, computer network management, satellite services management).

For the U.S. to be competitive in the 21st century, it must have a strong, robust, growing, and innovative IT industry. U.S. competitive advantage in the IT industry, as well as in other industries that rely on information products, cannot be taken for granted. Competitive advantage in IT, by its nature, is transitory. A single, truly innovative idea can shift competitive advantage in a particular sector of the IT industry overnight. World-class competitors can be found in countries as diverse as Japan, Germany, Italy, the Netherlands, the UK, Singapore, Taiwan, South Korea, and China. These same countries, along with India and Israel, are also highly competitive in software. Countries like Thailand compete on the basis of cost, benefiting from low labor costs. There are significant challenges to the industry and to the global economy, yet there is reason for great optimism; IT has great potential to help raise global standards of living and enhance security by facilitating e-commerce and the free flow of information.

II. Industry challenges in the near-term

The U.S IT industry has led the way in the early decades of the Information Age, which has had a profound, positive impact on the competitiveness of the U.S. economy as a whole. For the U.S. to maintain this lead, the industry must stay on the cutting edge of innovation and be able to generate the capital required to convert those new ideas into new products. This will require a strong, competitive business environment, well-funded research and development (R&D), the free flow of information, a world-class workforce, global protection of intellectual property rights, and an ever-expanding marketplace. Four near-term challenges stand out:

Security. The U.S. and many of its allies rely heavily on information technology, creating a strategic vulnerability that must be resolved. One of America's adversaries' most lucrative military or economic targets may be its information infrastructure. The threat is very real. In the 2001 Computer Crime and Security Survey, respondents reported an accelerating rate of security intrusions and an even greater increase in attendant financial losses.[2] Actions taken to address this profound vulnerability require close coordination within the global community and must be consistent with American values, preserve free and open access to information, and must not constrain the innovative spirit that has made America the indisputable leader of the IT industry.

Workforce. Simply stated, U.S. citizens are not choosing to become IT professionals at a rate commensurate with the demand. U.S. universities and the IT industry attract the best minds from around the world to fill the gap. Clearly, it is in America's best interest to have the world's best minds working in the U.S. for U.S. IT companies. However, there are valid longer-term concerns that must be addressed. Ideally, policies adopted today, in concert with market forces, will encourage more bright young citizens to choose the IT profession in the future.

Bandwidth. Universal high-speed Internet access promises to bring the next quantum leap in IT-driven productivity improvements. Currently, bandwidth limitations constrain the market for hand-held mobile computing devices, graphics-intensive Internet content, and the transition to a web-based application architecture. "Last mile" infrastructure shortfalls, lack of "killer applications," frequency allocation conflicts and legal/regulatory constraints have combined to prevent the U.S. from creating a high bandwidth-enabled market large enough to fuel this next quantum leap in innovation.

Digital divide. IT-enabled businesses and individuals generally have a competitive advantage over those without IT. Over time, the gap between these two communities will grow at an increasing rate. While it is a vital U.S. interest to sustain long-term leadership in the IT industry, it is also in the U.S. interest to encourage other countries to embrace IT. For every country that joins the global community of interconnected nations, markets expand, economies grow, people become empowered with information, and the world slowly evolves into a more stable place. Yet, there are still some nations whose regimes resist, to varying degrees, the free flow of information in their efforts to retain control over their populations. These populations will fall increasingly farther behind in IT-driven

economic growth that characterizes the Information Age. This economic gap will continue to be a source of political conflict as long as there are significant populations that are prevented from sharing in global prosperity.

III. Current industry conditions

The IT industry's first recession. The IT industry has survived its first recession but many individual firms have not. The most recent "recession" only lasted one quarter (July-September 2001), with a 0.3% drop in GDP. This short-lived decrease in GDP, however, belied a major drop in IT industry investment, sales, and employment that began in the second half of 2000.

In both nominal and real terms, output from IT industries as a group – but especially software services and communications equipment – grew at nearly 20% in 2000.[3] Net growth in computer inventory slowed dramatically while the net stock of communications equipment increased sharply.

Just as the growth in IT industries helped overall GDP during 2000, the decline in the IT sector contributed to weakened GDP in 2001. Business demand for IT equipment and software fell at annualized double-digit rates for the first three quarters of 2001 before leveling out in the last quarter. The dollar value of IT shipments fell even more drastically (-25%) during the first three quarters, leading to a serious inventory glut. Fortunately, consumer and government demand for IT goods (about 14% of total IT spending) remained stable, softening the net impact on GDP.

The most dramatic example of the IT "bust" was in the "dot-coms" sector which, during the 1990s, received significant outside funding from venture capitalists or other investors:[4]

> *"At least 537 Internet companies shut down or declared bankruptcy in 2001, more than twice as many as in the previous year, when 225 dot.coms failed. December's [2001] 21 shutdowns bring the total toll to 762 since January, 2000."*[5]

The worst of the dot-com purge was over by the end of 2001. Fortunately, as dramatic as these shutdowns were, at least 90% of the more "substantial" dot-coms survived. In general, surviving IT companies have restructured, streamlined, and otherwise improved their business models for improved competitiveness as the economy comes out of recession. Unfortunately, the investment capital required to convert new ideas into new products has yet to return to the industry.

The telecommunications sector was particularly hard hit by the recession and IT slow-down. Peaking at a value of $2 trillion in the spring of 2000, the sector has lost some $1.4 trillion in investor wealth since then.[6] In the past year, fifteen telecommunications firms filed for bankruptcy, including Global Crossing (the fourth largest bankruptcy in U.S. history), 360° Networks, PSINet, and Net2000. The Securities and Exchange Commission

is investigating possible accounting irregularities at two of the biggest long-distance telecommunications firms, Qwest and WorldCom. Spending on telecommunications equipment continues to plunge.

The IT industry as employer. Because demand for IT workers has historically exceeded supply, demand for IT workers is still strong in spite of large-scale layoffs in 2001, especially in occupations related to services, security, networking, and e-commerce.[7] In 2000, IT jobs grew from 3.6 million to 5.6 million. Growth in IT service jobs slowed in 2001, while the IT goods sector actually shed jobs. In 2000, the average annual wage in the IT industries was $73,800, more than twice the annual wage for of $35,000 for all other private sector workers.[8]

International sales. During 2001, the international balance of trade for U.S. IT firms improved, although the dollar value of both imports and exports dropped through the third quarter – imports by $28 billion and exports by $19 billion. The U.S. IT industry has seen chronic trade deficits in all categories of IT goods (except for software and instruments) with large countervailing trade surpluses in computer and information services and software royalties and license fees.[9]

Far from indicating a weakness in U.S. production of IT goods, the trade deficit shows the extent of globalization in the IT industry. In 1998, foreign sales of goods and services by majority-owned overseas affiliates of U.S. companies exceeded $202 billion – almost twice the value of comparable exports that year ($113 billion) from the United States.[10] Increasingly under pressure to reduce costs due to competitive pressures, leading U.S. IT firms have transferred labor-intensive manufacturing and assembly operations overseas. The largest trade deficits in absolute terms were for labor-intensive components and accessories. Although such production is highly globalized, IT plants in the U.S. retain most of the value-added production, accounting for three-quarters of the combined value-added of companies in the U.S. and their foreign affiliates.[11]

New economy or new accounting?

> *"Fading dot-coms, new tech giants, and venerable blue chips all hype their earnings. Cisco Systems, Inc. subtracts payroll taxes on employee stock options in its earnings-per-share numbers. IBM lifts its earnings by assuming it would pay less into its pension fund, and Motorola, Inc. boosts sales by lending huge sums to customers."*[12]

In retrospect, the strength of the IT industry was probably overestimated during the boom of the 1990's. As *Business Week* pointed out last year, firms are increasingly resorting to "pro forma" business accounting practices.[13] Such reporting bypasses generally accepted accounting principles and enables firms to inflate their reported earnings – while masking costs – so as to make their stocks appear more attractive. Public firms in all sectors have resorted to such tactics in recent years; the IT industry is no exception.

U.S. Government (USG) statistics may also have inflated the contribution of IT. Some adjustments to nominal data are needed to reflect productivity changes, but current USG practice is out of step with statistical procedures in other advanced economies. Such divergences in procedures exaggerate the U.S. lead in IT technology and investment compared with other leading economies.

The IT industry's enduring contribution. Heavy spending on IT infrastructure over the past decade will pay dividends as the industry and the economy recover during 2002. Individual firms got into financial difficulty because they were unable to recoup heavy upfront investments, such as a heavy fiber optic cable infrastructure. The investments will survive even if some of the firms have not. The real net stock of IT equipment and software is available to underpin a later economic recovery.

Another sign of the IT industry's underlying vitality is that IT firms continue to dominate standard market listings such as the Fortune 500 Global Ranking.[14] Ranking second, CISCO Systems is currently the largest of the IT firms; but its position is slipping. (The top twenty also include Microsoft, Intel, Oracle, SBC Communications, International Business Machines, Emc, and Verizon Communications.)

Productivity trends and comparison to international trends. The IT industry has shifted away from vertically organized companies toward a greater reliance on global linkages and outsourcing from both U.S. and foreign sources, especially in manufacturing. The computer manufacturing industry lost over 30% of its workforce due to 1) increased automation and 2) offshore companies supplying more hardware for domestic assembly. Major U.S. vendors implemented build-to-order and configure-to-order processes instead of simply manufacturing to meet anticipated demand. This significantly lowered inventory costs and enabled firms to deliver their products more quickly.

The IT industry in the global environment. The trend of U.S. IT companies toward a global supply chain and business model, combined with the independent growth of foreign IT industries and the global expansion of the IT marketplace, has made international trade issues central to U.S. economic growth.

> *"Our goal is to ignite a new era of global economic growth through a world trading system that is dramatically more open and more free. By doing so, we can improve the job opportunities, incomes, productivity, purchasing choices, and family budgets of America's workers, farmers, ranchers, small businesspersons, and entrepreneurs."*[15] – President George W. Bush

President Bush advocates an agenda for trade liberalization on multiple fronts – globally, regionally, and bilaterally – believing that trade liberalization enhances America's leadership by strengthening its economic ties, leverage, and influence around the world.

The Internet and e-commerce now account for a growing proportion of world trade. The emergence of global networks has begun to influence the way individuals interact with each other, how businesses conduct their affairs, and how governments provide services to

their citizens. Common to all conceptions of globalization are the greatly increased range, intensity and speed of international political, economic, and social interaction. This speed is particularly apparent in financial matters, in the transmission of news media and the resultant political effect.

The following topics are central to understanding international trade issues in the sector:

The Information Technology Agreement (ITA) of 1997. The ITA required country signatories to eliminate tariffs on IT products by January 1, 2000. ITA covers approximately 95% of world trade (currently estimated to exceed $1 trillion) in IT products (not services).[16]

General Agreement on Trade in Services (GATS). The Uruguay Round of Trade talks broke new ground by broadening the scope of world trade rules to include *services* which encompass banking, transportation, telecommunications and professional services such as engineering, law and Internet-based service offerings.

1997 Agreement on Basic Telecommunications Services. This agreement includes pro-competitive regulatory principles aimed at obtaining commitments from those countries that have made less than full market-opening commitments.

Export controls and other trade barriers. Under the 1998 National Defense Authorization Act, the U.S. applies export controls on its fastest, highest performance computer equipment and the security risks posed by the recipient country possession of the equipment.[17]

Individual privacy. In the wake of the September 11, 2001 terrorist attacks, the U.S. is tightening its generally liberal policies on privacy. With passage of the USA PATRIOT Act of 2001, law enforcement officials have broader access to Internet and telephone communications, including financial transactions.[18] This law also amends the Family Educational Rights and Privacy Act (FERPA), which protects student privacy records including coursework, grades and student financial information. Due to security concerns, other pending legislative items may affect the privacy rights of Internet users.

Intellectual Property (IP). The U.S. has the strongest enforceable legal protection of software in the world due to copyright protections embodied in the 1980 Computer Software Copyright Act. Globally, the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement provides comprehensive multilateral protection on intellectual property. Article 7 of this agreement holds that the protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology. The World Intellectual Property Organization (WIPO) attempts to bring global harmony to IP rights.

Domestic production versus trade and Foreign Direct Investment. The current position of the United States as the world's leading producer of value-added high-technology products reflects its success in supplying both the large home-based market and foreign

markets. The nation's long commitment to investments in science and technology, and success in serving the demanding domestic market, have permitted exploitation of the international marketplace. Much of the globalization of the IT sector has taken place via U.S. foreign direct investment, as indicated by the rapid international expansion of large IT companies such as Intel, Cisco, Compaq, IBM, and Motorola.

Transparency and e-commerce. A binding transparency agreement would establish global norms for the open conduct of procurement by governments through e-commerce. The World Trade Organization (WTO) is actively trying to extend the ongoing moratorium on imposing customs duties on electronic transmissions. This should provide the U.S. with an opportunity to continue its efforts to press other countries to eliminate measures that impede the growth of electronic commerce, leading to improved discipline in government purchases and making a contribution to combating corruption and a more efficient use of taxpayers' money.

IV. Industry outlook – the next ten years… …and beyond

The next ten years. Assuming a strong and growing R&D partnership between industry, government, and universities, the U.S. IT industry will continue to be the world's IT leader over the next ten years in spite of (some would argue because of) the continuing development of highly competitive foreign IT industries. U.S. competitive advantage will be a function of its ability to innovate and raise venture capital to bring new ideas to market quickly. The dominant trend for the industry over the next ten years will be continued progress toward "convergence" of the many forms of IT to accomplish distributed, multi-step complex tasks. Convergence will manifest itself in mobile, networked computing platforms, content-rich broadband applications, intelligent devices and web-based application software services. Innovation within the context of convergence will lead to the next quantum leap in improved productivity in the U.S. economy. The lack of a comprehensive solution of the broadband "last mile" and frequency allocation issues currently retard the rate of convergence.

Universal high-speed Internet access. In a controversial decision, the Federal Communications Commission (FCC) approved a rule change on 14 March 2002 that reclassified broadband via cable modem as an "information service," freeing the industry from regulations typically applied to "telecommunications services." This was an important step toward achieving universal high-speed Internet access, but much work still needs to be done. Over the next ten years the U.S. will likely achieve universal high-speed Internet access. The quicker this happens, the greater the U.S. competitive advantage in the IT industry and its resultant positive impact on the economy as a whole.

VoIP. Voice over Internet Protocol (VoIP), which uses a digital signal and Internet access to allow its user to talk, is now available. The quality of the latest VoIP is equivalent to the quality of the traditional hard-wired home phones. VoIP allows a much simpler and cheaper means of switching and requires less bandwidth than the old analog phone to

provide the service. Over the next ten years, VoIP will take over as a primary means of voice communications.

3G Wireless. Third Generation (3G) is a *wireless* alternative that offers the subscriber the ability to transmit data at speeds of 307 kilobits per second.[19] These are speeds typically associated with broadband access currently available in many homes. 3G is a necessary precursor for enabling handheld computing devices to send and receive high bandwidth content quickly enough to make them useful and attractive to consumers. Because of their similar requirements for propagation characteristics in terrestrial environments, both the Department of Defense (DoD) and the Telecommunications Industry seek use of the same frequencies. To date, this has been an intractable political and national security issue that has delayed deployment of 3G technology, putting the United States well behind many of its foreign competitors. Industry appears to be deploying an interim wideband wireless data communications capability using existing frequencies that some term "2.5G." 3G, originally projected for U.S. deployment in 2003, may well be delayed to beyond 2005.

Computers. The quest for faster and smaller computer processors will continue. The physical limits of silicon will be reached before the decade is out. Smaller, faster computers combined with 3G wireless internet access will lead to an explosion in remote and handheld networked computing devices. Users will have one device allowing them to perform operations that currently require several different devices. Remote and mobile networked computing devices will enable users to automate many business processes that until now required manual data recording and time delayed reporting.

Software. Along with faster computer processors and universal high-speed Internet access there will be a gradual shift toward leased, network resident, application services. Clients will select applications they desire from application service providers on the web or network and pay a periodic fee for their use – in much the same way customers subscribe to cable TV today. As the market switches to web services, it will allow software companies to reduce unauthorized piracy of software. Consumers will gain the convenience of access to their applications from any location and any type of device, configured to their own user profile.

Industry outlook – beyond ten years. The IT industry is progressing so rapidly that forecasting beyond ten years is extremely difficult. Even the wildest predictions may be gross underestimations of the true potential of IT. Assuming Moore's law continues to prevail (i.e., the number of transistors in a computer chip will double every 18 months, increasing processing power), ten years from now computers will be at least 128 times faster than they are today. Considering the potential of nano-, bio-, and quantum computing technologies, this may well be an underestimation of future computing speed. 4G wireless technology promises data communication rates exceeding 100 megabits per second! While it is possible to predict that nanotechnology and 4G will provide quantum advances in terms of processor speeds and data communication rates, it is impossible to comprehend at this point the implications of combining the capabilities of these two technologies in terms of "reach" and "richness" for the IT industry and for American society in general.

Artificial Intelligence (AI) has been limited by the speed of processors. Computing power is expected to duplicate the processing speed of the human brain in the next decade. With this in mind, AI will emerge as a means to advance the world of computing. According to a 1996 report on AI by the NEC Research Institute and the Computing Research Association:

> *"Work is progressing on developing systems that converse in natural language, that perceive and respond to their surroundings, and that encode and provide useful access to all of human knowledge and expertise… ..But the ultimate promises of AI are still decades away, and the necessary advances in knowledge and technology will require a sustained fundamental research effort."*[20]

V. Major Issues

Issue: Information security – a strategic vulnerability

> *"We have built our future upon a capability that we have not learned how to protect."* – George Tenet, Director, Central Intelligence Agency

One can liken the U.S. networked environment to a super highway where there are virtually no traffic laws and where no one is responsible for damages if an accident occurs. While standards for securing the infrastructure are slowly emerging, there is no way of assigning liability, the cost of negative publicity outweighs the cost of security compromise, and the public is poorly informed about the risks. Regulating the industry is further complicated by the fact that the "highway" crosses traditional state borders without any real restrictions and no single, national jurisdiction. Additionally, while the private sector would prefer to self-regulate, industry leaders often view securing the information infrastructure as a "public good" and thus, something in the purview of the government. Industry is therefore reluctant to bear the cost.

With over ninety-five percent of U.S. information infrastructure (including that vital to the military) owned and operated by private enterprise, close government-industry cooperation is necessary to keep U.S. information secure. This partnership has been slow getting off the ground in large part due to conflicts over business risk exposure from information sharing and a lack of government funding for expensive government mandated security requirements. Securing the information infrastructure will require government action to mandate and pay for those security measures above and beyond private enterprise's responsibility and capability to address. Part of any comprehensive plan to secure the information infrastructure should include laws establishing legal liability for security failures and breaches of personal privacy. A lack of liability diminishes any incentive to protect privately owned systems.

Securing technologies. The fundamental requirement of securing technologies is to ensure the integrity, authenticity and confidentiality of information. The established

approach is through a series of layers that builds firewalls, installs intrusion detection, and increases confidence in the use of the Public Key Infrastructure (PKI). PKI refers to the infrastructure and procedures required to facilitate the management, distribution, storage and revocation of certificates based upon public key cryptography. This, in turn, seeks to provide secure data exchange over third-party networks such as the Internet. Not everyone needs or desires this increased level of security. Many are content with the security provided by their Internet Service Providers. For commercial and legal transactions, however, there is obviously a higher level required. Additionally, there exists concern of the possibility of a private key being misused or stolen.

Biometrics offers the potential to considerably enhance the PKI model. A fingerprint, for example, provides a substantially higher level of confidence. The likelihood of an unauthorized individual using a biometrically protected private key is reduced to almost infinitesimal proportions. Merging biometric and encryption technologies provides exciting possibilities to successfully secure data exchange.

Cybersecurity – privacy and security clash. The conflict between security and privacy manifests itself in three areas. First, between security and privacy of personal, corporate or federal data; that is, preventing unauthorized persons from using the network to access files or plant programs or viruses into other systems. Second, ensuring the privacy of data on another system (a website on another server, for example). Even if a site has a good privacy policy, if it is not secure, unauthorized users can gain access to data stored there. Finally, measures that protect privacy on the Internet, especially anonymity, can complicate the task of increasing security.

Privacy safeguards can work against security technology implementation. Assigning a permanent, remotely accessible identification number to each chip, for example, greatly reduces privacy. Anonymity on the Internet allows hackers to avoid liability (and terrorists to avoid being tracked!). The USA PATRIOT ACT raises alarms that perhaps the government has removed important barriers to protect individual privacy and civil liberties. While the Act is intended to obviate a serious and legitimate threat to national security, it does leave open the possibility of infringements on individual privacy. A national dialogue is required to define the trade-offs and to help achieve the balance between security and privacy.

Recommendations: U.S. information infrastructure permeates every aspect of society today, and promises great efficiencies to Americans. The challenge remains to build user confidence and trust in the network, so that the great benefits of the system may be achieved. In order to build that level of confidence, the U.S. must institute effective regulations that protect the privacy of the honest users of the system, while allowing for detection and punishment of those who wish to exploit or abuse the environment. Government must create the necessary incentives, positive and negative, to encourage industry to build the redundant layers of security that engender trust and confidence in the system. To make this public-private partnership more effective, the details of the partnership must be designed with three overarching principles in mind. First, to survive, any business must invest in security commensurate with its business risk. This should

form the basis for private cost sharing. Second, any government's first priority is to provide security for its people, territory, and interests. Government must assume ultimate responsibility for infrastructure protection and must fund levels of security in the public interest that are beyond the limits of private business risk. Finally, information sharing is critical to effective infrastructure protection. Government must remove all impediments to complete information sharing.

Issue: Universal high-speed Internet access (broadband)

Discussion: The technology to enable universal high-speed Internet access via cable modem from the local cable service provider, Digital Subscriber Line (DSL) from the Local Exchange Carrier, and terrestrial 3G and space-based wireless systems, has been available for a few years. Domestic legal, regulatory, political, and economic obstacles have prevented the U.S. from achieving this critical capability before some foreign competitors. The primary problem in providing low-cost, high-speed Internet access to fixed sites is in encouraging the building out of the "last mile" infrastructure. For mobile, high-speed Internet access – 3G wireless – the primary problem is determining how to allocate frequencies. The underlying issue is not simply that other nations have been able to achieve this capability first, but rather that the U.S. may have ceded to these other nations the initiative in the next quantum leap in innovative new products made possible by universal high-speed access. The U.S. must act decisively to overcome the legal, regulatory, and economic impediments in order to accelerate universal high-speed access and the associated productivity improvements.

The "Last Mile." Broadband is far from reaching its full potential due to 1) the cost of laying a fiber optic infrastructure (for cable modem access), and 2) the restrictions placed on Baby Bell companies (Qwest, Verizon, SBC, BellSouth) constraining them from entering the broadband arena for Digital Subscriber Line (DSL) access. The Telecommunications Act of 1996 requires the Baby Bells to meet a series of pro-competitive provisions before they can transmit computer data outside local service regions via DSL. The conditions include opening their local phone networks to competitors and ensuring rivals gain access to portions of any new networks they build that can deliver the high-speed services. These conditions do not create an environment conducive to encouraging investment in the costly DSL infrastructure. Legislators have three options: 1) lift the restrictions (overturn sections of the TA 1996) and allow the Bells to compete head-to-head with cable – what the recently passed House bill (Tauzin-Dingell, March 2002) advocates; 2) keep existing rules in place and hope that competition will evolve without intervention; or 3) pass new laws to promote competition and timely construction of new systems.[21] Tauzin-Dingell may die in the Senate; but the resolution of this issue to promote faster deployment of broadband, with better quality and lower prices to consumers, is vital.

Frequency Allocation. To achieve global harmonization of 3G wireless frequency bands, the World Telecommunication Council requested the USG to allocate the 1755-1850 MHz portion of the electromagnetic spectrum for commercial wireless use. This band was selected because propagation characteristics at these frequencies are optimal for terrestrial-

based mobile communications.[22] Unfortunately, for the same reasons, these frequencies are already heavily subscribed, much of it for tactical radios used by the U.S. armed forces. In response to a presidential memorandum (October, 2000), the Commerce Department's National Telecommunication and Information Administration (NTIA) issued a plan to select spectrum for potential use by 3G wireless systems in the United States and estimated the cost of transitioning current subscribers to other compatible frequencies at $2.5 – $4.5 billion. The DoD issued a report to NTIA in February 2001 concluding in essence that vacating that band was not feasible until well into the next decade.[23] Congressional hearings are ongoing to decide this allocation issue. Ultimately, the failure to aggressively transition to 3G wireless technology is also a serious national security issue as U.S. companies continue to lose ground to foreign competitors in the economically vital IT industry.

Recommendations: To accelerate deployment of broadband access to homes and businesses throughout the country, unfettered competition seems to be the most effective way to encourage investment while keeping consumer prices as low as possible. Potentially, there will be some significant casualties in this "deregulation," perhaps most notably for the Baby Bells, but the longer-term fallout from loss of IT industry leadership may carry much greater costs.

Issue: E-commerce: what role for the government?

Discussion: The remarkable growth of the Internet and electronic commerce (e-commerce) has revolutionized business and national productivity. New models of consumer-commercial interaction are evolving at great speed. Entrepreneurs start businesses more easily. Trade growth in digital products such as software, entertainment products, financial services, and travel services has huge potential. Furthermore, e-commerce will revolutionize retail and direct marketing, with consumers shopping at home for a myriad of products from retailers worldwide. But the greatest value in e-commerce is the massive exchanges being made in the business-to-business (B2B) sector. E-commerce sales totaled $32.6 billion in the U.S. in 2001, an increase of 19 percent over 2000.[24] The U.S. Bureau of Census estimated that 94% of that e-commerce was in the B2B sector. Using electronic data interfaces over both value-added and open networks, the business sector has revolutionized manufacturer-to-wholesaler trade. The implications of e-commerce's role as an increasingly important component of U.S. economic power are significant. Globally, e-commerce is growing as well, with projections that e-business sales to non-U.S. customers will exceed those to customers inside the U.S. in 2003.[25]

Despite the great promise that the Internet and e-commerce offer, significant obstacles remain. The dot-com bubble-burst drastically changed the landscape of firms conducting business on the Internet and slowed the pace of visible Internet investment. The visible sector affected, such as the online retail trade and online services sector, pales in comparison to the online manufacturing and merchant-to-wholesaler business, which has continued remarkable expansion. The manufacturing and wholesale community remains unfettered by the slowdown and has used the availability of people and equipment to further advance their B2B systems to enhance supply chain management and financial

management systems. But additional issues remain with an information infrastructure that enables e-commerce: online security, taxation of the Internet, privacy, the digital divide, and vulnerability to cyber criminals and cyber terrorists. In the increasingly insecure environment called cyber-space, determining the proper role for government to play is increasingly difficult.

***Recommendation**:* Although the government played a significant role in developing the Internet, e-commerce growth has been driven by the private sector, especially in the B2B sector. Additionally, the Internet and e-commerce have evolved so rapidly they have bypassed the government. The USG has not been agile enough to keep pace. Therefore, the government should play a supporting role to the private sector and generally should allow market forces to advance industry self-regulation. The government's role should be limited to: 1) ensuring a secure information infrastructure, 2) ensuring fair competition, 3) protecting intellectual property and privacy, 4) facilitating dispute resolution, and 5) fostering consistency across state, national, and international jurisdictions.[26]

Issue: The growth of electronic government is essential for a more efficient USG

***Discussion**:* "E-Government" is simply the application of e-commerce technology to government services. It is similar to e-commerce in that it is customer-focused and time sensitive; yet it differs greatly from the for-profit initiatives that drive e-commerce.

Under the leadership of the Office of Management and Budget, the federal government has formed an E-Government Task Force whose strategy is to support multi-agency projects so that "…conducting business with the government is easier, privacy is protected and security provided. Citizens and business can visit one point-of-service site – online or by telephone – that reflects the 'United States Government'."[27] According to a poll for the Council for Excellence in Government, 77% of Americans said E-Government should be a high or medium priority for the government.[28] Since the USG will allocate over $48 billion in FY 2002 and $52 billion in FY 2003 on Information Technology, the Task Force determined that the government could significantly improve services to the citizen by focusing more of that spending on twenty-four high-payoff, government-wide initiatives.

The Task Force has put its effort behind Government-to-Citizen (G2C) initiatives like *Recreation.go*v, a new service offering citizens comprehensive recreation planning information.[29] For both the Government-to-Business (G2B) and Government-to-Government (G2G) interfaces, *Federal Commons* was developed, a one-stop shop for federal grant applications. The *Federal Commons* will provide public information, such as grant programs and funding opportunities, as well as the secure processing of e-grant transactions.[30] Finally, for Government-to-Employee solutions, the Task Force oversaw the implementation of *Employee Express*.[31] This is a single customer service portal to provide services for leave and pay, health benefits, Thrift Savings, and numerous other services essential to government employees. Like the Internet use for e-commerce, the general perception of the value is misplaced. In e-commerce, most people think the value is in the on-line retail sector, which is only 2.75% of e-commerce.[32] The emphasis in e-

government has been on the G2C interface, but the greatest value will be found in the G2G exchange of data, much like industry has found in the B2B exchanges.

Recommendation: To ensure E-Government achieves its potential, an overall federal CIO with authority over spending on the architecture, security and citizen-centric initiatives must be appointed. The CIO must develop an incentives system to assure positive change. Finally, the CIO must rapidly develop the next generation of E-Government initiatives, with greater emphasis on the value of G2G exchanges, in order to economize agency budgets. In summary, E-Government is a new way to serve the needs of the nation while fueling the nation's economic engine. By overcoming barriers such as security, bureaucratic stagnation and the digital divide, the USG can leverage E-Government to enhance its national power.

Issue: A sustainable IT workforce?

Discussion: The demand for highly skilled, experienced IT workers leads all other occupational groups. Providing a world-class IT workforce will continue to be a major challenge. Industry experts estimate a shortfall of 190,000 high-tech, core IT workers and predict that this shortfall will worsen without pre-emptive action.[33] Skilled IT workers are also required in government. Roughly half of these positions will go unfilled. These labor shortages make skilled IT labor a highly valued commodity, driving the price of labor ever higher. Ultimately, the higher cost of IT labor makes U.S. IT products more expensive on the global market. Labor shortages undermine U.S. innovation, productivity and competitiveness. It could threaten U.S. national security in the long term.

The Office of Technology Policy (OTP) analyzed Bureau of Labor Statistics growth projections for the core occupational classifications of IT workers (computer engineers, systems analysts, computer programmers, database administrators and computer support specialists) to assess future industry demands. Between 1998 and 2008, new jobs for core IT workers are expected to increase by 78.7%.[34] These growth rates compare to a projected 14.4% increase for all other occupations, an increase of almost two million job openings for core IT workers due to growth and net replacements. This number could be even higher because OTP does not account for the impact that the Internet, e-commerce and other IT factors have had on the demand for IT workers throughout the rest of the economy.

In the short-term, numerous IT employers use the recruitment of skilled foreign workers under H-1B visas as a stopgap method to fill IT workforce shortages. Recent legislation has increased the number of H-1B visas to 195,000 annually for the next six years. Since the events of September 11, 2001, the IT industry (as well as all H-1B visas employers) must take a harder look at its policies for hiring foreign workers to address security implications. In the not-too-distant future, as foreign IT industries develop, the U.S. ability to attract the best minds from these countries may be negatively impacted. By that point, the U.S. will need to have revised policies to encourage greater numbers of its own citizens to choose IT as a career.

Education is a long-term solution for bridging the gap in the demand for IT workers. To remain competitive in the IT arena, there are three main areas of education that must be addressed: math and science curricula for grades K-12, IT qualification standards for public school teachers, and the recruitment of students into IT careers and programs. Without sufficient investment in education, the U.S. will quickly lose its high-tech advantage, leaving national security vulnerable.

Community colleges have made sweeping changes in response to the demand for IT workers. These institutions have tailored their curricula to meet specific demands in networking, database management and web design. Additionally, several corporations, such as Cisco Systems, Novell, IBM, and Microsoft, offer their educational and training programs to any community college that wants to participate. Changes in IT education are also occurring at four-year colleges and universities, but at a slower pace. Educators and institutions must bring course offerings in line with current requirements in the IT industry. For an industry that changes so rapidly, this is a significant challenge.

Recommendations: Industry and government should offer a number of incentives to recruit and retain IT workers – such as scholarships for a "Cyber Corps" in the field of information technology. As a result, these graduates would be committed to work for the company or government for a set number of years after graduation. Industry could develop short IT training programs for graduates of non-IT college programs, tied to a work commitment at the companies that sponsor the training. The disabled community offers great promise – companies should aggressively recruit this labor pool. The U.S. must continue to support the hiring of H-1B visa workers to fill the short-term gap and invest in the education of its children and teachers to solve the long-term problem.

Issue: Legal and regulatory: balancing regulatory requirements in a free society

Discussion. The IT sector is at a critical phase. Modern society is on the cusp of quantum leaps in computing power and communications bandwidth. Many analysts opine that IT is still in its infancy. The legal and regulatory policies adopted now may have profound implications for the speed and direction of the IT industry and U.S. competitiveness in the future. On the one hand, there is the temptation to regulate – to impose laws affecting those who either profit from IT or those who rely on it – in an effort to achieve a variety of social and economic objectives. On the other hand, there is the tendency to permit the IT industry to regulate itself with modest government intervention to assure fair competition. The USG has contributed to a free market climate that has allowed the Internet to flourish. Deregulation of telecommunications and other sectors has provided an enabling climate.

Individual privacy. Privacy is potentially threatened by common practices within the cyber domain. For instance, the insertion of "cookies" by businesses wishing to provide better service to Internet users is one way that information about people's viewing and purchasing habits is obtained without their knowledge. These tactics create distrust in an American citizenry that is fiercely protective of its right to privacy. The U.S. Supreme Court has ruled that the Fourth Amendment of the Constitution (freedom from search and seizure absent warrant) affords Americans the right to privacy when there is a reasonable

expectation of privacy. Without a reasonable expectation of privacy, however, there is no privacy right to protect. Data files stored in the home are, in principle, protected, but the rule becomes less clear when applied to files stored on an Internet Service Provider's server. Currently, there is no standard practice. Several businesses clearly advertise how they handle personal information; others do not. The effectiveness of advertising privacy policies remains unclear.

Internet taxation. Should Internet access and/or e-commerce be taxed? Commerce on the Internet lacks clear and fixed geographic lines of transit that historically have characterized physical trade of goods, making sales tax assessments by jurisdiction exceedingly difficult to implement and enforce. The Internet Service Provider would pass the burden of the tax on to consumers, thereby making Internet usage more expensive, counter to the 1996 Telecommunications Act policy statement regarding promotion of the Internet and interactive computer services. Exemplifying the evolution of the USG's philosophy on this topic, President Bush recently signed legislation that extends the Internet Tax Freedom Act (ITFA) for two years, through November 1, 2003.

Intellectual Property (IP). The growth of the Internet has created an increase in the number of IP legal issues. The software industry has been struggling with the piracy of its products from the onset of the computer age. The recent "Napster" litigation shows how serious the issue of piracy is to individual artists or businesses seeking rewards for their creative energy. Current legislation, such as the Digital Millennium Copyright Act and the Secure Digital Music Initiative can help address the problem. While these laws are only enforceable in the United States, the Internet knows no borders. Clearly, piracy is a global issue requiring a global response.

Recommendations: Protecting individual privacy is critically important; thus, the government must balance restraint with a need to be cautiously proactive. Building confidence in artists and businesses that their creative energy is protected demands government intervention. Finally, collecting taxes is a governmental role for those goods and services provided within designated borders. Cyberspace has no defined borders and should remain free of taxation at this point in its evolution. Other government roles include: 1) ensuring competition, 2) preventing fraud, 3) facilitating resolution of disputes, and 4) working toward consistent rules and regulations across state, national, and international jurisdictions.

Issue: Interoperability, integration, and standards

Two important elements directly affecting the pace of IT advancements are standards and interoperability – of both hardware and software components. The more seamlessly an application or device on one computer communicates with other computers, the more valuable that application or device becomes.

Discussion: In spite of the tremendous growth and the ever-widening range of applications and functionalities of cutting edge IT, there is sometimes an uneven pattern of development in some new technologies due to factors such as industry conflicts concerning

standards. In the past, proprietary approaches by industry were believed to maximize market share because only the developer's products would interoperate. Now, however, many realize that it is usually advantageous to build products that can interoperate with as many other vendors' products as possible. Standards are the foundation blocks of IT interoperability and integration, and they increase the flexibility and ultimate usefulness of IT components. When there are standards for connectivity and information flow between components of an information system, or applications that access common information between systems, interoperability has been achieved. The pace of change in IT has become so fast that the traditional standard-setting organizations have become ineffective. Instead, more standards are being developed and fielded by developers themselves, becoming the de facto standard bearers. Firms that can develop and implement successful standards in any large market sector will have a strong competitive advantage over the longer term.

Recommendation: The expanding need for integrated IT products and services emphasizes more than ever the critical role interoperability and standards play in the IT industry. With IT changing so rapidly, global standards must be developed and published faster than ever before. The IT industry must address the interoperability challenge with urgency. Government should take a back seat, acting only to facilitate global participation in standards setting efforts.

VI. National security implications for IT

The health and well-being of the IT industry is a vital national interest. The IT industry fuels the information revolution that is transforming America's economy, social interactions, domestic and international political relationships and military capabilities. IT serves as the catalyst for innovation, collaboration, economic growth, and political and economic liberalization everywhere that it is embraced. However, growing reliance on IT also creates a vulnerability that will require government and private enterprise collaboration in order to resolve.

Maintaining world leadership in the IT industry is crucial to maintaining a competitive advantage for the United States across all instruments of national power – economic, military, diplomatic, and informational. America must sustain an environment conducive to the level of innovation and entrepreneurial risk-taking necessary to continuously accelerate the development cycle time for new technologies. The U.S. must invest in educational programs to create a growing world-class workforce as well as increased funding for research and development to sustain the innovative spirit needed to keep the nation on the cutting edge. Also critical to innovation is government commitment to the free flow of information, the expansion of foreign markets, the security of the global information infrastructure and the protection of intellectual property.

While accounting for only eight percent of the national economy,[35] two-thirds of recent productivity growth in the United States is attributed to information technology.[36] In short, IT drives the economy. By fostering innovation, the U.S. achieves a multiplier effect required for higher productivity, long-term economic growth and a higher standard

of living. Highly skilled IT human capital provides the key to developing new industries while enhancing the competitive advantage of more mature industries. The demand for skilled IT workers will continue to increase; there will be greater competition for foreign IT workers as IT industries develop in other countries. Labor shortfalls will drive the cost of labor higher and slow product development cycle time, having a negative impact on global competitiveness. Adoption of strong policies to encourage greater numbers of U.S. citizens to choose IT careers is necessary.

Globalization has changed the international order. By facilitating the free flow of information, IT fosters economic prosperity and the development of a world community of democratic nations that adhere to free and open market principles. Those countries that seek to choke off this flow condemn themselves to economic and political isolation. Therefore, the U.S. must continue to develop and refine its dominant, IT-enabled economy and military capabilities while seeking long-term solutions to the root causes of political instabilities, where they exist.

The global proliferation of IT has vastly increased the potential for the use of information as a primary tool of the U.S. National Security Strategy. Therefore, government actions to secure the global information infrastructure must be balanced with the critical need to promote the free flow of information and the proliferation of information technologies. As well, the U.S. must provide leadership internationally to foster cooperation and collaboration in the IT domain. For instance, the U.S. must employ the information instrument of national power in a more sophisticated way in order to convince disaffected peoples that their best hope for progress is in seeking political reform leading to individual freedoms and responsible representative governments that join the global community of interconnected nations.

With over ninety-five percent of U.S. information infrastructure owned and operated by the private sector, close government-industry cooperation is essential to its safeguard. Government must assume ultimate responsibility for information infrastructure protection and must fund levels of security that are beyond the limits of private business risk.

A strong economy and a thriving IT industry provide the United States Armed Forces with unparalleled capabilities. Even with U.S. IT dominance however, potential adversaries could still make resourceful use of modest IT abilities and resort to weapons of mass destruction to pursue their political objectives. Over-riding strategic objectives remain to prevent the proliferation of weapons of mass destruction, the elimination of terrorist organizations with global reach and regimes that support them, and protection against physical and cyberterrorist attacks. Evolving capabilities to conduct IT-enabled military operations within an Information Operations context will be crucial to achieving these objectives. The U.S. military must continue its development of a dominant, knowledge-based, precision strike information age warfare capability.

IT proliferation, combined with the new dynamics post-September 11, have significantly altered and complicated the role of diplomacy in pursuit of national interests. The interconnected nature of the Internet and the “real time” media coverage of important

events made possible by satellite communications, have significantly altered the way that public opinions are formed. The ability for IT to carry a message directly to the peoples of other countries has transformed public diplomacy into a far more potent tool of national power.

American leaders may well find that rather than confronting, coercing, sanctioning and competing with potential adversaries to make them pursue U.S. policy preferences, it is more productive to cooperate, assist, and mentor these countries to foster IT-enabled economic growth, bringing them into the community of interconnected nations. This will require a longer-term, more patient view, but perhaps will result in a more comprehensive solution to the root causes of terrorism and international conflict. With this in mind, the U.S. should pursue initiatives to assist developing nations to execute appropriate national IT strategies to begin to build information infrastructure frameworks while educating an IT workforce that could result in an information-enabled economy.

VII. Conclusions: National policy recommendations

Four principal challenges within the IT sector have been identified: *security of the information infrastructure, IT workforce, allocation of bandwidth, and digital divide.* If the U.S. does not address these four challenges, it will not maximize the benefits the IT industry has to offer. The private sector, given an enabling environment, will deliver. The government must facilitate this enabling environment to nurture a strong IT industry, an industry in which the U.S. has a strong international competitive advantage.

Security of the information infrastructure. IT is a public good that not only serves the private sector but also ensures the critical national infrastructure. The USG must protect this infrastructure without impeding the innovation and competitiveness of the IT industry. As a first step, the USG should make clear who in the government is ultimately responsible and accountable for IT security. Only such an unequivocal IT "chief" can ensure against inconsistent regulations and enter a fruitful dialog with industry regarding issues like assigning liability for IT security breaches and striking the right balance between security and privacy. Next, the government must develop a national information security strategic plan – linked to a new National Security Strategy – that clearly and unequivocally delineates roles and responsibilities. In addition, the Federal government should mandate education programs for workers and school children in order to train the population on appropriate information security behavior and standards.

The DoD should develop offensive as well defensive information warfare capabilities. A defensive capability will allow the application of effective military power in spite of cyber-attacks. An offensive information warfare capability will deny any adversary an advantage through the use of the information domain.

IT Workforce. More can and should be done to ensure a sustainable supply of IT workers entering the workforce. The USG should establish a scholarship program – a Cyber Corps – for young IT up-and-comers. As well, final passage of the Technology Talent Act of

2001 will also help the supply of IT workers in both commercial and government spheres by supplying educational grants.[37] For the time being, USG should maintain the H-1B visa program. However, policy makers must look for long-term solutions that train U.S. citizens to be more competitive in the IT workforce – and these solutions demand fundamental reform in the education sector to raise math and science scores and reward higher quality teachers at all grade levels. Several policy options are available to the federal government in the IT workforce domain. In 2000, the Office of Personnel Management (OPM) established an increased pay scale for Federal IT workers, enabling Federal agencies to compete from a more level playing field for graduating IT workforce each year. This is a step in the right direction and should be sustained. Private sector stock options and other benefits are still lucrative attractions for the non-governmental positions. As well, the Federal Chief Information Officer's Council (CIO Council) introduced 13 primary recommendations for "creating a Federal IT work force that brings innovation and creativity to all Federal functions and improves the government's service and responsiveness to its citizens."[38] These initiatives should also be sustained to attract IT workers to government service.

Bandwidth. Passage of the Tauzin-Dingell bill would be one way to promote growth in the fiber optic domain. Ensuring unregulated Internet access is in the best interest of the consumer. Regarding the wireless spectrum allocation, however, government policies can and should do more. Currently, the military is the priority consumer on a major portion of the usable frequencies. However, because of the great increase in commercial demand for wireless spectrum and the economic importance of greater commercial wireless activity, the DoD must compromise on spectrum allocation issues. For now, commercial growth in fiber optics will satisfy the lion's share of new demand for greater bandwidth. But the DoD must prepare for change and be prepared to compromise. Setting target dates for sharing more bandwidth will also help the private sector prepare for greater growth into the wireless arena.

Digital divide. Two of America's primary national interests are: 1) expanding economic growth and 2) facilitating expansion of democratic principles internationally. IT not only provides information to disenfranchised populations that furnishes them with the ability to make choices (political *and* economic), it also promotes economic growth. Given U.S. competitive advantage in both domains, investments that ensure that more people and nations are "on the net" is in the United States' interest.

The U.S. Government must develop and implement policies that will create an enabling environment that will enhance the development of a secure IT sector while not creating negative secondary and tertiary effects. The challenges are vast. But U.S. economic strength, combined with strategic leadership, technological know-how and innovative spirit, provide a foundation for unprecedented opportunities. If U.S. leadership harnesses IT properly, the payoff will be increased global prosperity and improved opportunities for global peace.

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