Spring 2009
Industry Study

Final Report
Information and Communications Technology Industry

The Industrial College of the Armed Forces
National Defense University
Fort McNair, Washington, D.C. 20319-5062

INFORMATION & COMMUNICATIONS TECHNOLOGY 2009

ABSTRACT: The U.S. Information and Communications Technology (ICT) industry is economically vibrant, competitively innovative, and a key contributor to U.S. economic productivity and national well-being. The U.S. is the global ICT leader but its position is being challenged by China and other countries. The convergence of ICT technologies and the ever-increasing speed of information transfer are creating a "connectedness" that manifests itself through immediate, high-quality communication virtually anywhere on the globe. This connectedness brings many benefits but also comes with vulnerabilities as our dependence grows. Greater security and information assurance efforts are needed to protect individuals, businesses, and critical national infrastructure from cyber threats. The U.S. should continue to exert smart global leadership in the ICT industry, create conditions for continued innovation by supporting basic R&D and fostering high-tech education, and promote the benefits of increased connectivity that result from cloud computing and Web 2.0.

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PLACES VISITED

Domestic

BDA China, Washington, D.C.
Brocade Communications, San Jose, CA
Center for Strategic and International Studies, Washington, D.C.
Cisco Systems, San Jose, CA
Comcast Corporation, Washington, D.C.
CTIA – The Wireless Association, Washington, D.C.
Federal Communications Commission, Washington, D.C.
Google Incorporated, Washington, D.C.
ICSA Labs, Mechanicsburg, PA
Information Technology and Innovation Foundation, Washington, D.C.
International Business Machines, Washington, D.C.
Juniper Networks, Mountain View, CA
Microsoft Corporation, Washington, D.C.
National Association of Manufacturers, Washington, D.C.
National Cable and Telecommunications Association, Washington, D.C.
National Telecommunications and Information Administration, Washington, D.C.
Nortel Government Solutions, Fairfax, VA
Northrop Grumman, Arlington, VA
Novak Biddle Venture Partners, Bethesda, MD
Oracle, Redwood Shores, CA
Semiconductor Industry Association, San Jose, CA
Software Information Industry Association, Washington, D.C.
Sprint-Nextel, Reston VA
Sun Microsystems, Santa Clara, CA
Technology Association of America, Washington, D.C.
U.S. Chamber of Commerce, Washington, D.C.
Verizon Communications, Washington, D.C.

International

American Chamber of Commerce, Beijing, PRC
American Chamber of Commerce, Hong Kong
American Institute in Taiwan (AIT), Taipei, TW
BenQ Corporation, Taipei, TW
BDA China, Beijing, PRC
China Mobile, Guangzhou, PRC
Chinese Academy of Telecom Research, Beijing, PRC
Chunghwa Telecom, Taipei, TW
Cisco Guangzhou Technology Center, Guangzhou, PRC
CSL Limited, Hong Kong
FarEasTone Telecom Co, Taipei, TW
Guangdong Communications Administration, Guangzhou, PRC
Huawei, Shenzhen, PRC
Microsoft Guangzhou Technology Center, Guangzhou, PRC

PCCW, Hong Kong
REACH Teleport, Hong Kong
University of Posts and Telecommunications, Beijing, PRC
U.S. Consulate, Guangzhou, PRC
U.S. Consulate, Hong Kong

INTRODUCTION

In 1929, two American Telephone and Telegraph (AT&T), Inc. engineers applied for a patent for a revolutionary transmission system based on the coaxial conductor—the first broadband coaxial cable. Their efforts paved the way for inter-city distribution of moving images and what would become modern television and set the stage for the dynamic, fast-paced, high-technology environment known as the Information and Communications Technology (ICT) industry.[1]

Information and communications technologies are pervasive in today's society and can no longer be portrayed as mere enablers of business and defense activities; instead, they must be seen as essential components that are crucial to the success of both business and national defense. Overall, the industry is performing well, provides a solid foundation for maintaining the nation's competitive advantage, and is widely recognized as a critical component of national security.

Access to the internet is expanding, internet use is increasing, and both businesses and individual consumers are demanding products and services that facilitate mobility and provide an enriched experience. That demand is fueling market competition and spurring the high degree of technological innovation that characterizes the ICT industry.[2] The innovative nature of this industry is reflected in its heavy investment in research and development (R&D). As of 2005, ICT industry investment in R&D, patents, and venture capital was three times larger than that in other industries, such as motor vehicles, chemicals and pharmaceuticals.[3]

The investments in R&D are paying off with transformative and popular products such as the Apple iPhone and leading to a convergence of technologies. Not only does this convergence enable users to surf the internet and watch streaming video on hand-held wireless devices, it also allows them to order wireless services and cable television from what were once traditional wireline telecommunications companies. This convergence of technologies is blurring the lines between telephone and cable, between voice, video and data, and between mobile and fixed infrastructure. This trend is likely to accelerate.

The emergence of what many are calling a second generation internet, or Web 2.0, is allowing people to discover, connect, communicate with, and organize to create informed group action more readily than ever before. Some of the fastest growing and most popular software applications are those specifically designed to connect people.

Just as consumers are warming to the idea of social networking, the government is also beginning to leverage its possibilities. The Air Force is using Facebook, Twitter, blogs, and YouTube to "humanize the Air Force,"[4] and the Coast Guard Commandant employs a Facebook fan page.[5] Today's technologies are enhancing national security by producing a "connectedness" that manifests itself through immediate, high quality communication virtually anywhere on the globe.

Throughout the 1990s the ICT industry was a significant driver of the U.S. economy. Now – in the first decade of the 21st century – unprecedented demand, a competitive

environment, and attractive new technologies are combining to reinforce this record of strong performance and solidify the ICT industry's position as a driving economic force for the future.

THE INDUSTRY DEFINED

For the purpose of this study, the ICT industry may be defined in an abbreviated fashion as: communication services, including telecommunications, cable and satellite; software design and publishing; hardware manufacturing (including computer and telecommunications equipment); ICT consulting; and internet search engines.

CURRENT CONDITION

In some ways, the internet is old news. An increasing portion of the U.S. population can scarcely remember not being able to get information through a computer connection. The internet business has already gone through a boom-bust cycle – the "dot com" crash of 2000-2001.[6] However, information technology continues to fuel the economy even through the current recessionary down cycle, and Moore's Law – which decrees that computer processing power doubles every two years – is relentless. Computer memory and high-speed processors cost less than a penny on the dollar of a decade ago. Additionally, wired and wireless networks carry information to consumers at rates thousands of times greater than a decade ago – to places previously disconnected from the modern world. These trends of increased computing power, cheaper memory, higher throughput rates, and greater mobility are redefining the ICT industry. The industry as a whole is growing, converging, and a key element of U.S. competitive advantage and national security.

United States

Communications Service Providers

State of the Sector: The communications service provider sector includes firms that provide voice, video, and data services through wired and wireless telecommunication systems, satellites, cable, and internet protocol (IP) networks. Collectively, these firms generate an estimated $500 billion in revenue[7] [8] [9] [10] and 2.4% of the nation's gross domestic product (GDP),[11] directly employing 1.2 million people.[12] Traditionally, wired telecommunication firms have dominated this industry. They were highly regulated, but operated in an atmosphere of low competition because of high entry barriers driven by infrastructure expenditure requirements, licensing structures, and protection from international competition. However, deregulation has loosened this stranglehold, and technology has brought about dramatic change over the last 15 years.

The overriding factor driving these changes has been convergence: a convergence of networks, markets, industries, and devices spurred on by the rapid expansion, affordability, and miniaturization of computing power. These advances have enabled a giant leap in the amount and types of information that can flow across phone, cable, IP, and wireless networks. They have also allowed an individual packet of information to flow across multiple networks on its path from source to end point.[13]

The convergence of networks and data flow is spurring unprecedented competition as cable companies such as Comcast and Time Warner go head-to-head with telecom giants AT&T and Verizon in the internet, cable, and telecommunications markets. Additionally, hundreds of upstart voice over internet protocol (VoIP) providers and resellers now compete with incumbent firms for telephone service. Moreover, the expansion of broadband wireless networks, combined with new "converged" multifunctional mobile computing and communications "smart phones" such as the iPhone and Blackberry, have given customers the option to drop wired telephones altogether.[14] Indeed, the lines that formerly demarcated internet service providers (ISPs), cable companies, and wired and wireless telecom providers are now increasingly blurred. In order to remain competitive, most of the largest providers offer at least three of these four services in bundled packages. This groundswell of competition has resulted in steadily falling prices, improved service quality, faster internet speeds, convenient bundled services, and inexpensive cellular handsets. For the U.S. government (USG), this has meant lower operating costs and improved worker productivity and mobility.

Trends: With the exception of wired telecommunications, this sector is transitioning from a phase of rapid growth to a more mature stage, as both the wireless telephone and internet service markets are approaching subscriber saturation.[15] [16] Despite recent mergers, competition should remain intense over the next several years with a focus on high data rates and value added services that include enhanced content. ISPs are taking significant risks and making huge investments in infrastructure to deliver ever increasing broadband service and speed to demanding consumers. Cable firms are collectively spending over $10 billion a year to expand and upgrade their infrastructure, and Verizon – once recognized solely as a telecommunications provider – will spend $23 billion over the coming years, betting that its fiber-to-the-home initiative will steal customers from *cable* providers.[17]

On the wireless side, firms are investing heavily in the development of fourth generation (4G) broadband technology, with some firms backing Long Term Evolution (LTE) and others its competitor, Wi-Max.[18] For wireless firms who are increasingly dependent on data services for revenue, the outcome of this battle is crucial. Additionally, the iPhone and other smart phones, with their vast array of applications, are disrupting the balance of power, changing the role of mobile handset manufacturers and threatening to commoditize wireless service.[19] The success or failure of these investments will play a key role in determining how this sector matures.

Software Publishers

State of the Sector: The software sector is a key enabler of the global economy; its innovative products have dramatically improved productivity around the world. Although Microsoft is the first name in software for many, this sector extends well beyond Microsoft's primary role of providing software applications and related web-based services. The software sector is among the fastest-growing and most important sectors of the U.S. economy, reaching $150 billion in revenue and nearly 350,000 employees in 2007.[20] Margins in the software sector are among the highest of any large industry, and barriers to entry are low, so the market continuously attracts new competitors.[21] While there is increased global competition, U.S. firms such as Microsoft, IBM, Oracle, and Symantec are the dominant players in the global software publishing sector. Exports of U.S. software firms were $28 billion in 2007 while imports were negligible.[22]

The main drivers of growth in software are operating systems, database management software, and business applications such as enterprise resource management, customer relationship management, and supply chain management software – all important applications for the Department of Defense (DoD). While the overall software sector is contracting slightly during the current economic downturn, these software segments will continue to grow as companies seek new ways to cut costs and improve inventory and process management.[23]

Trends: Numerous challenges, issues and innovative trends are emerging throughout the U.S. software sector. The most notable trend is known as software as a service (SaaS). Software publishers are migrating from packaged delivery of software that is installed on an individual computer to a service accessed via online subscription, with the software application and most data retained at the software firm's central data center. By maintaining greater control of their products, software firms can not only enhance service through constant product updates but also mitigate software piracy and other intellectual property rights concerns.

A growing share of software development is moving towards open source applications, such as Linux and MySQL. Open source software relies on collaboration between software firms and lowers development costs, threatening proprietary software vendors such as Microsoft and Oracle. This trend promotes interoperability and software development by smaller competitors.

Off-shoring is another key for the U.S. software sector. U.S.-based firms face increasing price competition and are moving R&D offshore to countries where labor costs are less expensive. Robust information-sharing networks allow software development processes to "follow the sun" around the globe, creating a 24/7/365 development cycle. While this trend keeps U.S. software firms competitive and brings products to market more quickly, it challenges U.S. employment and has security implications for the development of software for DoD.

Hardware Manufacturers

State of the Sector: The U.S. ICT hardware manufacturing sector is primarily comprised of large firms designing and producing computers, peripherals, networking equipment, and storage devices. In the face of intense competition and falling prices, companies like HP, Dell, Cisco, and Juniper stay competitive by creating innovative products, streamlining sales and inventory processes, and by increasingly moving manufacturing offshore. As a result, the industry has been able to draw profit margins of 14-20% despite flat revenues in the $90-95 billion range over the past four years.[24] [25] Revenue has remained steady because increased sales of networking and switching equipment have offset drops in computer and peripheral revenue. The U.S. hardware industry is increasingly globalized, with exports at $58 billion and imports at $120 billion in 2008.[26] [27] While R&D and product development still take place in the U.S., manufacturing processes are increasingly being moved overseas where labor and facilities costs are frequently lower. As a result, U.S. employment in this sector plummeted from 139,000 in 2005 to an estimated 105,800 in 2009.[28] [29]

Trends: While the overall revenue trend for hardware manufacturing may appear troubled, there are some growth areas. These areas are being driven by concept known as

"device 2.0." This concept of computing is made possible by today's fast, reliable IP networks and relatively inexpensive centralized computing and storage. Leveraging these developments, consumers and businesses are buying smaller mobile computing devices that have *just enough* computing power, storage, and communications capabilities to accomplish tasks while reducing costs and improving mobility. This new trend is driving rapid growth in the purchase of smart phones and netbooks, which are less than half the cost and size of a laptop, yet have much of the same functionality. An explosion in growth of netbook sales has come at the expense of PCs and laptops, and unfortunately for manufacturers, they also generate much smaller margins.

At the other end of the spectrum, the emerging focus on mobility, SaaS, and cloud computing is driving significant capital investments in data centers. These $600 million facilities require hundreds, if not thousands, of network routers, switches, and high-speed storage devices to support the skyrocketing demand for content. Text and voice are no longer sufficient; video is the new medium of choice, and these centers are essential to its storage and distribution. This trend bodes well for firms who are positioned to equip these centers.

ICT Consulting

State of the Sector: ICT consulting is a diverse, competitive sector that contributes greatly to the competitiveness of U.S. industry and the effectiveness and efficiency of government. ICT consulting firms provide expert advice, assistance, and customization and integration of systems, software, web services, and communications networks.[30] U.S. ICT consulting firms employ 1.5 million people and generate nearly $250 billion in revenue and $6 billion in exports. While International Business Machines (IBM) and Computer Sciences Corporation (CSC) are two of the most familiar firms, this sector is characterized by small firms and individual consultants. Of the 105,000 ICT consulting firms in the U.S., 85% employ less than ten people.[31]

ICT consulting sector growth has outpaced U.S. GDP growth since the turn of the millennium, fueled by strong demand from the finance, banking, and insurance sectors, which generate 40% of the sector's revenue.[32] In addition, U.S. firms are increasingly willing to outsource ICT support in order to contain costs and risk. Growing federal budgets, particularly in the ICT-intensive homeland security and defense arenas have also driven growth. Margins are high (over 21% in 2007),[33] and entry barriers are low since the main input is human capital and expertise. These factors have increased investment and interest in this industry, leading traditional software firms like Oracle and Microsoft to establish consulting enterprises – including offices overseas.[34]

Trends: Globalization and off-shoring are the primary factors that will impact this sector in the future. Like the software sector, large consulting firms are taking advantage of high talent and low labor costs in other nations. While in the past, only routine support was sent offshore, increasingly sophisticated products and support are now being sent overseas. Imports in this sector are small, but growing faster than U.S. consulting service exports. Although off-shoring will keep the larger consulting firms competitive with their Asian competitors,[35] it may eventually negatively impact the sector's ability to serve DoD and national security interests by decreasing the pool of cleared U.S. citizens capable of providing some critical services.

Internet Search Engines

State of the Sector: Perhaps no industry sector demonstrates the innovation and success of the ICT industry over the past decade more than the internet search engine sector. Rising from the ashes of the turn-of-the-century high-tech flameout, this industry sector has become one of the fastest growing and most profitable in the U.S., with average profit margins of over 24%.[36]

This sector has blossomed because of the popularity of the internet and e-commerce, its business model which subsidizes free, useful consumer services with advertising revenue, and its ability to deliver cost-effective, highly focused advertising. This has allowed search engine sites like Google, Yahoo!, and MSN, which combined account for 90% of industry revenues, to attract an ever larger share of advertising dollars that previously went to other media. As these search engine sites have become more popular, they have developed an increasing array of free services which attract even more long-term visitors and thus more advertising revenue. For example, Google now offers free email, file storage and sharing, web-hosting, chat, and collaboration tools. Since 2000 this industry has grown from an idea to a $20 billion a year industry.

Trends: Despite the rapid growth in this sector, internet advertising still only garnered a 7.6% share of the $150 billion U.S. advertising market in 2008.[37] This sector will therefore continue to grow as the recession hastens migration of advertising to the internet, which provides cheaper and more focused ad campaigns to cash-strapped firms that must be increasingly cost-effective with their marketing budgets. As the search engine industry matures, growth rates are expected to slow significantly, particularly as other online services take advantage of its new business model.

Firms in this sector will continue to be highly innovative as they vie for faster and cheaper ways to provide results, attract users, and extract advertising dollars. For example, a new startup called Cuil claims it has indexed over 120 million websites, three times that of Google. More importantly, it uses algorithms which allow site indexing with fewer servers than Google, reducing their overhead. Whether Cuil succeeds has yet to be determined, but it illustrates this industry thrives on innovation and employing the newest, most disruptive technology first.[38]

The biggest future threat to the large search engine firms' profitability may be their own appetite for market share. With significant cash reserves, search engine firms are paying large amounts to acquire complementary and immensely popular web sites, especially social networking sites like YouTube and Facebook. The problem is that while these sites have a huge clientele, they are hard to monetize. For example, Google spends around $360 million per year to operate YouTube, but only generates about $200 million in revenue.[39]

The U.S. and the Global ICT Industry

The U.S. is widely acknowledged as the most important engine of global economic growth and is considered to be the preeminent leader and driver of innovation in the global ICT industry. Therefore, while the U.S. may not be the world's leading provider of a *specific* ICT product or service, or have the world's most advanced ICT *infrastructure*, when the size of the U.S. economy is coupled with its ability to leverage the ICT industry, U.S. leadership of the ICT

industry appears guaranteed. This position is of vital importance to the United States, contributing significantly to U.S. economic well-being and national security.

The global ICT industry, however, is intensely competitive and many nations seek to equal or surpass the U.S. They view the development of their ICT industry and infrastructure as the underpinning of their nation's economic health and international stature. The European Union is a key competitor, and European countries claim nine of the top ten rankings on the International Telecommunications Union's (ITU) ICT Development Index (IDI).[40] Japan, Korea and Taiwan are also global ICT powerhouses that have used the "Asian model" of government-directed, export-led growth to build "state-of-the-art" ICT infrastructure and world-class ICT businesses. For example, Japan has developed "the world's fastest and cheapest broadband environment,"[41] Korea ranks number one on the ITU's Digital Opportunity Index and Korea's premier ICT firm, Samsung Electronics, out-spends every ICT firm in the world on R&D[42], and Taiwan, with just over 20 million people, is the third largest producer of IT products in the world,[43] including 75% of the world's personal computers.[44]

India and China are the up-and-comers. India, with an extensive, well-educated and English-speaking work force, is excelling in software development and benefiting greatly from outsourcing, off-shoring and the return to India of experienced workers from the U.S. China, with a population of 1.3 billion, has the world's largest fixed-line and mobile network in terms of both capacity and subscribers. China boasts world-leading connectivity with 630 million mobile phone users, currently adding over 7 million new users per month, and roughly 300 million internet users, almost more than the U.S. population.[45] Given its vast human resources and market size, high growth rates, extensive government support, and ambivalent security relationship with the United States, China is the country in the strongest position to challenge future U.S. leadership in the ICT industry and markets.

Other regions are not as advanced in the ICT arena, but most are striving to catch up. Latin America, led by Brazil and Mexico, has applied significant resources to bridge the 'digital gap,' reduce income inequalities, and generate robust economic growth. Similarly, although Middle East ICT capabilities lag significantly behind those of developed countries, Middle Eastern countries are looking to the ICT industry for future growth. This is part of a strategy to reduce their dependency on oil-based resources as the world looks for alternative energy resources. Africa is even further behind, and although its ICT capabilities are spreading as the cost of basic ICT services drop, Africa's lack of ICT development raises the concern that the "digital divide" is growing and could persist in the face of poverty, underdevelopment, and political instability.

KEY ICT DEVELOPMENTS

Internet Use

Internet use continues to increase rapidly, enabled by improving ICT infrastructure. Worldwide, 1.5 billion people are online, representing 23.2% penetration of the world's population, up from only 7% eight years ago. The largest number of internet users is in China (300 million, 22% penetration), but penetration rates are highest in Europe and the United States (74% of Americans used the internet in 2008, up from 56% in 2000). Fixed broadband

connectivity is also expanding quickly, but developed countries are outpacing the developing world (19.4% to 2.2%). Wireless telecommunications have grown sharply worldwide (it now triples wired phone lines), but again mobile internet access has risen primarily in the developed countries (14% versus 0.9% in the rest of the world). While increasing investment in 3G/4G globally holds promise to close that gap, it is America, Europe, and parts of Asia that dominate the internet.[46]

In the United States, the younger generations still form the majority of the adult internet population[47], but older Americans are increasingly online. In 2008, 45% of people in their 70s were online, up from 26% in 2005[48], and women over 55 are the fastest growing group of Facebook users.[49] Online activities vary by age: teens and Generation Y use the internet primarily for entertainment and networking, while older generations are more inclined to look for information (i.e., searching for healthcare information) and use email. Among teens, the most popular activity by far is online gaming.[50] Email is the predominant communication method for Generation X and older, but among younger internet users, email popularity has declined. Social networking is now a more common online activity globally than email among all users.[51]

Internet Trends

Web 2.0

Web 2.0 refers to new ICT capabilities – made possible by next generation technology and software applications – that enable enhanced two-way communication and collaboration over the internet. These capabilities were dubbed "Web 2.0" to distinguish them from previously one-way web page interface.[52] Web 2.0 and social software are largely overlapping, and represent dynamically hyperlinked multi-sourced content "mashed" together for user interface, which allows readers to alter and publish their own content. Web 2.0 applications are on the way to becoming the predominant format on the internet. Of the top 50 internet sites, 21 are predominantly Web 2.0 while most others have portions that provide collaboration or user generated content.[53] Among social networking sites, perhaps the most important and fastest growing are Facebook,[54] YouTube,[55] and Twitter.[56]

Web 2.0 allows for groups to form, organize, coordinate and collaborate for almost any purpose. Such groups can be preexisting or completely ad hoc, formal or informal, centrally-directed or consultative, static or constantly changing. Organizations including businesses or government agencies can use such social software to "grow" their group virtually. However, Web 2.0 capabilities could also be exploited by criminal or terrorist groups to further their objectives. DoD and other USG agencies must monitor this threat closely.

President Obama has accelerated government use of social software—sometimes termed "Gov 2.0"—in all its forms. Immediately post-inauguration, the President issued a memorandum on "transparency and open government," in which he set forth the guiding principle that government should be transparent, participatory, and collaborative in order to "promote accountability," take advantage of "dispersed knowledge," and "engage Americans."[57] He also appointed the former Washington D.C. Chief Technology Officer, Vivek Kundra, who had implemented aspects of Web 2.0,[58] to fill the same position in the White House and implement the technological aspects of the transparency imperative. As a result, the President energized the

wider government and technology community; there already have been numerous conferences, blogs, and social networking focusing on transparency and Gov 2.0 implementation.[59]

Cloud Computing

Cloud computing is the provision of computer applications and services over the internet rather than through software loaded on a PC or an organization's information system.[60] While the concept is not new, cloud computing is now emerging as a commercial and disintermediating force.[61] By pushing the most significant computational workload to regional data centers, it diminishes the need for the processing-intensive individual 'desktop' computing model and hardware. The attractiveness of cloud computing stems from the ability of software providers to develop, deploy and run applications that are scalable, offer fast performance and high reliability, and generate little concern over the nature and location of the underlying infrastructure.[62] Convenience, flexibility and low cost are the driving force behind why 69% of American internet users have used some form of cloud computing, like webmail, online storage, or system backup services.[63] Examples of service providers include Google's net-based email service called Gmail, and storage solutions like Amazon's Simple Storage Service that offers inexpensive and unlimited online storage.[64] While large companies are doing the heavy lifting of building and supporting the data centers needed to support cloud computing, small and medium-size companies are most likely to take advantage of the new services.[65] While DoD and USG agencies may be reluctant to take advantage of cloud computing because of security concerns, huge cost savings await any agency that effectively mitigates these concerns.

Social Networking

Just as cloud computing is poised to change the way software and hardware are used, social software is changing the way people interact and exchange information. "More people can say more things to more people than ever in history,"[66] observes internet visionary Clay Shirky. In his book *Here Comes Everybody*, he describes the increasing power of individuals relative to the traditional hierarchical structural power of businesses and government. People can now discover, connect to, communicate with, and organize informed group action more readily than ever before. Software applications specifically designed to connect people are among the fastest growing and most popular applications anywhere. Social networking is now more popular on the internet than email. USG agencies, including DoD, should look for ways to use social networking to convey their messages to the U.S. and international public while also developing measures to counter similar efforts by adversaries.

The wide array of technology and applications that make up Web 2.0 are resulting in fundamental changes in social and business interaction. By changing the manner in which people communicate, the rapid convergence of ICT elements is transforming entertainment, financial management, and business. The underlying theme of this advance is ubiquitous connectivity that enables meaningful social networking in ever-widening circles. Industry and government should continue to utilize such empowering technologies to achieve their objectives.

ICT AND THE FEDERAL GOVERNMENT

The U.S. Government plays two significant roles in the ICT industry: as a regulator it safeguards the public good through policy and regulatory initiatives, and as a consumer it

stimulates the development of the ICT industry through its acquisition and procurement decisions.

Role One: Regulator

A key feature of the regulatory environment in the U.S. is its conduciveness to innovation. From a financial system that enables the development of venture capital firms to bankruptcy laws that provide a "soft landing" for failing businesses to a strong IPR regime that fosters invention and creativity, the regulatory structure in the U.S. is clearly designed to enable innovation.

Considering the key role ICT plays in economic development, regional planning, and social networking, it should be no surprise the USG has taken a special interest in the ICT industry.[67] That interest has manifested itself in varying levels of regulation across ICT industry segments. In the aggregate and compared to other countries, the U.S. ICT industry is regulated at a moderate level. Regulation is decreasing for most of the heavily regulated segments, including cable television and network providers and communication equipment manufacturers; remaining steady for segments with a medium level of regulation, including the wireless, wireline, and satellite telecommunications providers and recordable media manufacturers; and increasing for most of the lightly regulated segments, including computer and peripheral manufacturers, ICT consulting firms, software publishers, search engines, and internet service and VoIP providers.

For consumers, the results of ICT industry regulation have been mixed. Finding the balance between effective industry regulation and full and open competition is not easy. This delicate balance is maintained very well in the area of radio frequency (RF) spectrum management, which is executed domestically by the Federal Communications Commission and the National Telecommunications and Information Administration, and internationally by the ITU. These agencies have historically regulated in a manner which supports the *idea* of balanced spectrum management, achieving critical buy-in from the beneficiaries of this public asset. Although a strong case is often made for less regulation or even deregulation of the ICT industry, consumers and legislators should be reminded that there are consequences to leaving markets to self-regulate, as is apparent in the current state of the unregulated sectors of financial markets.

Many regulators, primarily in other countries but to some extent in the U.S. as well, have been unable to keep pace with the rapidly changing ICT industry, and regulatory reform is needed. The ITU advocates for global ICT regulation that: (1) establishes independent entities to develop regulatory mechanisms for interconnection, licensing, and tariff rebalancing; (2) sets deadlines for the termination of market exclusivities in order to prepare incumbents for increasing competition; (3) allocates scarce resources in a non-discriminatory manner; (4) expands access to ICT networks and services; and (5) promotes consumer interests.[68] Regulatory reform will enable the ICT industry to continue to evolve well into the 21st century. Reform in the U.S., when appropriate, should reinforce American competitive advantage in the ICT industry.

Role Two: Consumer

As a consumer, the USG both procures commercial off-the-shelf (COTS) equipment for use in government networks and develops customized systems to meet mission-specific needs. These needs are arguably more complex than those of any other corporate user: a worldwide network with thousands of users at multiple security levels connected via diverse means ranging from trunk lines to UHF radio data links. Notwithstanding the size of this network, the USG's ability to drive the industry as a consumer is limited: even though the USG is Microsoft's largest single customer, its procurement represents only 1% of Microsoft's annual revenues.

COTS Software

A recent ICAF speaker noted that the era of large system "acquisition" is over, and that future needs would be met through smaller "procurement" efforts, meaning that technology is now standardized enough to push purchasing decisions to the lowest levels. This is particularly true in the ICT industry, where the USG often uses hardware and software that is largely the same as commercial systems. While not all agencies have fully adopted the U.S. Air Force's construct of a single configuration computer,[69] ICT industry interface with the majority of government users is minimal and installation-level personnel typically manage and service USG systems.

Custom Software & Specialized Systems

For specialized mission-related ICT needs, the USG is still developing and acquiring large IT systems. Primary examples include the DoD's Net Centric Enterprise Services (NCES) and Net Enabled Command Capability (NECC) contracts. NCES builds a "secure, agile, robust, dependable, interoperable data-sharing environment for DoD where warfighter, business, and intelligence users share knowledge on a global network."[70] Similarly, the $600 million NECC program "is the DoD's principal C2 capability focused on providing the warfighter with the data and information needed to make timely, effective and informed decisions."[71]

A paradigm shift is required. In the area of custom software, DoD often defaults to creating systems that operate within established processes. Software is modified to fit the process, regardless of the efficacy of the process itself. DoD should use existing tools in a more effective manner and investigate changing processes to take advantage of features resident in these tools. Government 2.0 is a step in the right direction, one that leads back to COTS solutions.

Government 2.0

"Gov 2.0." is the term for government use of Web 2.0 technology and is being implemented at an accelerated pace in response to the President's Open Government mandate. Such efforts take advantage of Web 2.0's ability for groups to dynamically form, organize, coordinate, collaborate, and evolve for almost any purpose. These efforts represent a move toward greater government transparency and operating effectiveness. Notably, many executive branch departments – including DoD – have already begun to employ these tools for both formal and informal information sharing and mission-oriented applications;[72] this trend should continue.

CHALLENGES

At the dawn of the 21st Century the U.S. ICT industry faces a variety of challenges. The two foremost challenges facing the ICT industry are: sustaining competitive advantage and adequately addressing security issues.

Sustaining and Protecting U.S. Competitive Advantage

U.S. leadership in the ICT industry, once a given, is increasingly difficult to sustain. China, India, Taiwan, and some Eastern European nations are beginning to challenge U.S. primacy in this industry. U.S. competitive advantage is mostly derived from its strong culture of innovation. This culture springs from a vibrant venture capital industry that provides funding for risky start-ups, a robust body of commercial law, an education system that values creative thinking and innovation over rote memorization, and robust intellectual property rights protection. The U.S. also has a long history of producing or attracting from other countries the human capital necessary to sustain the ICT industry. Going forward, however, U.S. firms may need to be more aggressive to counter a decline in the number of commercial research and development laboratories and domestic science, technical, engineering, and mathematics graduates. Sustaining U.S. competitive advantage is further complicated by the growing belief that another nation will one day supplant the U.S. as the dominant industrial powerhouse.

Security

As the world becomes increasingly connected, capabilities once considered luxuries now become necessities. The internet, once the playground of the scientific elite, has become – if not the backbone – no less than the central nervous system of modern society. Internet outages, once a mere inconvenience, are now in some cases literally a matter of life and death as VoIP providers begin to dominate the telecommunications infrastructure that brings critical emergency services. Beyond physical security and safety, security in the cyber realm may be challenged by both internal and external threats. The hardware and software at the core of the U.S. ICT infrastructure are vulnerable to malicious and unintended activity from both traditional and non-traditional threats, including carelessness and operator error. With increased dependency comes increased vulnerability, and the U.S. must take a leading role in securing the infrastructure on which the nation's economy and security depend.

Two lesser challenges to the ICT industry are the current recession and standards and regulation.

The Global Recession: As producers of both goods and services for an ailing economy, ICT industry members are far from immune from the effects of the current global economic crisis. Depressed business and consumer spending is resulting in lower profits and forcing layoffs across the industry. However, the overall ICT industry should be impacted *less* by the recession than other elements of the global economy. For example, while travel budgets are being slashed, ICT investments enable the conduct of business via video teleconferencing applications such as Cisco's TelePresence system. In addition, because of the convergence of communications and internet services, cable television and internet service providers are increasingly providing critical services – services that cannot be neglected even in time of financial crisis.

Regulation: The traditional U.S. approach to regulation has been to create a largely hands-off, market-driven environment that balances the development of strong private firms with the assurance of high-level service to the public. An alternate regulatory model – seen explicitly in China, but present in other nations as well – is very hands-on, unafraid of deep dives into matters such as directing the licensing of technology between firms, significant government ownership, or asymmetric regulations that attempt to manage the market. Without exception, the U.S. firms visited during the course of this study insisted that "less regulation and government involvement is better," but the absence of regulation is fraught with perils all its own.

ESSAYS ON MAJOR ISSUES

Security in the Information Age (Col James Gfrerer)

ICT has become a great enabler of the American society and way of life. ICT is now a national *critical capability* – something without which society cannot function. As such, ICT has equally become a national *critical vulnerability.*

The speed, tempo, and accuracy with which information may be leveraged have increased the effectiveness of all elements of U.S. national power at a lower cost than that of any of U.S. ally or competitor. Further, U.S. industry and defense systems – and system of systems – have become completely intertwined and dependent upon ICT. This dependency and connectedness creates a strategic fragility within the U.S. critical infrastructure (CI), demanding protection at multiple levels. ICT critical infrastructure protection (CIP) and communication in an emergency environment are therefore fundamental to our national security. The security and protection of these ICT systems are also closely related to the issues of internet privacy and IP security. Clearly, there is a tradeoff between security, privacy and transparency. Achieving the appropriate balance between these objectives is a significant challenge for policymakers.

Protecting ICT Critical Infrastructure

The complexity and depth of the ICT industry continue to increase as the use of ICT expands into other industries. Further, as the ICT industry evolves, two complimentary themes emerge: (1) increasing functionality and capability and (2) ever-increasing consolidation and concentration of the internet backbone. As such, protecting the ICT critical infrastructure is even more challenging and important, given our growing dependence on ICT for economic vitality and national security. The following policy recommendations are proposed as a way to improve National Security (NS) and Emergency Preparedness (EP) communications.

National Policy and Strategy: Information and communication technologies underpin all of our elements of national power. As such, it would make sense to have a national metric to determine whether our ICT systems are able to operate in an NS/EP environment. With upwards of 85% of the ICT infrastructure in the private sector, security can be seen as a high-priced externality and a drag on efficiency. To drive a new, more secure posture, some portion of the cost of all ICT systems should be dedicated to infrastructure protection to better ensure availability during NS/EP scenarios. Given the recent national disasters and terror attacks, the Congressional Committee on Homeland Security and Subcommittee on Emergency Communications, Preparedness, and Response[73] tend to be proactive regarding the role of the USG in the NS/EP effort. Unfortunately, industry representatives and policy experts have

observed that there is a significant lag between policy guidance and industry implementation. The real focus for lawmakers, therefore, should be on resourcing issues, including prescriptions for taxes and tax credits to monetize the cost of insuring against the potential of an 'ICT 9/11.'

Office of National Information: The United States would benefit from a more holistic view of information, communication, and the ICT infrastructure. Too many aspects of information are unsynchronized, and thus less effective. Just as the other elements of national power have a single process owner, information management and protection of the ICT infrastructure may benefit from a National Security Council-style fusion and ownership. Appointing a Chief Technology Officer or Chief Information Officer[74] alone is insufficient. This process owner must truly understand both the opportunities – and, in the case of CIP, vulnerabilities – of information *and* the infrastructure on which it depends.

Comprehensive National Cyber-Security Initiative (CNCI): Since the President established the CNCI in January 2008, enormous attention has been focused on the newly-labeled "cyber domain" and infrastructure protection and efforts to respond to and recover from attacks. The most unique aspect of this domain, however, remains the legal aspect. With the borderless and anonymous nature of the cyber domain, serious challenges confront our ability to protect and ensure security and national sovereignty.[75] The U.S. and the international community must better define the law surrounding cyberspace, including what constitutes an "act of war", given the serious and catastrophic consequences that cyber-related CI attacks can cause.[76]

Information Professionals: Human capital concerns are becoming more of an issue in the CIP arena. Ironically, two decades into the information age, the U.S. is still not investing as much as necessary to develop information security experts. The USG should, as the U.S. Navy has already done, establish an "Information Professional" specialty corps that focuses on areas such as NS/EP. This corps would further bolster U.S. capabilities to meet future threats.

Privacy and Transparency

The specter of identity theft calls for complete privacy; President Obama's open government initiative calls for complete transparency. While absolute privacy within the ICT domain is impossible, and absolute transparency is foolhardy, the industry's challenge is to act in a manner where all information is handled with appropriate degrees of both. Online shopping, for example, requires each transaction to be transparent enough to ensure both parties have confidence in the identity of the other, yet private enough to ensure no one outside the transaction can alter or manipulate it. Resolving this tension is a critical issue for the ICT industry, as its continued expansion depends upon the ease with which billions of online transactions take place every day across the globe.

Security and Internet Protocol Version 6 (IPv6)

The daunting task of balancing security and convenience in the ICT realm is eased by Internet Protocol Security (IPSec), a suite of protocols for securing IP communications by authenticating and encrypting each IP packet of a data stream. IPSec includes protocols for establishing mutual authentication between agents at the beginning of an internet session and negotiation of cryptographic keys to be used during the session. IPSec can also be used to

protect data flows between a pair of hosts (e.g. computer users or servers), between a pair of security gateways (e.g. routers or firewalls), or between a security gateway and a host. The grand improvement in IPSec comes with the implementation of IPv6, which facilitates a world where every grain of sand can theoretically have its own IP address. This matters because of the proliferation of connectivity, with every conceivable device being linked in, and thereby requiring an IP address – one that is secure and addressable.

The U.S. has come an incredibly long way in securing ICT critical infrastructure, but with each passing day, new threats and vulnerabilities arise. Enabled by IPv6, communication capabilities continue to expand in both the everyday "steady-state" and emergency parts of the NS/EP environment. With this expansion, the appearance of new threats, and ever-increasing dependence on ICT, the U.S. must enter a continuously evolving cycle to balance privacy with transparency, improve CIP, and reinforce NS/EP efforts. This requirement cannot be ignored. America's $14 trillion economy and the American way of life depend on it.

Human Capital (CDR William J. Guarini)

The U.S. derives much of its economic and military competitive advantage from its well-educated and highly-skilled science and technology workforce and the spirit of innovation it brings to the business world. Indeed, the Council on Competitiveness concluded in 2001 that, "a well-educated and technically-trained workforce is essential to a nation's competitiveness in two ways. First, it enables a country to shift more of its economic activity into higher technology and more productive activities that support higher wages. Second, an educated workforce is necessary to retain domestic investment and attract multinational investment."[77]

America's successes in high technology industries make it appear that continued U.S. dominance in these industries is assured. Unfortunately, the U.S. science and engineering (S&E) workforce is aging – with more than half over 40 years old – and younger Americans appear less interested in science, technology, engineering, and mathematics (STEM) careers. Current employment trends suggest an increased reliance on foreign-born workers to foster the technological innovation that has fueled the U.S. economy—a reaffirmation of the anthropology of America's development, expansion, and economic prosperity.

The raw numbers are eye-opening. In 2000, immigrants accounted for only 12% of the U.S. workforce but 47% of all scientists and engineers with doctorates. Furthermore, 67% of those who entered the S&E workforce between 1995 and 2006 were foreign-born.[78] In 2006, a quarter of all U.S. patents named foreigners as inventors. Immigrants founded nearly one-third of all U.S. technology and software companies, including 52% in Silicon Valley.[79] Some of America's most successful companies can claim foreign-born founders; including Intel, Sun Microsystems, Yahoo, and Google. In short, immigrants continue to contribute greatly to America's success.

America's success in continuing to leverage this foreign-born talent is tempered by political pressures to reduce the influx of foreign workers. The annual allocation of Special Occupation H-1B worker visas, which was raised to 195,000 between 2001 and 2003, is now only 65,000. The net result is that foreign graduates of U.S. universities are returning to their

native countries, where their salaries – while below U.S. standards – are nonetheless sufficient to yield a relatively high standard of living in closer proximity to family and friends.[80]

Given the restricted supply of STEM talent, why are U.S.-born citizens avoiding the STEM career fields? Native-born Americans often cite three factors detracting from S&E careers: first, they note the lengthy and difficult process to graduate with a STEM degree. Second, students complain of lower workforce pay and benefits, particularly when compared to those in law and business. Third, potential S&E workers voice concerns over reduced career opportunities and the impact of off-shoring on the ICT industry. Do these perceptions match reality? Evidence suggests they do not. In fact, Bureau of Labor Statistics (BLS) reports indicate that the average salary in the ICT industry – including non-college graduate technicians – is 65% higher than for the average American worker, and computer and electronic engineers earn up to 127% more.[81] Unemployment rates for ICT workers have been lower than average during the current economic downturn and most of the ICT jobs being off-shored are lower-skilled and therefore lower-paying jobs, leaving the higher-paying jobs in the U.S. Job growth trends are similarly encouraging. Trade journals predict a 36% growth in ICT jobs through 2014 and that ICT job growth will surpass growth in other occupations and sectors by a factor of three.[82] The ICT job market appears to be robust; is the U.S. education system failing?

While 17 of the top 20 universities worldwide are found in the U.S.,[83] there is widespread debate about the quality of America's primary and secondary education system. Two widely-referenced standardized tests, the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMMS) come to opposite conclusions, adding fuel to the debate.[84] In the final analysis, there is reason for optimism: between 1990 and 2004 the percentage of American high school students taking chemistry increased from 40% to 60%; these same students are also taking 40% more math and science courses.[85]

The ICT industry is a prime driver of the U.S. economy; well-trained and highly skilled workers fuel its engine. The U.S. must secure access to the scientists and engineers it needs to fill critical skilled positions in its ICT sector, but challenges abound. These challenges, including S&E workforce retirements, reduced enthusiasm towards S&E careers, and greater reliance on – but restricted access to – foreign-born workers, threaten to stifle the explosive growth that has characterized the ICT industry since its inception. Only by continuing to create and attract the best and brightest knowledge workers in the world and invest in S&E education programs can the U.S. maintain its competitive advantage in the ICT industry.

Innovation (CAPT Bruce Loveless)

The importance of research and development (R&D) in the ICT industry is well documented; it has fueled U.S. economic growth over the past two decades by providing U.S. companies with a competitive advantage in international markets.[86] But some now fear that the U.S. is losing its international leadership role in the ICT industry, leadership that springs from a deep tradition of R&D. While the environment for ICT R&D in the U.S. "remains unquestionably the strongest… in the world today," it is now under pressure from the global economic crisis and international competitors encouraged by rapid globalization of markets, labor pools, and capital flows.[87] Most troubling, according to a March 2009 report by the U.S.

National Research Council (NRC), "the U.S. position in IT leadership today has materially eroded compared with that of prior decades, and the nation risks ceding IT leadership to other nations within a generation unless the United States recommits itself to providing the resources needed to fuel U.S. IT innovation."

The Seeds of Innovation

Sustaining the economic growth delivered by the U.S. ICT industry and realizing future growth depends on many factors. Most important is the ability to maintain an environment in which new and innovative products and services can emerge. As described in a 1995 report by the NRC, ICT R&D in the United States results from an "extraordinarily productive interplay of federally-funded university research, federally and privately funded industrial research, and entrepreneurial companies founded and staffed by people who moved back and forth between universities and industry."[88] That report included a compelling graphic illustrating the complex relationships between federally-supported university-research and industrial R&D efforts and was updated in the NRC's 2009 report. It charts the development of IT from its origin in industrial and federally-funded university R&D, to the introduction of the first commercial products, through the creation of billion-dollar ICT industries and markets. The economic impact of government-industry-university relationships in the ICT field resulted in 19 "multibillion-dollar industries that are transforming our lives and driving our economy."[89]

> *The innovation that creates the technologies that drive the new economy today is the fruit of investments the federal government made in basic research 10, 15, 30 years ago. Essentially every aspect of information technology upon which we rely today – the internet, web browsers, public key cryptography,…parallel database systems, high-performance computer graphics, portable communications such as cell phones, broadband last mile…essentially every billion-dollar sub-market – is a product of this commitment, and bears the stamp of federally-supported research.*[90]

The U.S. R&D Ecosystem

The R&D partnership among government, industry, and universities in the U.S. is described in several recent studies as the ICT R&D "ecosystem" and includes many players, ranging from individuals to institutions to governments. Building on Michael Porter's concept of a national innovation ecosystem, it is comprised of ICT researchers and scientists, businesses, customers, and "powerful contextual forces such as regulatory and legal environments, the supply of financial and human and intellectual capital, the economic infrastructure, and the pressure of international competition, in the production of IT-based goods and services."[91]

Government and Corporate R&D. While traditional government laboratories like the Defense Advanced Research Projects Agency (DARPA) still play a significant role in U.S. ICT R&D, large industrial or "corporate research labs [like AT&T Bell Labs and Xerox Palo Alto Research Center] essentially disappeared in the 1970s and 1980s as companies focused more on efficiency and productivity" and shifted their research toward more applied R&D.[92] Only a few large companies like IBM have retained industrial labs, resulting in a perceived "lab gap" in the U.S. ICT R&D ecosystem. Likewise, while U.S. government funding for ICT R&D has increased significantly over the past two decades, it remains only a small portion of the overall

federal R&D investment.[93] For example, in 2007 U.S. federal funding for ICT R&D was over $3 billion, while "the total Federal R&D investment [was] a record $137 billion."[94] The President's Information Technology Advisory Committee recommended doubling federal investment in ICT R&D over a period of five years, noting that "critical problems are going unresolved, and we are endangering the flow of ideas that have fueled the information economy," and described the level of investment at that time as "dangerously inadequate."[95] Moreover, the majority of corporate ICT R&D funding in the U.S. supports product development, with limited funding devoted to basic and applied research. Corporate research tends to be focused on product and process development, areas that have more immediate impact on business profitability. However, it is basic research that develops the concepts for later use in innovative products.

Start-up Firms and Venture Capital. In contrast to the disappearance of large industrial ICT labs, the U.S. has the largest number of ICT start-up firms, many that began in the 1980s and concentrated primarily in clusters such as California's Silicon Valley. Over the past two decades, these small firms have partly replaced the corporate research labs as "a major source of innovation and national competitiveness" in the ICT field.[96] Some of these small innovative start-ups have risen to prominence, growing into large corporations such as Microsoft, Intel, Dell, Cisco, Oracle, Apple, and Google. Moreover, firms like Cisco and Oracle have recently pursued a corporate strategy of "research by acquisition" instead of establishing and maintaining a central research function, "allowing the ecosystem to do its R&D."[97] Others argue that the demise of the large corporate labs is partly a result of a shift in ICT R&D "up the supply chain" to the component makers, like Intel, and to software firms such as Microsoft, Adobe, Intuit, and others.[98] So, while the U.S. may have a "lab gap" when compared to the earlier years of the ICT industry, much of the innovation shifted to small start-up firms that either grew into or were acquired by larger corporations, or it shifted to other parts of the ICT industry aligned with the final product or service. Furthermore, ICT start-ups often receive initial funding from private sources such as venture capital. "The U.S. venture capital industry has led the world in the magnitude of the funds raised and deployed, as well as in the number of successful firms that it has enabled and the financial returns that it has generated for its investors."[99]

Sustaining the Innovation Edge

Government funded research lies at the heart of many of today's multibillion-dollar ICT industries. Over time, ICT research conducted at universities or federal agencies led to entirely new product categories 10 to 15 years later that became multi-billion dollar products or services in the ICT industry. The role of the federal government in sponsoring research in the ICT industry will continue to be essential. This includes sustaining government-funded ICT research at universities and federal agencies, sustaining partnerships between government, private industry, and universities, and committing resources to support education and training a highly-skilled ICT workforce. Private sector R&D cannot replace government investment in research as few companies can afford to invest for a payoff that is 10 or more years away. If the U.S. government does not continue to invest in ICT R&D and innovation, it runs the risk that when an improving economy justifies an increase in R&D investment, there may be few new innovative ideas in which to invest. Today's government-funded and federally-sponsored R&D investments are essential to tomorrow's world leadership in ICT industries.[100]

Protecting Innovation – Intellectual Property Rights (Col Eric Fick)

ICT and innovation may power the U.S. economy, but it is the establishment and enforcement of intellectual property rights (IPR) that protect the ICT inventor's ability to profit from those innovations, encouraging continued investment. The ICT industry is unique in that it is both a victim and an enabler of IPR abuse. By enabling global internet connectivity, the ICT industry paved a broadband path to IPR piracy, one that allows easy copying and dissemination of movies, games, music, pictures, and software. For example, the 2001 Napster case demonstrated that peer-to-peer file sharing enabled an egregious internet-based violation of copyright law and was the opening round in a brutal digital war between the pirates and the innovators; between those who take, and those who create.

Software Piracy: Through the physical or digital duplication and distribution of copyrighted software, piracy plays a major role in IPR infringement. Domestically, the Digital Millennium Copyright Act of 1998 defines software piracy and "makes it a crime to circumvent anti-piracy measures built into most commercial software."[101] The U.S. Trade Representative's (USTR) most recent IPR report reveals that China and Russia dominated the copyright piracy field in 2008 with annual business software losses within these two nations reaching $5.7 billion in 2008. The Business Software Alliance (BSA) paints an even bleaker picture, with the worldwide software piracy rate in 2007 at 38% and total losses of $47.8 billion. A closer look at the BSA report, however, reveals that American software users are also to blame for the piracy epidemic. While the United States had the lowest *rate* of piracy in the study at 20%, it also had the highest *losses* due to piracy: $8 billion.[102] [103] Furthermore, the Software & Information Industry Association (SIIA) notes that in 2007 Intuit's TurboTax was the most highly infringed software on auction sites and the fourth most infringed software on the internet.[104] Few people overseas need TurboTax, so clearly portions of the U.S. software piracy problem are home grown.

The BSA study reported that the worldwide software piracy rate increased from 35% to 38% between 2006 and 2007.[105] This is largely attributable to the dramatic spread of personal computers to developing nations whose citizens and governments have little regard for IP protection. Furthermore, many citizens in these markets lack the resources to purchase legal software. The net effect is an overall global increase in piracy as the sheer number of new computers in the developing world begins to overtake those in more advanced nations. As a result, eliminating software piracy has proven to be a daunting challenge. Nonetheless, industry associations like the SIIA continue to press their anti-piracy efforts through both technological barriers, such as digital rights management encryption, and the threat of legal action. For example, SIIA offers cash rewards to individuals who identify online sources of pirated software. SIIA also is working diligently to curtail the sale of pirated software on eBay. In 2007, SIIA was responsible for taking down approximately 25,000 websites selling pirated software.[106]

Other software producers have a different perspective on software piracy, one that seeks to take advantage of the "lock-in" effect. They recognize that small businesses and individual consumers in developing countries are the primary sources of piracy and hope that these users of pirated products will switch to legitimate copies as their wealth increases. Significantly, intense negotiations between U.S. and Chinese officials recently curtailed the Chinese practice of using pirated software in government offices.

Problematic Patent Processes: Patent reform is SIIA's top issue.[107] As the internet and ICT industry have expanded, patent filings have skyrocketed. According to the 2008 OECD[108] IT Outlook, "Strong growth in ICT sector patenting is first and foremost a result of high R&D expenditures and the innovative nature of the ICT sector."[109] Rising at a rate of 5% per year, the number of ICT-related patents filed under the Patent Cooperation Treaty (PCT) reached 50,000 in 2005.[110] The result is an over-worked and under-qualified U.S. Patent and Trademark Office that alternatively delays the granting of patents for critical new technologies or releases patents that fail to reflect the diffusion of technology in the ICT industry.[111] These patents are frequently either too late to serve their intended purpose or so broad as to invite a flood of lawsuits. Finally, patent trolls, firms that purchase patents for the sole purpose of extracting litigation returns, add a significant burden to the software and hardware segments of the industry.

IPR and Developing Nations: Developing nations are uniquely challenged by the concept of IPR in the ICT industry. In most cases, not only are the concepts of IPR foreign, but the citizens and small businesses of these nations are fundamentally unable to afford legitimate versions of the popular applications they need to improve their economic situation. Researchers have observed that in the near term, IPR enforcement leads to higher prices and less consumer choice, slowing the spread of technology. Conversely, mid- to long-term growth is closely linked to an effective IPR regime, as a weak one discourages foreign direct investment, slowing overall growth.[112] For example, India "experienced an increase in foreign investment and technology transfer once it expanded its patent protection."[113]

Although strong IPR protection is the goal of the ICT industry and patent reform is required to address deficiencies in patent processes, completely eliminating infringement is an impossible task. It is just too easy to create and distribute illegal products and too much of the world cannot afford to buy legitimate ones. The only salvation for ICT innovators is that many are still willing to buy the real thing and that the rapid pace of technological change gives innovators a chance to stay one step ahead of the copiers. This makes their investment in innovation worthwhile.

CONCLUSION

"The future often comes to us in disguise, with toys that grow up to spark a business revolution."[114]

The ICT industry is vital to the world economy and the United States' national security. The relentless technological advances created by this U.S.-led industry show no sign of abating; Moore's Law of rapidly expanding computer power is still valid. The convergence of voice, video, and data is accelerating the ongoing transformation of how more and more of the world's population entertains, manages finances, conducts business, and communicates. The resulting ubiquitous, high-bandwidth connectivity enables meaningful networking of people and access to information in ever-widening circles. While there are commensurate challenges to be addressed, businesses and governments will continue to utilize such empowering technologies as critical elements of all other aspects of business and society.

Video, voice and data will very soon be just data—the first "all-IP" network went operational in Hong Kong in March 2009. More and more of that data will travel faster and

faster over fiber-optic backbones and networks that deliver broadband via both fixed-line and wireless means. Within two years, the distinction between cellular (2G/3G) and wireless data (WiFi) will disappear and data rates will approach that of current hard-wired connections. This broadband data capability will continue to enable computing and data concentration in large centers (cloud computing), and highly mobile devices will enable connectivity virtually anywhere. The resulting online collaboration and networking (Web 2.0) is driving much of the industry's innovation.

Like the technologies themselves, the various domains of the ICT industry continue to converge and reform. The lines between hardware, software, consulting, and online search have blurred due to the concentration on data storage and software as a service, the focus on information and entertainment accessibility, and the ubiquity of informatization across all industries

The United States maintains its traditional leadership role in an increasingly globalized world through concentration on innovation and business management. This role is being challenged, however, by other governments' purposed market interventions to gain leadership, a globalised trend toward off-shoring, violations of intellectual property rights, and the human capital deficiencies exacerbated by U.S. immigration and education trends and policies.

Other challenges are shared globally. Cyberspace is recognized as a distinct domain among the global commons to be protected for fair use by all parties. Cyber security and information assurance are critical to all users, but there is also an important need for the United States to create and maintain capabilities to operate with sovereign advantage in cyberspace.

The U.S. should continue to exert smart leadership in the industry in a globalized free market world economy. It should create the conditions ripe for innovation and comparative advantage by supporting research and development and incentivizing increased STEM education. It should promote and take advantage of the promise of increased connectivity and the convergence of technologies that enable cloud computing and Web 2.0 social interactions. Finally, the United States should seize every opportunity to reinforce its freedom of action in cyberspace.

ENDNOTES

[1] Lloyd Espenschied and Herman Affel recognized in the early 1920s that the open wire and cable in use by telephone companies of the day would not be adequate for the high frequencies needed for broadband systems of the future, developed a coaxial based solution, and applied for a patent on May 23, 1929. See "1929: Broadband Coaxial Cable," *AT&T Enterprise, Technology Timeline*, http://www.corp.att.com/attlabs/reputation/timeline/29cable.html, March 24, 2009.

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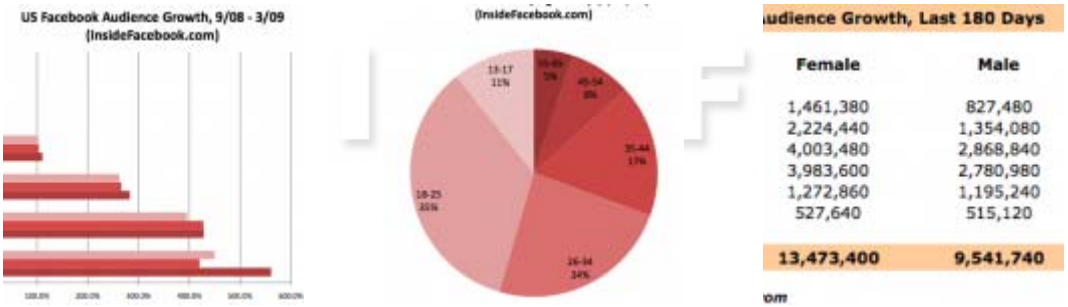

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2. Yahoo	**12. WordPress**	22. FC2	32. yandex.ru	42. google.mx
3. YouTube	13. Google India	23. Google UK	**33. AOL**	43. IMDB
4. Windows Live	14. go.com	24. Google.cn	**34. Flickr**	44. Ask.com
5. Facebook	15. Google.de	**25. Hi5**	**35. Amazon.com**	*45. www.163.com cn*
6. Microsoft Net (MSN)	16. QQ.com	**26. Craigslist.org**	36. Google.jp	**46. odnoklassniki.ru**
7. Wikipedia	17. Microsoft Corp	27. Mail.ru	37. Google.es	47. BBC
8. Blogger.com	**18. RapidShare**	28. Google.br	38. taobao.com	**48. youporn.com**
9. Myspace	19. sina.com.cn	29. Double Click	**39. Photobucket**	49. pornhub
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start small and grow hardware resources as needs increase, and 3) an ability to pay for computing resources on a short-term basis. From a software perspective, cloud computing simplifies software and hardware installation and centralizes version control for providers, while allowing users access to services "anytime or anywhere". See Ibid.

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coordinated on the use of multiple forms of social media to rapidly pass accurate information about the recent peanut butter salmonella issue. Moreover, Web2.0 allows agencies to interact with public on a two-way basis for inbound sharing. During recent flooding in Fargo, North Dakota, the National Guard Task Force and other state and local officials used Twitter and blogposts to gather and share flood information and coordinate response actions. On March 23, 2009, Air Force officials learned of an apparent C-17 crash in Texas via Twitter and then CNN. They were able to quell a bad rumor started by an observation of the low-flying aircraft through the use of Twitter, blogposts, and traditional media. (Three days later Air Force Public Affairs was quick to validate the actual crash of an F-22 via the same channels.) In Madagascar, United States embassy personnel were attuned to social media during the recent coup and were able to quell potential aggression against the embassy by an angry crowd who incorrectly believed the deposed leader was being sheltered in the embassy. For more details, see:

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