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Information and Communications Technology Industry

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ABSTRACT: The U.S. Information and Communications Technology (ICT) industry continues to be a world leader, however, this lead is threatened by increasingly competitive global ICT firms. While the increasing connectedness enabled by the ICT industry brings the benefits of globalization to us and to less developed areas of the world, it also increases vulnerabilities in our critical infrastructures, supply chains and human capital. The U.S. government must pursue policies that maintain our global ICT leadership, promote consumer surplus and our standard of living, and address vulnerabilities in our critical infrastructure to promote our national security and protect our way of life.

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Domestic:

Accenture Defense Industry Group, Reston, VA
Apple, Cupertino, CA
Brocade Communications, San Jose, CA
Cisco Systems, San Jose, CA
CSC, North American Public Sector, Reston, VA
CTIA- The Wireless Association, Washington, DC
Google, Washington, DC
Information Technology and Innovation Foundation (ITIF), Washington, DC
Information Technology Industry Council (ITIC), Washington, DC
Juniper Networks, Mountain View, CA
Microsoft Corporation, Reston, VA
National Telecommunications and Information Administration (NTIA), Washington, DC
National Cable & Telecommunications Association (NCTA), Washington, DC
Oracle, Redwood Shores, CA
Palm, Sunnyvale, CA
Software and Information Industry Association (SIIA), Washington, DC
Sprint, Reston, VA
TechAmerica, Washington, DC

International:

American Chamber of Commerce (AMCHAM), Hong Kong
American Chamber of Commerce in Vietnam (AMCHAM), Ho Chi Minh City, Vietnam
China Academy of Telecommunications Research (CATR), Beijing, China
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China Mobile, Beijing, China
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EVN Telecom (Southern Center), Ho Chi Minh City, Vietnam
FPT Software, Ho Chi Minh City, Vietnam
Huawei, Shenzhen, China
HPT, Ho Chi Minh City, Vietnam
Motorola, Tianjin, China
PCCW, Hong Kong, China
Reach Teleport, Hong Kong, China
Saigon Postel, Ho Chi Minh City, Vietnam
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The Information and Communications Technology (ICT) industry, a.k.a the Information Technology (IT) industry, is a major contributor to the U.S. economy and a strategic enabler of the nation's defense. This paper analyzes the global industry by looking at its current condition, challenges, trends, future outlook, and national security and government policy implications.

THE INDUSTRY DEFINED

This study divides the "ICT industry" into three sectors: 1) Wire-line, Wireless, and Cable Communications and Internet Services; 2) Software and Computer Services; and 3) Computer and Network Systems Manufacturers. Industry performance data sources include Datamonitor, Standard and Poors, and IBISWorld, as well as meetings with industry in the U.S. and abroad. See Appendix A for a more detailed definition of the industry, including the discrete North American Industry Classification System (NAICS) industry elements.

THE UNITED STATES ICT INDUSTRY

The U.S. ICT industry develops ICT solutions for defense communications, weapons systems, infrastructure and cybersecurity, making it critical to our nation's security. Extremely competitive on a global scale, this industry's future outlook is complex, but the U.S. firms remain capable of leading the world. It is poised to fully support U.S. national interests, but significant collaboration between industry and government is needed to resolve key challenges.

This industry contributes 4% to U.S. Gross Domestic Product (GDP), has grown about 8% per year, and generated $516B in 2007,[1] before the 2008 global economic downturn resulted in deferred IT investment by consumers and businesses.[2] It creates very substantial consumer value and makes major contributions to economic and productivity growth throughout other industries. Challenges include globalization, cybersecurity, lagging government policy, weak STEM (Science, Technology, Engineering and Math) education, industry consolidation, proliferation of mobile devices, fast-paced technological development, and immigration issues. The industry is nevertheless expected to recover and to meet these challenges better than most others.[3]

U.S. Wire-line, Wireless, and Cable Communications and Internet Services

State of the Sector: This sub-industry includes companies that provide common over-wire telephone and internet services (Wire-line), cellular telephone and internet services (Wireless), and fiber-optic or coaxial telephone/television and Internet services (Cable). Corresponding NAICS codes are 5171, 5172, and 5152. Their respective 2009 revenue streams were: -7.5%;[4] +2%;[5] and +1.2%;[6] but prior to 2008's economic downturn all three areas showed strong growth.

Challenges and Trends: Key issues include the movement from voice over copper wire to voice over Internet protocol (VOIP) and data, the proliferation of mobile devices, 3G/4G expansion (see Appendix G for a description of these systems), the government's developing broadband plan, continuing industry consolidation and net neutrality. (See Section IV for details on related policy issues). It is predicted that eventually all communications will be via Internet protocol, with even voice communications converted to data.[7] Consumers increasingly want mobile access to this data, which has created a "mobile revolution" and depressed cable and wire-line revenues.[8] This revolution is characterized by smart phones, mobile applications for consumers and businesses, and a requirement for faster and more capable 4G technology.[9]

Future Outlook: Out to 2015, major issues will include the National Broadband Plan, industry consolidation, and net neutrality. (See Section IV). The industry will be marked by a continued move toward 4G wireless technology, with companies competing on cost and service differentiation. Already as of 2009, 39% of cellular devices were smartphones. By 2015, wired and cable use will be flat, and 40% of all home communications will be wireless.[10] By 2025, the overwhelming majority of home communications will probably be wireless, with 4G eclipsed by 5G or another technology. Thus far, more content and more applications have moved at increasingly faster speeds. This will likely continue.

U.S. Software and Computer Services

State of the Sector: This sub-industry includes firms that provide software development; data processing, hosting, and related services; and other IT outsourcing. Corresponding NAICS codes are 5112, 518, and 5191. It is highly competitive, creates high consumer value and contributes greatly to overall productivity growth. From 2002 to 2007, it experienced receipt growth rates as high as 30% across the board.[11] The 2008 economic downturn slowed software revenue growth to 1.2%[12] in 2009, resulting in lower financial outlooks.[13]

Challenges and Trends: Key issues include intellectual property rights (IPR)/patent reform, anti-piracy, cybersecurity, immigration reform, outsourcing, Internet penetration, and cloud computing. According to the Software and Information Industry Association, IPR is a major problem worldwide,[14] and piracy is a significant problem tied to IPR. Meanwhile, internet growth and the emergence of cloud computing are changing the industry. The Internet enables "software/infrastructure/platform as a service" in an on-demand model for IT services, wherein varying degrees of a consumer's computing are done remotely "in the cloud" by an outside provider.[15] See the issue papers in Part 2 for more on IPR and cloud computing.

Future Outlook: By 2025, this sub-industry will be driven by the proliferation of mobile devices, social media, collaboration, cloud computing, data decisions, 4G/5G technologies, and a new worldwide web.[16] Together these factors will produce markets in which there is "access to anything, by anyone, from anywhere, on any device, at almost no cost."[17] U.S. providers must stay ahead with innovation in order to drive and leverage these changes.

U.S. Computer and Network Systems Manufacturers

State of the Sector: This sub-industry includes companies that provide computer and peripheral hardware and networking equipment. NAICS codes are 33411 and 33422. Prior to 2008's global economic downturn, growth was strong, but this sub-industry has been contracting due to lagging domestic demand.[18] The computer hardware manufacturing industry is expected to generate about $56B in 2010 with most of that revenue generated from exports. However, most of the actual manufacturing is done outside the U.S. The communications equipment manufacturing sub-industry is expected to produce $39B in 2010, followed by slow growth to 2015 due to import market penetration and loss of domestic market share.[19]

Challenges and Trends: Key issues include cybersecurity standardization, slow future growth, access to emerging markets, taxation issues and other government involvement, geographic and skills-based stratification of the labor market, globalization (China/India competition, in particular), off-shore production/increased imports, and increasing research and development (R&D) requirements/barriers to entry.TT[20,21] Stratification of the labor market is the result of globalization and property rights issues: companies have moved manufacturing jobs overseas to lower-cost labor markets but have kept innovation/R&D and engineering in the U.S.

Future Outlook: Through 2025, the outlook is bleak. There will be negative revenue growth in both communications equipment (0.1%)[22] and computer manufacturing (-0.5%)[23] out to 2015, caused mainly by the movement of industry overseas, limited market access, increased competition, and falling prices. Technological changes such as cloud computing will also contribute. Without countervailing government policies and incentives, this sub-industry will continue to become further bifurcated, with innovation in the U.S. and production elsewhere.

The Mobile Device Market

State of the Sector: The mobile device market is relatively young compared to cars, televisions or other technology-heavy markets, but the global rate of penetration of mobile devices is staggering, with at least 4.6 billion subscribers today.[24] Although about 1.2 billion of these are duplicate customers who own and use more than one device,[25] the global market still includes about 3.4 billion unique users, meaning half the world's population owns and uses some type of mobile device. By comparison, only one billion personal computers (PC) were operating in 2008, and this number will not reach two billion until 2014.[26]

Challenges and Trends: Handset manufacturers are reliant on service providers not only to complete the sale, but to develop and field the most desirable networks. Manufacturers must therefore "pick the winner" and build tailored devices for networks they predict will provide value to the end customer and generate sales. This is especially acute as WiMax and Long Term Evolution (LTE) culminate their battle for the 4G customer base, and developing countries either build out 3G networks or jump a generation and move to 4G. (See Appendix G for a description of these systems). Each manufacturer invests millions in their product lines with limited or no guarantee on return. They must accurately assess demand for features and frequently introduce new designs to keep up with the extreme mobility customers expect.

Future Outlook: Given that the average mobile phone is replaced every 18 months, manufacturers can expect to sell over 1.5 billion devices each year. Given the continued growth in developing countries, that number will rise. Other trends, like location-based services, mobile banking, and phones as sensor/data creators, will open up completely new streams of revenue. The data generated by mobile devices will eventually hold more value than the cost of subscription, as mobile and targeted advertising become commonplace.

THE GLOBAL ICT INDUSTRY

Many aspects of the ICT industry are globally integrated, particularly hardware manufacture, but significant differences exist between ICT in the U.S. and other parts of the world. As a sampling, this paper examines ICT in Europe; the Middle East; Sub-Saharan Africa; China, Hong Kong and Taiwan; and Vietnam.

ICT in Europe

State of the Industry: 2008 European ICT revenue was $459 billion, after stable business or little-to-moderate growth in fixed line telecoms, computer hardware, semiconductors, and software, as well as substantial growth in mobile phones and Internet access. (See Appendix B). Europe is the world leader in broadband Internet with 114 million subscribers (22.9% in 2009), and availability to 93% of the European Union (EU) population. Europe has also reached 2.5 million fiber-to-the-home (FTTH) subscribers. Several initiatives have been launched by

network operators, municipalities, and national governments (e.g., Germany) to roll out FTTH/B to penetrate 10% of total households,[27] but only 3% of the EU population used a 3G mobile phone to access the Internet in mid 2009.[28] High monthly consumer prices - often with post-paid contracts, as opposed to flat rates for fixed broadband access - and little usability until the arrival of iPhone and Android phones are deemed to be the reason for the low adoption rate.

Challenges and Trends: Privacy is a primary concern of EU citizens and the European Commission. The EU works to protect users from advertising without prior consent. Key social networking providers signed an agreement on "Safer Social Networking Principles for the EU" wherein users under the age of 18 are by default considered private and not searchable. To facilitate a single market, radio frequency spectrum allocation is harmonized across borders on a Europe-wide scale. Due to orography and population distribution, 100% wired network coverage will probably never be reached,[29] and questions on how to close the broadband gap/digital divide remain. Since wireless (UMTS-3G, WiFi, WiMax, and satellite) access is more suitable in some areas, national broadband policies promote its use to ensure universal broadband availability.[30]

Future Outlook: Experts predict moderate growth at 16% from 2008 to 2013, with $532 billion of revenues in 2013. Growth will be fueled by mobile phones, Internet access, and especially software, which has a large ICT revenue share and expected growth rates of 6% per year. Semiconductors and computer hardware will have little growth, and fixed lines are expected to stagnate. Mobile broadband subscribers and revenues (and data demand) are set for near 100% growth by 2011.[31] 22 million subscribers were estimated at the end of 2009; over 43 million are expected by 2011. Nevertheless, given the belief that only fiber to the home can fulfill the bandwidth demands of a networked world,"[32] by 2020, European urban areas will be covered by 100% fiber optics networks. "Broadband for all" will fertilize the emergence of eSociety and institutions will go digital (eGovernment, eHealth, eLearning services, etc). In conjunction with this, some countries like Germany will introduce Identity Cards with legally binding digital signatures for use in eCommerce or eGovernment.

ICT in Sub-Saharan Africa

Current State of the Industry: The fifty countries in Sub-Saharan Africa (SSA) comprise a tiny part of the global ICT industry. SSA has 261 million cell phone subscribers, with an average of 32% cell phone penetration that varies widely by country.[33] Several cell phone companies provide service in multiple countries. The two largest are MTN of South Africa and Zain of Kuwait. MTN has 116 million subscribers and reaches 16 African countries. Internet access is considerably more costly than in other regions, and high-speed access is even more expensive. In 2007 the ITU estimated the cost of basic DSL at $366 per month.[34] The World Bank estimates wholesale bandwidth prices are 20-40 times higher in SSA than in the U.S,[35] but with low labor costs and strong English and French skills, a number of SSA firms offer business process outsourcing. Their ability to compete is however compromised by the high communications costs. ICT permeates SSA economic activity, though to a lesser extent than elsewhere. Per a recent World Bank Enterprise Survey, 44% of all SSA firms surveyed use e-mail to communicate with clients and suppliers, compared with 61% worldwide.[36]

Challenges and Trends: Home to nearly a billion people with combined annual purchasing power of $1.6 trillion, SSA is often characterized to be on the wrong side of the digital divide. Cell phone use is less widespread than elsewhere, and broadband access is limited and costly. The ICT backbone relies on costly satellite connectivity for global access, and many national regulatory structures and business environments do not foster competition and transparency.

Future Outlook: The most promising development is a fiber optic backbone expansion to link Africa to the rest of the globe. This $2 billion investment will lay nearly 36,000 miles of new cable, completely surrounding Africa's coastline within the next three years.[37] This expansion will rapidly and dramatically reduce communications costs, making a wider range of global economic activities viable. Widespread ICT use in SSA promises to enhance democratization, education and prosperity.

ICT in the Middle East

State of the Industry: In the Middle East's (ME) 14 countries, markets are evolving, with demand growth and a rapidly changing regulatory landscape, particularly in telecommunications. Some commonalities include widespread high-speed Internet, wireless communications, and satellite TV. Areas of diversity include home telephone line, smart phone, and microwave link use, as well as GDP per capita.[38] The region has more than 32 service providers, 14 of which were once state-owned. Each country has at least two providers (UAE, Qatar, and Kuwait, for example) while Israel has six.[39] Satellite phones are more prevalent than in other parts of the world, supported primarily by IntelSat, INMARSAT, Iridium, Global Star, and Thuraya.[40] Internet penetration is 28.3% versus 25.5% elsewhere.[41] In general, Internet service is provided by fixed copper telephone line, but High-Speed Packet Access (HSPA) services are now offered throughout the Gulf region and in Israel. Telecom regulatory authorities exist in most of the region, but the market is generally government controlled, either indirectly as in Israel and Jordan, or directly as in the Gulf Cooperation Council states. See Appendix C for more details.

Challenges and Trends: Challenges the region must address to increase ICT access and benefits among its population include market liberalization, high-speed network deployment, and migration to next-generation infrastructure and services.[42]

Future Outlook: By the end of 2010, mobile Internet speeds will reach 150 Megabits per second (Mbps) down and 50 Mbps up.[43] As ME states join the World Trade Organization (WTO), they will also adapt their legal and regulatory systems to accommodate trademark, patent and IP protection.

ICT in China, Hong Kong, and Taiwan

State of the Industry: The Chinese economy has grown rapidly for more than 15 years, and ICT has led that growth throughout China, Hong Kong and Taiwan. Having weathered the 2008 recession, China is especially well prepared for continued strong growth led by its ICT industry, which is large and growing at rates over 10% in the next five years. Telecom (fixed and wireless) penetration is over one billion in China. Meanwhile, the Internet – especially gaming – has become the primary entertainment mechanism for many Chinese, with over 384 million users; 360 million of them broadband.[44] Hong Kong/Taiwanese firms lead the region, with the manufacturing base largely in mainland China. The Chinese government maintains majority ownership in competing, publicly-traded telecom companies; an interesting alternative to U.S. privately-owned oligopolies. Throughout the region, a growing focus on innovation has the potential to challenge U.S. leadership in ICT and ICT-driven technological areas.

Challenges and Trends: The Chinese market, including Hong Kong and Taiwan, is an important factor in the global ICT industry. Its size and growth means U.S. companies can make lucrative profits there. Due to the Chinese human resource base, many top U.S. ICT companies operate there to enhance their research, product development, and manufacturing. This trend is likely to continue through the next five years and beyond, as double-digit growth continues.

Future Outlook: Continued broad ICT growth is expected over the next five years, approaching or exceeding 10%. The wireless telecom market (cell phones, pagers, wireless services) in China/Hong Kong alone now includes over 600 million subscriptions. This number will exceed one billion by the end of 2013, with many subscribers adopting smart phones.[45]

ICT in Vietnam

State of the Industry: As ICT expands to developing ASEAN countries like Vietnam, economies predominately supported by agricultural and manufacturing businesses are rapidly becoming technology and service sectors. As in China, Vietnam employs a competing-but-state-owned-firms model, and it seems to be working. Between 2002 and 2006, Vietnam's mobile phone ownership nearly tripled from 25% to 72% and during the same period home computer ownership more than doubled from 18% to 45%.[46] Vietnam has approximately 70 million mobile users, compared to 17 million in 2007, and more than 20 million Internet users with 171,000 Internet hosts.[47] Internet users grew from 10,000 in 1998 to over 20 million in 2009, or 25% of the population.[48] This is a direct result of a new strategy to close the gap with developed countries in the region like Singapore, by exploiting opportunities in the Vietnamese Telecom Industry and expanding foreign direct investment (FDI) to increase ICT infrastructure. This new approach, referred to as the Taking-Off Strategy, should produce substantial ICT growth.[49]

Challenges and Trends: Producing $25 million in annual revenues in 1999, the software sector was small but growing, and appealing to several large U.S. investors.[50] In 2006, the sector generated $350 million in revenue, of which $110 million was from outsourcing.[51] Growth has been significant but is limited by widespread piracy and the lack of effective IP protection. In order to encourage software exports, the Saigon Software Park, with high-speed Internet access, voice/video over Internet protocol, and e-business services, has a dedicated private transmission line.[52] The rest of the country, however, is subject to a national firewall, censored web browsing, email, and chat, and filtering of access points like Internet cafes and hotels.[53] Vietnam restricts business-oriented groupware like Lotus Notes to prevent the transfer of encrypted material, and forces multinational companies to use expensive unrestricted data lines out of the country.[54]

Future Outlook: The government is actively seeking to develop the ICT market by creating favorable competitive conditions for telecom and Internet service providers.[55] It expects new telecom entrants will achieve 40-50% market share by 2020.[56] Furthermore, the government aspires to compete in regional and international markets by retaining investment in its largely underdeveloped software and hardware segments. The goal is to grow the software and digital content segments to compete with imported products, and to make the hardware segment more profitable by shifting from product assembly to component production in the 2010-15 period.[57]

III: EMERGING ICT TRENDS AND TECHNOLOGY DEVELOPMENTS

While others are indeed catching up, the U.S. ICT industry has managed to hold on to its traditional lead in R&D and innovation. U.S. R&D spending was 36% of the world's total in 2007. Significant emerging developments in new processes, products, and services include wireless, smart grid, and cloud computing. For a detailed discussion of the fastest-growing trends – cloud computing and social networking – see Part 2. Significant game-changers farther out on the horizon include nanotechnology and quantum computing, discussed below.

Research & Development and Innovation

No models predicted the incredible growth of Internet-based information and computing services that now employ several million. Innovation, initially catalyzed and continuously

supported by government investment, made key contributions to the U.S. economy. Experts estimate the Internet adds as much as $2 trillion to annual GDP, or over $6,500 per person.[58]

Innovation is the development of new processes, products, and services. In the increasingly competitive, globally interconnected world economy, nurturing and promoting innovation is a vital part of a comprehensive economic strategy. Increased innovation will lead to a more productive and faster-growing economy, resulting in increased American living standards.[59] "America's average standard of living will double every 23 years if innovation catalyzes annual productivity growth of three percent, but it will take 70 years if productivity growth is only one percent."[60] President Obama budgeted $75 billion to make the research and experimentation tax credit permanent, to incentivize private sector innovation investment.[61] As he put it, "The United States led the world's economies in the 20th century because we led the world in innovation. Today, the competition is keener; the challenge is tougher; and that is why innovation is more important than ever before. It is the key to good, new jobs for the 21st century. That's how we will ensure a high quality of life for this generation and future generations."[62]

ICT is infused throughout the U.S. economy. U.S. consumers increasingly embrace products and services like wireless 3G telephones, the Internet, Google, and broadband. Innovation/R&D are critical for current and future ICT health and profitability, as over the next decade they will spawn technologies like miniaturization, wireless power, and virtualization. For example, the Wireless Telecommunications Carriers sector is characterized by rapid technological change driven by large investments in R&D and infrastructure, as well as abbreviated product life cycles.[63] Demand is driven by new innovative services such as email, multi-media messaging services (MMS), music downloads, gaming, and TV. In addition, R&D has led to new technologies to include 3G variations and emerging 4G.[64] The sector will grow rapidly (5.3%) over the next five years, driven largely by the establishment of 4G infrastructure, which will spawn another "wave of new value added products, such as machine to machine (M2M) and smart grids, as the cloud affects our social and business environments."[65]

Recent efforts have introduced inexpensive network computers that tap into remote servers, offering application software and computing power: cloud computing. IBM is broadly investing in R&D to develop on-demand computing for corporate customers. HP plans to provide more enterprise computing service on a pay-as-you-go basis.[66] Ongoing computer storage research seeks to improve data protection, security, capacity, availability, and performance. Businesses in the future will no longer buy storage boxes, but will instead buy access to a storage facility.[67]

Innovation and R&D are critical for the current and future health and profitability of the ICT industry as they will usher in technologies over the course of the next decade to include product miniaturization, cloud computing, quantum computing, wireless power and virtualization. Product innovations and concepts currently in R&D include blade computers, grid computing, throughput computing, and flexible computers.[68] These new products will continue to reinforce Moore's law and promote U.S. ability to compete globally in the ICT industry.

Nanotechnology and Quantum Computing

Moore's Law states that computer processing power doubles every 2 years, and for the last four decades has accurately described the ICT industry. The continuous improvement is made possible through miniaturization of transistors, which enables increasing the number of transistors on a single silicon-based chip. This exponential growth has been the catalyst for productivity that has enhanced U.S. economic and military strength. But even Mr. Moore predicted his law would fail in the next ten to fifteen years, as the size of transistors approach a single atom and the laws of classical physics are replaced by the laws of quantum physics.[69]

Nanotechnology R&D has now produced transistors in the nanometer (nm) scale, called nanotransistors. Today, these nanotransistors are as small as 32 nm.[70] But as nanotransistors approach the atomic level, binary logic gates ("on" or "off"; "one" or "zero") cannot function because signal loss between transistors is too great. At this atomic level, quantum computing, a subcomponent of the nanotechnology effort, offers the best potential for further progress - or even revolution - of the industry. It employs computation based not on binary bits, but on quantum bits (qubits). Through the phenomenon known as superposition, a qubit can express "one," "zero," or "both" states simultaneously. In this way more data can be encoded, with higher computational potential. Thus far, scientists have successfully built simple quantum logic gates between two atoms, but more complex circuits remain elusive because isolating and controlling large numbers of atoms is currently not possible.[71]

The U.S. remains the leader in nanotechnology, having created the National Nanotechnology Initiative (NNI) in 2000 and appropriating over $12.4 billion to it from 2001-2010. President Obama has requested $1.762 billion for the NNI in FY 2011.[72] But other international competitors, including the European Union, China and Russia, are increasing their R&D efforts.[73] Criticisms of nanotechnology range from concerns about a slow transition to market, to concerns that government is moving too fast and not considering potential adverse impact to human health and the environment. Eight proposed laws in the 111th Congress focus on promoting nanotechnology development, as well as studying its potential impact.[74]

NATIONAL SECURITY AND GOVERNMENT POLICY IMPLICATIONS

The U.S. government plays significant roles in enabling and/or hindering the ICT industry. Trade policies have much the same effect on ICT as they do on other goods, but additional recent policy issues have included network security, IPR and piracy, supply chain risks, human capital, wireless spectrum management, broadband growth, net neutrality, and using ICT for development to help close the gap with the undeveloped world.

Security

America and other developed nations have an overarching dependence on ICT and must address how the Internet is changing and the security issues around "the cloud." It will need to upgrade to and secure new 4G wireless systems, while DoD makes a leap of its own to mobile devices. The U.S. must develop and routinely exercise a comprehensive public-private critical information infrastructure protection program, develop a cyberspace operations strategy, and foster international cooperation to protect critical information infrastructure. See issue paper on Cybersecurity and Critical Infrastructure Protection in Part 2.

In its role of spurring the economy and the competitiveness of its citizens, the U.S. government must address problems with copyright/patent laws and piracy. The government must move to protect U.S. intellectual property by engaging other governments diplomatically. National security dictates the U.S. should take the lead in developing international security standards for cyber, intellectual property, and the digital supply chain.

Chinese companies and Chinese labor are increasingly becoming part of the U.S. ICT supply chain. This poses potential risks to DoD and U.S. critical infrastructures, whose leaders must understand who their suppliers are in globally-sourced ICT products. Also, as Chinese ICT prowess develops, our competitive advantages in both warfighting and business will wane. The rise of Chinese ICT will affect the competitiveness of U.S. companies and bring pressure from

them to modify the International Traffic in Arms (ITAR) restrictions, as these companies are increasingly driven by the commercial market to research, develop, and sell globally.

Human Capital

Economic growth is dependent on innovation and improved technology. Many scholars, however, argue that U.S. technological advantage is eroding as the country lags behind the rest of the world in providing STEM education to prepare future generations to compete in a technologically advanced world. (See Appendix D, Table 10). America lags in math and literacy assessments among high school students, interest in STEM-related occupations, and the number of STEM advanced degrees awarded. In order to remain competitive in a global environment, the U.S. must emphasize and fund STEM education and R&D.[75]

U.S. companies must attract, retain, and leverage the STEM graduates from the global market. Employment trends computed by the Bureau of Labor Statistics (BLS) show substantial growth among most IT occupations (with the exception of computer programmers), with compensation remaining competitive. (See Appendix D, Table 9). Engineers and managers earn approximately twice the national average (with total compensation higher in areas with a high concentration of ICT industries, like northern California and northern Virginia).[76]

Companies target recruitment on the most highly qualified and best talent, including non-U.S. citizens. They would like to fill more jobs by using H1-B and L-1 employment visas. With H1-B visas capped at 65,000 per year, however, most IT firms advocate raising or eliminating the cap to capture specialized skills, knowledge, and innovation from around the world.

Spectrum Management

Spectrum management is a hotly debated topic in the U.S. ICT industry. The Federal Communications Commission (FCC) recently released its National Broadband Plan (NBP), with portions devoted to spectrum management.[77] In the past several years, the FCC has also reallocated large portions of spectrum to free space for new innovations and technologies; the 2009 switch to digital television is the best-known example. In the next ten years, the FCC wants to free 500 MHz (Megahertz) more spectrum, adding 300 MHz in the first five years.[78]

No one can create new spectrum, and the usable portion for wireless is also the most desired by several other major players, including the television industry.[79] To date, the ICT industry has focused on making more efficient use of existing spectrum, but it is quickly approaching a culmination point on compression and coding techniques, barring new methods or technology. To free more space and enable better use of wasted "white space," the FCC started reallocating users to new bands and passing the costs to the users. The requirements are huge. In 2009, the U.S. had over 275 million mobile subscribers generating $150 billion in revenue a year and these numbers are still growing.[80]

The National Broadband Plan

The goals of the NBP are to (1) establish competition policies, (2) ensure efficient allocation and use of national assets/resources, (3) create incentives for universal availability and adoption of broadband, and (4) update policies, standards, and incentives to maximize national priorities.[81] These are reasonable and laudable goals.

To meet the first goal, the FCC intends to create greater transparency in the broadband market through the collection and publishing of pricing and services across the entire country and in multiple market segments.[82] It also intends to update rules and clarify laws that control spectrum usage, video distribution (set-top boxes for television), and competition (to spur innovation and competitive entry). The second goal centers on efficient use of spectrum, and fair

access to poles, towers, and rights-of-way for infrastructure development and deployment.[83] Standardizing access fees and simplifying access procedures will spur development across the broadband industry and increase competition and innovation.

The third goal is more controversial. For decades, telephone companies have participated in the Universal Service Fund (USF), a tax which subsidized basic voice services in underserved areas. In order to maximize affordable broadband services, the FCC wants to create a "Connect America Fund" and transition the USF to broadband expenses over a ten year period.

The fourth goal drives at using broadband to innovate in areas like healthcare, education, energy, economic development, and public safety.[84] Most related laws were crafted before the Internet, crippling industry's ability to leverage the Internet and broadband access. The FCC believes regulatory changes can improve the quality of American lives and create significant savings. A "smart grid" using the broadband network would reduce energy usage. A nationwide public safety mobile broadband network would save lives and money during crises. Affordable access to broadband networks would improve education and government service delivery.

Net Neutrality

Net neutrality - the concept that information content on the Internet should be unrestricted and the (dubious) provision that Internet providers should therefore be prevented from managing or charging for it - has two opposing camps. Information providers, like Google and Amazon, are ardent advocates Their goal is to ensure unrestricted access to data with no service provider ability to screen, restrict or favor data of one type or from one source over another type or source. While obviously this serves their business model, their public argument is "free speech": no one should be able to restrict an American's access to lawful data on the Internet.

Service providers, such as Sprint and Verizon, generally support unrestricted access to data, but assert that all data is not equal. For example, email is not time- or connection-sensitive, whereas video and voice are very sensitive, thus they require different speeds and management at the packet level to ensure data moves efficiently through the networks. Service providers fear becoming "dumb pipes," and feel they should be able to charge for those different throughputs. The loss of this profit motive would also disincentivize innovation and infrastructure investment.

In 2008, the FCC took action against Comcast for throttling user data on their network. Comcast customers were using a program called BitTorrent to move data peer-to-peer. When BitTorrent traffic impacted other services, Comcast reduced the bandwidth available to that data, effectively slowing down the network for those customers.[85] In April of 2010, the District Court of Washington, D.C., overturned the FCC ruling, stating that the FCC "has failed to tie its assertion" to any basis in law,[86] denying the FCC authority to implement net neutrality. Of note, net neutrality is not controversial internationally; users pay for whatever speed/bandwidth used.

The next step is unclear. The FCC has promised to develop net neutrality rules,[87] but several net neutrality bills have died in Congress since 2006. Without legal authority to control Internet providers, one option for the FCC is to define Internet providers as common carriers (like telephone companies).[88] Law clearly supports the FCC jurisdiction over common carriers, but Congress and even the FCC are divided on whether that jurisdiction should be extended. As there is no market failure, Net Neutrality legislation would seem to be premature.

International and Economic Development

The U.S. has a national security interest in helping Sub-Saharan Africa (SSA) and other underdeveloped parts of the world expand the ICT industry in ways that enhance prosperity, trade, and cybersecurity. A more democratic, educated, and prosperous SSA will contribute to

the strategic goal articulated in the Department of State USAID 2007 Strategy of "a more democratic, secure, and prosperous world composed of well-governed states that respond to the needs of their people, reduce widespread poverty, and act responsibly within the international system."[89] As the global leader in ICT, the U.S. ICT industry is poised to be a major supplier of the technology, software and services that SSA and other regions will need as their ICT industries grow. See issue paper in Part 2 for a more in-depth exploration.

ESSAYS ON MAJOR ISSUES

1. Social Networking: Implications for Collaboration, Innovation, Productivity and Society

Social networking is exploding. The incoming workforce has grown up in the digital age and is the dynamo behind social networking and its rapid growth. Businesses that can tap successfully into this rising workforce, leveraging social networking along the way, will find new resources for innovation and productivity. Integrating social networking as a collaborative tool is not without risks, especially in regard to data security. Society as a whole will also face challenges from looser norms of privacy. However, real business and societal value can be extracted using social networking, if we master it as a tool, instead of becoming slaves to it.

Social networks come in a myriad of forms. Facebook is the second most visited site on the Internet (after Google) and claims over 350 million users—larger than the population of the U.S. Approximately 70% of its users live outside the U.S.[90] MySpace focuses on music and entertainment; LinkedIn is geared toward career professionals; Twitter is a "micro-blog" site (limited to short 140-character "tweets"). Approximately 20 hours of video content is uploaded to YouTube every minute. Across these and a milieu of other global options, it is estimated that one in every six minutes spent online is at a social networking site.[91] Notably, this is not just a U.S. phenomenon. In China, for example, social networking is growing rapidly and the chat room features of some games are as popular as the games themselves.

Online social networking is largely an outgrowth of the so-called Millennial generation (born 1977-1997). Author Don Tapscott sees eight characteristics of Millennials: freedom, customization, innovation, scrutiny, integrity, speed, entertainment, and especially collaboration.[92] Millennials have pushed collaboration on Wikipedia, through over 100 million blogs, via peer-to-peer file sharing (especially movies and music), and on the $40-plus billion online gaming industry.[93] Today's teens watch less TV than their parents but spend over 30 hours per week on the Internet.[94] Millennials expect instant access and the latest technologies, prefer texting to face-to-face, choose lifestyle over work, and are, in one observer's opinion, "oblivious to corporate policies."[95] In the workforce, they want to be heard and to receive constant feedback, with networking skills valued as important for advancement as technical competence. Outcomes mean more to Millennials than face time,[96] and they value collaborative teamwork even more than baby boomers.[97] Social networks provide their tools of choice, and with them, Millennials can be a catalyst for new growth and productivity.

The meteoric rise of social networking has led to an evaluation of its business prospects. The business strategy of most online social networks can be generalized as "ubiquity first, revenue later."[98] Despite burgeoning user growth, 2009 revenues in the U.S. were only 4 percent higher than the previous year.[99] Facebook's revenues, estimated at over $500 million, finally put it "into the black" in 2009.[100] Advertisers are attracted to social networks because of their global scale and ability to target ads based on details of users' profiles. Twitter is profiting from deals to share its treasure trove of user tweets as searchable content. Other firms are also willing to pay Twitter for selectively analyzing market "buzz" in the tweet universe.[101]

Social networking also shows promise to boost productivity—and the bottom line. Its tools have become more prevalent in three specific business areas: recruiting, customer service, and innovation. For recruiting, millions of dollars have been saved by using social networks such as LinkedIn, instead of expensive headhunters, to find top talent.[102] For customer service, Twitter and similar micro-blog services provide valuable tools, since content is public and can be mined

using built-in search engines. Companies can thus "listen in" to online commentary about their brands, products, and services, benefitting from these "instant focus groups" at very nominal cost.[103] Finally, innovation gets a boost from social networks that tie individuals with complementary skills and interests together, enabling pooled expertise and shorter product development times.[104] Companies have also seen real business value by using social networks for specific idea-generation events.[105] In some cases, this is morphing into social production, where consumers help design or produce goods.[106]

Adoption of social networking is not without risks. Security concerns and uncontrolled content top the list. Companies are trying to find the right balance between employee access and corporate control of social media. Some block access, others issue guidelines, and many automatically scour sites for potential leaks of intellectual property.[107] The Department of Defense only recently relaxed its policy to allow access to Internet-based capabilities, including social networking sites, across its unclassified networks.[108] Concerns about security are magnified by the less stringent norms of privacy among social network users. As Tapscott warns, "Lives have been shattered thanks to unsuspecting people flinging open their kimonos in the seeming intimacy of their Web sites. The Internet has a long memory."[109] Unfortunately, many social networking sites encourage these "open kimonos." Facebook faced a storm of criticism in 2007 over a service that automatically shared users' online purchase information with their friends.[110] The default loose privacy settings Facebook established in 2009 have drawn fire from the Federal Trade Commission.[111] In addition, a flood of independent applications now populate social networking sites, and users who install them enable developers to mine valuable personal data.[112] Indifference to privacy also opens the door for nefarious conduct. Social network users have seen a 70-percent jump in spam and hacking attacks between 2009 and 2010.[113] Finally, there is the concern of wasted time. A 2009 survey of 1,400 CIOs found that many blocked corporate access to social networking sites over concerns of "social notworking" (e.g., excessive chatting on Facebook).[114] Others noted that corporate time-wasters have always existed; Facebook just provides a new outlet for their usual behavior.[115]

Concerns with social networking should not overshadow the prospects for real productivity growth. Clients of SelectMinds, which builds tailored social networks for corporations, stated that social networking boosted productivity by 10%, new business by 12% and retention by 5%.[116] Corporations save millions in travel costs by having employees participate as "avatars" in online virtual meetings.[117] These virtual, networked offices provide business resiliency: one large firm lost only 4% to 5% of its productivity during severe winter weather that shut down its entire metropolitan community.[118]

The future of social networking, especially given the mobile device explosion and now-ubiquitous geolocation capabilities, has staggering possibilities: cars that alert friends when you're enroute to their house; DVRs that automatically record shows based on your social tweet themes; checkout stands that let you instantly share store specials with your friends.[119] The creators of Facebook and Twitter often describe their products in Utopian terms: "the greatest transformative force in our generation" or with "the potential to change the world."[120] Observers note that the "free" communication and collaboration tools offered by online social networks are bringing about a "democratization of technology" and "socialization of the Web," fundamentally altering interactions between individuals, businesses and governments.[121] This may be techie hyperbole, but the incorporation of social networks into society requires our attention.

Social networking, and the Millennial generation that propelled its rise, are both here to stay. Society at large must understand their possibilities, and the business world must harness

this potential by smart incorporation of new collaborative tools and processes. Security and privacy issues should be addressed. However, outright bans on access to social networking are counterproductive. Firms will find it more difficult to attract young talent (who expect social media), and new outlets for productivity, innovation, and customer value will be missed. Perhaps a social network such as Facebook won't live up to the full hype of its creators, who see it becoming a "social utility" akin to electrical power grids.[122] Nevertheless, social networks can truly empower the adage that the wisdom of the many is better than the wisdom of the few.[123]

Lt Col Dan Daetz, USAF

2. Cloud Computing

Cloud computing is an on-demand model for Internet-based IT services, which represents an evolution of client/server architecture wherein varying degrees of a consumer's computing are done remotely "in the cloud" by an outside provider. Put another way, cloud computing represents IT asset virtualization. The National Institute of Standards and Technology (NIST) defines cloud computing as, "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."[124]

NIST says cloud computing can be further described with five essential characteristics and four deployment models and three service models. The essential characteristics are: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. The deployment models are: private, community, public, and hybrid. The three service models, in order of increasing consumer engagement, are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

SaaS allows the consumer to use the applications on a provider's computing infrastructure via the Internet through a thin client interface such as a web browser (e.g., web-based email). With the exception of user-specific application configuration settings, the consumer does not manage, control or have responsibility for the cloud infrastructure.

PaaS allows the consumer to deploy consumer-created or acquired applications onto the provider's computing infrastructure and then use them via the Internet through a thin client interface. With the exception of the deployed applications and some application hosting environment configurations, the consumer does not manage, control or have responsibility for the cloud infrastructure.

IaaS allows the consumer to deploy random software, including operating systems and applications, onto the provider's computing infrastructure, and then use it via the Internet through a thin client interface. The consumer has control of deployed operating systems and applications, as well as related data storage, and possibly even some limited control of select networking components (e.g., host firewalls), but the consumer does not manage, control, or have responsibility for the cloud infrastructure.

Common to all three of NIST's service models is the key fact that consumers do not own the physical infrastructure, thereby avoiding the capital expense therein, as well as the associated maintenance and support investments. Instead, consumers pay only for IT services they use, while being free to focus on the outputs rather than the mechanics of those services. Cloud computing is thus a productivity enhancer that, due to the commoditization of data storage and manipulation capacity, enables consumers to treat IT services like a utility. Advanced computing becomes easier and cheaper, and consumers benefit (to the detriment of producers).

Cloud computing is so new and becoming so pervasive that services are being offered by many new firms, as well as by established computing industry leaders. Big names include Amazon, AT&T, Cisco, Dell, Google, HP, IBM, Microsoft, and Oracle, but onCloudComputing listed 74 "Cloud Computing Solution Providers to Watch in 2009."[125] IBISWorld reports that concentration in the overall industry is low, and that fragmentation is high, with less than five employees at 56.5% of all sites in 2009, and 50 or more employees at only 8.5%.[126] Competition is therefore nearly pure, with low barriers to entry, and many smaller firms able to provide services to multitudes of prospective smaller clients. Larger players benefit from economies of scale, outsourcing, and resources better matched to service enterprise-size clients, but the market includes client firms of all sizes, including clients which may be of little interest to larger players or which may prefer more personalized handling.

InfoWorld.com has suggested that "cloud computing encompasses any subscription-based or pay-per-use service that, in real time over the Internet, extends IT's existing capabilities."[127] Defined that way, the opportunities are broad, which explains the interest from computing hardware companies like IBM and Intel, computing software and services giants like Microsoft and Oracle, merchandising giants like Amazon, and niche start-up providers like GoGrid and Salesforce.com. Cloud computing has become a business strategy employed at every level of the general computing industry, as a means of providing services that combine digital information processing requirements and by providing infrastructure on demand, while the business strategy for providing those services involves the five "essential characteristics" listed by NIST. Companies like IBM and Oracle are focusing on developing private clouds using client infrastructure, but adaptive technology will allow deployment of hybrid clouds with consistent data management and security throughout.

Despite stiff competition, which includes continuing foreign competition in the computing industry generally due to lower foreign labor costs (especially in India), domestic and foreign cloud computing market growth will continue to provide good opportunities for U.S. providers, especially as security becomes an increasingly important differentiator. Finding #9 of 2010's Global State of Information Security Survey, conducted by PriceWaterhouseCoopers, CIO Magazine, and CSO Magazine, indicates that while IT asset virtualization is a growing priority, only one out of every two respondents believes it *improves* information security, due primarily to an uncertain ability to enforce security policies at a provider (23%) and inadequate training and IT auditing (22%).[128] This security concern should favor large established U.S. companies, as well as smaller focused U.S. companies, where information assurance will develop along with productivity and profit margins, as technological solutions further enhance the returns from cloud computing service. So far, this is all market-driven. No subsidies, quotas, trade restrictions, or calls for protection apply.

As the global economy improves, U.S. firms offering cloud computing must take advantage of the inclination of consumers to invest in new application services as productivity enhancers, in order to offset U.S. losses in the share of overall computing industry revenue. Key to this kind of success will be the development of strategic alliances and partnerships between companies in the software, hardware, and computer consultancy services areas to offer clients comprehensive IT solutions at lower cost but with significantly enhanced capability.

Lt Col Eric Jorgensen, USAFR

3. Cybersecurity and Critical Infrastructure Protection

America and all other developed nations are critically dependent on ICT and the continuous availability of the Internet. This dependence carries with it perilous vulnerabilities to cyber

attack. To overcome emerging threats and challenges the U.S. must develop and routinely exercise a comprehensive public-private critical information infrastructure protection (CIIP) program and a cyberspace operations strategy. It must also continue international cooperation to dedicate resources to coordinated responses.

Developing threats present complex challenges that require authorities and responsibilities to detect, isolate, respond to and rectify the adverse impacts of infrastructure attacks; attacks that can span the range from malicious software to use of physical means to disrupt or destroy ICT infrastructure. The public and private sectors must collaborate to enhance ICT infrastructure resiliency and build information sources to guide protective capability development, thereby reducing vulnerabilities inherent in the proliferation of increasingly advanced ICT.

Resiliency and survivability must be considered in the design and manufacture of all ICT equipment, and plans and exercises that promote continuity of operations and mission accomplishment must be developed. The U.S. should also champion international laws and agreements for the investigation, identification, apprehension and prosecution of cyber criminals, and be prepared to initiate active and passive defenses against state and non-state attackers, up to and including the full range of military options to neutralize threats.

Responsibilities for Protecting Critical Information Infrastructure: The Department of Homeland Security (DHS) is charged with leading the nation's overarching infrastructure protection initiatives, and the DHS National Infrastructure Protection Plan (NIPP) is the central document that addresses CIIP. The NIPP provides the unifying structure for the integration of a wide range of efforts for the enhanced protection and resiliency of the nation's critical infrastructure and key resources (CIKR) into a single national program.[129] It emphasizes physical security and the prevention of terrorist attacks, to maintain operation of information networks essential to key business processes and delivery of essential goods and services throughout all levels of the government and the private sector. The NIPP strongly endorses public and private sector collaboration in addition to advocating cooperation with international partners to protect critical infrastructures globally.

Protection can include a wide range of activities, such as improving security protocols, physically hardening facilities, building resiliency and redundancy, incorporating hazard resistance into facility design, initiating active or passive countermeasures, installing security systems, leveraging "self-healing" technologies, promoting workforce surety programs, implementing cybersecurity measures, conducting training and exercises, and business continuity planning.[130] The NIPP also labels the electric power grid and the ability to distribute power for CIIP operations as critical to mission success and continuity of operations.[131]

National Cybersecurity Policies and Initiatives: Our nation's critical infrastructure includes public and private institutions in multiple sectors, including agriculture, food, water, public health, emergency services, government, the defense industrial base, information and telecommunications, energy, transportation, banking and finance, chemicals and hazardous materials, and postal and shipping. Cyberspace is the nervous system behind these operations, making it essential to our economy and our national security.[132] Current U.S. cybersecurity policy is focused on protecting federal government and national security systems while making information and recommendations available to state and local governments, private sector firms, and individuals. The 2003 National Strategy to Secure Cyberspace assigned broad responsibilities for federal government cybersecurity to the Department of Homeland Security and emphasized the responsibility of all cyberspace users to secure their own systems and networks. President Obama's 2009 Cybersecurity Policy Review recommended ten near-term

actions to help the U.S. achieve more reliable, resilient, and trustworthy digital infrastructure for the future.[133] The 2008 Comprehensive National Cybersecurity Initiative (CNCI), bridges to earlier strategies to ensure cyber protection of federal government systems.[134] (See Appendices H/I/J). In December 2009, President Obama appointed a White House Cybersecurity Coordinator, thereby elevating cybersecurity responsibility to the White House. The Coordinator works through the National Security Council's (NSC) Information and Communications Infrastructure Interagency Policy Committee to accomplish the remaining near-term actions.[135]

Critical Information Infrastructure Attack Threats – Challenges and Trends: Defense, exploitation, and attack in cyber operations presents a continuous, dynamic, and persistent challenge with a wide range of threat vectors that must be detected and countered. The most serious potential cyber attacks upon critical information infrastructure include denial of service attacks, distributed denial of service attacks, Trojan horses, viruses, worms, spyware, and botnets.[136] To exacerbate the challenges, the terrain includes a multitude of state and non-state actors, criminal groups, individual hackers, disgruntled insiders and terrorists, all of whom can employ cyber attacks to deny use of, disrupt, or destroy critical information infrastructure.[137]

Electromagnetic Effects on Critical Information Infrastructure: An increasingly potentially devastating critical information infrastructure threat is intentional electromagnetic interference (IEMI), which refers to the non-nuclear generation of electromagnetic pulse (EMP). IEMI is defined as "the intentional malicious generation of electromagnetic energy, introducing noise or signals into electric and electronic systems, thus disrupting, confusing, or damaging these systems for terrorist or criminal purposes."[138] Nuclear technology may also be used to destroy critical information infrastructure. "EMP attack can begin with the explosion of a nuclear weapon high in the atmosphere. This explosion interacts with the planet's magnetic fields, creating a pulse, which in turn causes extensive damage to electronic systems…Nearly 30 countries currently possess ballistic missile capabilities."[139] One possible attack method is a missile launched by a freighter in international waters, and subsequently detonated at high altitude above the U.S. (action colloquially called a "Scud in a tub)."[140]

Countering Critical Information Infrastructure Attack Threats: A growing consensus on the need for action is forming in response to greater awareness of the threats posed to ICT-dependent economies, governments and militaries. The DHS biennial exercise - "Cyber Storm" - is the most extensive government-sponsored cybersecurity exercise to date. Each Cyber Storm builds on lessons learned from real-world incidents, ensuring that participants face more sophisticated and challenging exercises every two years.[141] Such efforts should become more commonplace.

Public and private sector organizations can also build resiliency, improve preparedness, and enhance recovery and restoration readiness through incorporation of best practices consolidated by the Network Reliability and Interoperability Council (NRIC). NRIC was formed to "partner with the FCC, the communications industry, and public safety, to facilitate enhancement of emergency communications networks, homeland security, and best practices across the burgeoning telecommunications industry."[142] To encourage participation, the government should offer fiscal incentives (reduced taxes, preferential contracting, etc.) to firms with a demonstrated record of adherence to best practices recommended by NRIC and others.

The public and private sector should also continue to collaborate via the Protected Critical Infrastructure Information (PCII) Program. "The PCII Program is an information-protection program that enhances information sharing between the private sector and the government."[143] Public-private information sharing will be critical to reducing future

vulnerabilities, vulnerabilities which are increasingly shared by government organizations and businesses and other private entities throughout the world.

CDR Dave Carson, USN and Ms. Kolleen Yacoub, DIA

4. Intellectual Property Rights in ICT: Trends and Future Implications

The value of intellectual property (IP) has changed over the last two decades as technological advances drive domestic and global growth. IP is the "new capital" on which IT companies build revenue streams. Estimates of the largest companies in the Fortune 500 indicate the value of IP to be between 50% – 75% of assets; considered to be the highest growth area in the domestic economy.[144] IP is an important source of competitive advantage and with almost 18 million workers, IP industries are one of the largest sources of jobs in the U.S.[145] According to the International Intellectual Property Alliance, total U.S. copyright industries accounted for an estimated $1.52 trillion or 11.05% of U.S. GDP in 2007. The U.S. Patent and Trademark Office estimates U.S. IP to be worth more than $5 trillion. In most developed countries ICT companies retain value from intellectual property through the enforcement of confidentiality agreements (69%), copyright (41%), trademarks (31%) and patents (25%) in order to exploit innovation.[146]

Though the U.S. remains at the forefront of ICT patent development and exploitation, in 2009 non-Americans were granted more U.S. patents than resident inventors, for the first time accounting for 50.7% of new grants. This shift also marked only the second time in the last 25 years that patent applications decreased from the previous year.[147] The implication is that "the U.S. is losing its innovation base"[148] and will begin to lose its world dominance in the ICT industry. The rebalance of patent grants is partly due to the impact of globalization. The movement of R&D to foreign countries, the return of foreign ICT professionals and students to their native countries due to US immigration policy, and U.S. tax policy all have a direct impact on the ability of U.S. firms to sustain intellectual property market share. "The U.S. once boasted the most generous research and development tax credits among the 30 countries in the Organization for Economic Cooperation and Development. The U.S. currently ranks 17th, as other nations have cut taxes to spur investments in labs and equipment."[149]

The U.S. government recognizes the need to develop and implement a comprehensive policy to address these challenges. The Obama administration's approach will be implemented through the formation of the Department of Justice Task Force on Intellectual Property.[150] Vice President Biden has taken the administration's policy lead and tasked the inter-agency task force with developing a policy focused on strong enforcement through close coordination with state and local law enforcement partners as well as international counterparts with an increased focus on the links between intellectual property crime and international organized crime.[151] The task force works closely with the Office of the Intellectual Property Enforcement Coordinator (IPEC) which has been tasked with drafting an Administration-wide strategic IP plan.

Telecommunications and Internet companies believe the administration's approach favors the business models of Hollywood, TV and music companies and believe the evolving policy will saddle them with international legal obligations. ICT industry lobbyists have expressed concern over the prospect of international agreements allowing entertainment companies to sue high-tech companies in European courts whenever their networks, computers and software are used by anyone around the world to transmit an illegally copied movie, TV show or song.[152]

The administrations Intellectual Property Rights (IPR) reform is being developed in parallel with congressional action that will change U.S. IP law that has not been significantly updated in more than 55 years.[153] The Patent Reform Act of 2009 is supported by universities, biotech companies, high-tech companies, pharmaceutical companies, traditional manufacturers and

green-technology pioneers, as well as labor unions whose members' jobs depend on a strong intellectual property system.[154] The Act is not without its detractors. Of chief concern is the switch to a "first to file" system which opponents believe encourages more patents being filed faster, rather than better patents being filed.[155]

Because U.S. IPR laws are only directly enforceable in U.S. courts the government and U.S. firms must find a way to strengthen international IP enforcement and effectiveness utilizing opportunities such as the Trade-Related Intellectual Property (TRIPs) agreement. The TRIPs agreement, signed in 1994 as part of the multilateral trade negotiations attempted to establish minimum standards of intellectual property rights protection by all World Trade Organization (WTO) members by 2006.[156] India and China are considered to be the primary threats to U.S. global competitive advantage, albeit for different reasons.

The growth of India's ICT industry is a result of the development of its domestic educational institutions and the exploitation of professionals educated in the U.S. who are forced to return home due to U.S. immigration policy. Many of the individuals have extensive experience in Silicon Valley and bring that experience along with legally acquired IP rights to develop products and services in India that compete with U.S. manufacturers.

The Chinese threat to U.S. IP dominance is based on the potential growth of large untapped Chinese ICT markets, a lack of confidence in the enforcement of IP laws, policy and international agreements within China, and the Chinese government's position on IPR that runs counter to commonly held international rights standards. China is working to reverse the perception and better position its domestic industry by implementing policy that builds a functional intellectual property regime.[157] The growth of Chinese companies in the global market is also driving the Chinese government's approach to IP enforcement.

"Huawei Technologies Co. Ltd., a Shenzhen-based ICT firm, filed the most Patent Cooperation Treaty applications (the foundation of patent applications in other countries) in 2008, according to statistics published by the World Intellectual Property Organization—beating Panasonic, Phillips, Toyota and other multinational companies that used to hold the top spot. Chinese companies like Huawei benefit from strong IP protection and could help pressure policy-makers to strengthen the intellectual property regime in that country.[158]

China will continue to challenge U.S. dominance of the global IP value chain. In contrast to the trend of decreasing IP patent applications in the U.S., the Chinese Patent Office issued more than 580,000 patents in 2009; an increase of 41%. Applications increased by more than 250% during the period 2002 to 2009, making the Chinese Patent Office the third-busiest patent authority in the world. Surprisingly, "China surpassed the U.S. in 2008 to become the most litigious country in the world for intellectual property disputes though only about 10% of those patent applications were filed by foreign companies, and a foreign company was one of the parties in less than 5% of intellectual property lawsuits filed in 2008."[159]

COL Greg McClinton, USA

5. ICT's Role and Potential in Developing Economies

Because poor, unstable countries tend to be the sources of cross-border conflicts, transnational threats and terrorism, fixing "disconnectedness" is not just a humanitarian issue, but a U.S. national security priority as well. The solution is to develop those "gap" countries, especially economically, and one particular instrument – ICT – is proving to be both a powerful change agent and far more cost-effective than either economic aid or military intervention.

ICT is transforming the interactions between people, governments, and firms worldwide, and is becoming more and more integral to the international "development" process. ICT

produces a wide range of economic effects which can increase welfare and facilitate social and economic development. Direct effects include productivity gains resulting from the development and deployment of ICT and the development of new, related technologies. Indirect effects include trade creation and trade facilitation in service sectors, employment opportunities created by ICT-enabled reforms, enhanced flexibility for firms and workers and the creation of new business models and opportunities.[160] In the new global economy, ICT drives five key areas: productivity; employment; more efficient markets; higher quality goods and services; and innovation in new products and services. In the U.S. ICT capital has an impact on worker productivity three to five times that of non-ICT capital.[161] While in the developing world the impact is not yet as great, ICT is making a difference there as well. In China in 2006, for example, ICT usage was responsible for 38% of the increase in total factor productivity growth and 21% of GDP growth"; and productivity growth is the key to growing an economy.[162] ICT also allows economies to acquire and share ideas, expertise, services and technologies locally, regionally and across the world. It contributes to making the global economy more integrated, and can create and sustain new economic development.[163]

There are numerous examples: In developing countries, farmers receive updated crop prices and public health officials monitor medical inventories by text messages. Women, a particularly underutilized resource, are empowered to make decisions and access new opportunities through online information. Entrepreneurs obtain business licenses in a fraction of the standard time by applying for them through municipal government Web sites. In an increasingly integrated global economy, ICT enables people to access and share knowledge and services around the world.[164] Data shows that ICT, properly implemented, promotes and enables educational reform, motivates learning and promotes greater efficiencies in education systems and practices.[165] There is also a direct, measurable correlation between ICT penetration in a country and its economic growth. According to a recent World Bank econometrics analysis of 120 countries, for every 10-percentage-point increase in the penetration of broadband services, there is an increase in economic growth of 1.3 percentage points. This growth effect of broadband is significant and stronger in developing countries than in developed economies, and it is higher than that of telephony and Internet (see Appendix E, Figure 1).[166]

ICT also enables off-shoring, and in developing countries that means jobs. Another important positive impact of the growth of IT services and IT-Enabled Services (ITES) is on the status and employability of women.[167] Access to broadband networks has also had a positive impact on rural and farming incomes.[168] ICT has had a similar economic growth-related effect on the growing field of mobile banking, which gets poor families off their very high-cost current methods of financing (such as pawn shops and loans in the informal sector) and promotes both saving and borrowing, allowing families to pursue initiatives and gain wealth.[169,170] By networking experts together and enabling effective controls, ICT can aid in governmental functions such as emergency services, healthcare, search and rescue, and missing person and criminal identification and location. ICT's impacts on healthcare[171] and education are also very important.[172] It may be the key to building confidence in governments and democracy.

While ICT is starting to take hold in the developing world and continues to grow in response to both market demand and development programs, growth is uneven (see Appendix F). So how can we help? For a proven set of actions and policies the U.S. Government can build on, fund and expand, we can look to nascent efforts of the World Bank. The World Bank Group has three strategic ICT priorities: access to ICT infrastructure, improving delivery of public and private services; and innovation to support development of local ICT industries.[173] Fixed

broadband prices remain a major hurdle (see Appendix E, Figure 3), but policy reforms to expand *mobile phone* services in sub-Saharan Africa have already shown dramatic success.[174] Meanwhile the World Bank's "Information for Development" ("infoDev") program includes a number of promising, low-cost methods for leveraging ICT to improve government services.[175]

In addition, ICT both directly and indirectly promotes good governance. Electronic banking transfers are difficult to siphon off or use for bribery, because they leave a trail. When combined with other initiatives such as secure credentials and citizen's benefit cards – which enable secure voting, better security at airports and secure access to critical infrastructures – ICT has the potential to improve security and reduce corruption.[176] Among the World Bank's efforts, *e-government* "is the most cited and high-profile of all ICT applications, given its importance in underpinning development efforts."[177] Successful e-government projects have improved policy and investment coordination, administrative coordination and technical coordination in over a dozen developing countries.[178] This has reduced transaction costs and processing time, increased government revenues, and improved governance by reducing corruption and abuse of discretion, thereby making vital contributions to development.[179] These efforts have all proven very cost-effective for the results they produce, and should be expanded.

Public-private collaboration is the key. Positive private philanthropic examples include Accenture's "technology donations"; e-Learning sites in Dar es Salaam, Tanzania (which enable distance-learning); the Google Foundation's efforts; and the Gates Foundation's "one laptop-per-child" program. But private efforts can be further encouraged by fiscal incentives, lowering regulatory barriers to international business, and encouraging competition. Also, increased market liberalization and competition tends to reduce prices, which in turn leads to higher levels of ICT uptake.[180] A great example of public-private collaboration occurred in 2002, when, with funding from Japan, the World Bank's infoDev program began its "Incubator Initiative" which used ICT to provide developing countries with access to subject matter experts, with some 80 incubators in 50 countries working with 3,000 entrepreneurs.[181,182] ICT investment provides near-term, cost-effective outcomes: "Given the relatively short time-lag of ICT indicators compared to other development indicators, countries with low ICT levels could catch up relatively quickly, provided their ICT sectors receive adequate policy attention."[183]

While the current state of ICT in developing countries is weak, it is improving and can progress quickly via technological leaps such as mobile phones and wireless Internet access. ICT presents perhaps the most cost-efficient and most achievable path for U.S. government actions and policies to grow economies, improve government services, enable good governance and promote income generation to help close the gap between us and the developing world.

Lt Col Hans Palaoro, USAF

CONCLUSION

The global ICT industry is vital to both the U.S. and world economies, and to U.S. national security. While there are significant challenges yet to be overcome - to include globalization, cybersecurity, lagging government policy, STEM education, industry consolidation, proliferation of mobile devices, fast-paced technological development, and immigration issues - the ICT industry is innovative and resilient, and is capable of meeting these challenges given proper, rational industry-government collaboration. The U.S. ICT industry's future outlook is complex

and fraught with hurdles, but it is still well-positioned to support U.S. national interests and maintain its proper place, leading and benefiting the world.

Appendix A – The ICT Industry Defined

For the purpose of this study, the Information & Communications and Technology industry includes: computer and electronic product manufacturing (manufacture of computers, peripherals and related communications equipment); computer systems design and related services (software development, computer design and integration, and on-site management of client systems and data processing facilities); data processing, hosting, and related services (Web hosting, application hosting, computer data storage, and video and audio streaming services); software publishers (publishing and reproduction, reselling packaged software, designing software to meet needs of specific users); telecommunications (services related to telephony, voice over Internet protocol (VoIP), cable and satellite television distribution, and Internet access); and other information services (searching and retrieving information, operating Web sites that use search engines to allow for searching information on the Internet, or publishing and/or broadcasting content exclusively on the Internet).[184]

In this study, these sectors are represented by the following 8 elements as defined by the North American Industry Classification System (NAICS):

NAICS Code	Description
5171	Wired Telecommunications Providers in the U.S.
5172	Wireless Telecommunications Carriers in the U.S.
5152	Cable, Internet and Telephone Providers in the U.S.
518	Internet Service Providers, Web Search Portals, and Data Processing Services
5112	Software Publishing in the U.S.
5191	Other Information Services
33411	Computers and Peripherals
33422	Communications Equipment Manufacturing

Table 1: ICT Industry NAICS Codes

Appendix B – ICT in Europe

2008 company filings	Revenues ($ millions)	Profit Margin (%)	Employees
Deutsche Telekom	90.233	2,4	235.000
BT	37.995	8,4	112.000
France Telecom	78.266	8,4	183.000
Telecom Italia	44.129	7,3	57.000

Table 2: Fixed Line Phones in Europe[185]

2008 company filings	Revenues ($ millions)	Profit Margin (%)	Employees
Samsung Corporation	109.984	4,6	43.000
Nokia Corporation	74.201	7,9	122.000
Motorola Inc.	30.146	-14,1	64.000

Table 3: Mobile Phones in Europe[186]

2008 company filings	Revenues ($ millions)	Profit Margin (%)	Employees
Deutsche Telekom	90.233	2,4	235.000
France Telecom SA	78.266	8,4	183.00
Tiscali (values of 2007)	1.332	-8,3	1900

Table 4: Internet Access in Europe[187]

2008 company filings	Revenues ($ millions)	Profit Margin (%)	Employees
Hewlett-Packard	118.364	7,0	321.000
IBM	103.600	11,9	398.000
Dell	61.133	4,8	76.500
Fujitsu	51.523	0,9	167.000

Table 5: Computer hardware in Europe[188]

2007 company filings	Revenues ($ millions)	Profit Margin (%)	Employees
Samsung Electronics	67.553	11,7	13.400
Intel	38.334	18,2	86.000
Texas Instruments	13.835	19,2	30.200
STMicroelectronics	10.000	-4,8	52.000

Table 6: Semiconductors in Europe[189]

2008 company filings	**Revenues ($ millions)**	**Profit Margin (%)**	**Employees**
IBM	103.600	11,9	398.000
Microsoft	60.420	24,9	93.000
Oracle	22.430	24,1	22.300
SAP	16.937	16,0	51.500

Table 7: Software in Europe[190]

Appendix C – ICT in the Middle-East

Country	Population	GDP per capita($)	Internet Teledensity	Home telephone Teledensity	GSM Teledensity
Qatar	833,285	75,956	52.3%	20.56%	131.39%
UAE	4,798,491	46,584	60.9%	33.63%	208.65%
Kuwait	2,692,526	42,700	27.1%	18.53%	99.59%
Israel	7,233,701	29,672	72.8%	45.7 %	127.38%
Bahrain	728,709	24,355	55.3%	28.42%	185.77%%
Oman	4,017,095	18,718	13.6%	9.84%	115.58%
Saudi Arabia	28,686,633	14,871	126.8%	16.27%	142.85%
Lebanon	4,017,095	8,467	23.5%	17.88%	41.8 %
Iran	66,429,284	4,477	48.5 %	33.5%	34.03%
Jordan	6,269,285	3,766	23.9%	8.46%	86.6%
Syria	21,762,978	2,669	16.4%	17.12%	58.24%
Iraq	28,945,569	2,245	1.0%	3.60%	33.24%
Yemen	22,858,238	1,108	1.6%	4.87%	16.14%
Palestine	4,013,126		15.6%		
Regional average			28.3%	19.87%	94.1%

Table 8: ICT in the Middle East[191]

Appendix D – Human Capital in the ICT Industry

Country	Projected Job Growth	Competition for Jobs	Country STEM Investment	Industry Education and Training	Outsourcing & Offshoring	Challenges
USA	Growing faster than the average of all occupations	Keen competition for positions both nationally and globally	Lagging in K-12 and in Undergraduate Programs* World Leader in quality of PhD programs	Investment in initial employee training programs and leadership development programs	Conducted primarily to gain or maintain competitive advantage. Based on cost of labor; ability to expand market share; availability of capital & resources; govt. policies (tax laws)	Renew interest in STEM and finding qualified STEM teachers Finding qualified candidates Current immigration laws impede ability to retain foreign qualified labor (H1-B Visa program limits) Political pressure to retain jobs in the US
China	Growing in all sectors: Manufactur-ing focus for external, and Service focus for internal markets	Keen competition for positions both nationally and globally	Number of engineering PhD graduates in China continues to surpass the US**	Trend is individual firms create & tailor own training schools	Outsource to consulting firms to adapt business mgt. best practices	Finding qualified candidates Competition for resources growing
Hong Kong	Growing in all sectors	Same as China	Same as China	Same as China	Same as China	Same as China
Vietnam	Growing in all sectors – Govt. seeking foreign investment in IT fields – e.g., Intel Corp.	Keen competition for positions both nationally and globally	Lagging behind US/China, but significantly increasing students studying abroad	Trend is individual firms create & tailor own training schools	Outsource to consulting firms to adapt business mgt. best practices	Finding qualified candidates Availability of infrastructure – electricity, clean water, etc.

Table 9: Human Capital in Key ICT Economies

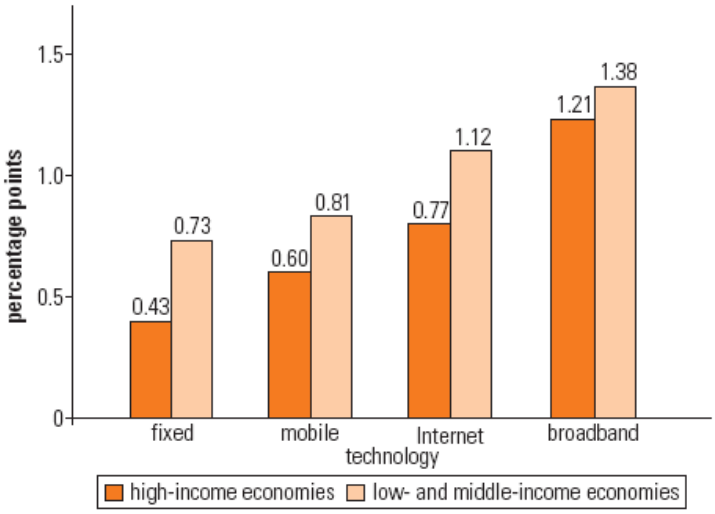
* Within the last two decades, the number of U.S. high-school students who expressed an interest in STEM occupations dropped from 36% to 6% with fewer than 2% of U.S. high-school graduates receiving engineering degrees.

** Between 1983 and 2003, the number of engineering PhD graduates in China increased by 306% (compared to 89% in the U.S).

Occupation	2008		Projected 2018		Change, 2008-2018	
	Employment (in thousands)	Percent of Industry	Employment (in thousands)	Percent of Industry	Number (in thousands)	Percent
Total, all occupations in	1,450.3	100.00	2,106.7	100.00	656.4	45.3
Computer software engineers, systems software	113.7	7.84	178.9	8.49	65.2	57.4
Computer support specialists	99.8	6.88	157.1	7.46	57.2	57.4
Computer software engineers, applications	175.2	12.08	275.6	13.08	100.4	57.3
Computer and information systems managers	47.9	3.30	69.4	3.30	21.5	44.9
Computer operators	8.9	0.61	12.7	0.60	3.8	43.0
Computer and information scientists, research	6.7	0.46	9.6	0.45	2.9	43.0
Computer hardware engineers	17.1	1.18	23.9	1.14	6.9	40.2
Computer systems analysts	126.3	8.71	177.2	8.41	50.8	40.2
Computer programmers	141.2	9.73	158.4	7.52	17.2	12.2

Table 10: Employment Growth in IT Sectors [192]

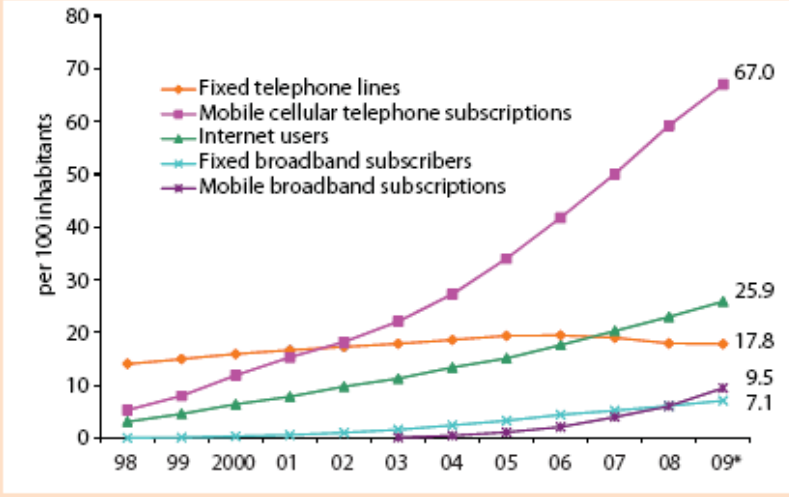
Appendix E – ICT in Developing Economies



Source: Qiang 2009.

Note: The y axis represents the percentage-point increase in economic growth per 10-percentage-point increase in telecommunications penetration. All results are statistically significant at the 1 percent level except for those for broadband in developing countries, which are significant at the 10 percent level.

Figure 1: Growth Effects of ICT[193]



Note: * Estimates.
Source: ITU World Telecommunication/ICT Indicators database.

Figure 2: "The Mobile Miracle" - ICT Penetration Worldwide, 2009[194]

Figure 3: Fixed Broadband Prices Remain Unaffordable in Developing Countries[195]

Appendix F – The Current State of ICT in the Developing World

By the end of 2009, there were an estimated 4.6 billion mobile cellular subscriptions, corresponding to 67 per 100 inhabitants globally. Last year, mobile cellular penetration in developing countries passed the 50% mark reaching an estimated 57 per 100 inhabitants at the end of 2009. Even though this remains well below the average in developed countries, where penetration exceeds 100%, the rate of progress remains remarkable. Indeed, mobile cellular penetration in developing countries has more than doubled since 2005, when it stood at only 23% (see Appendix E, Figure 2). Internet use has also continued to expand, albeit at a slower pace. In 2009, an estimated 26% of the world's population (or 1.7 billion people) were using the Internet. In developed countries the percentage remains much higher than in the developing world where four out of five people are still excluded from the benefits of being online. China alone accounted for one-third of Internet users in the developing world. While Internet penetration in developed countries reached 64% at the end of 2009, in developing countries it reached only 18%; only 14% if China is excluded.[196]

Broadband penetration rates correspond to 23 per 100 inhabitants in developed countries but only 4% in developing countries (and just 2% excluding China).[197] There are promising developments in the mobile broadband sector and the introduction of high-speed mobile Internet access in an increasing number of countries will further boost the number of Internet users.[198] Also, the latest results show that between 2007 and 2008, all 159 countries included in the ICT Development Index (IDI) improved their scores, confirming the ongoing diffusion of ICT and the overall transition to a global information society.[199] The results show that the digital divide is shrinking.[200] In fact, the gap between developed and developing countries in terms of ICT indicators is relatively small – in 2008 mobile cellular penetration and fixed broadband penetration in developing countries had reached the level that Sweden (ranking first in the IDI) had almost a decade earlier, and the number of Internet users per 100 inhabitants was the same as Sweden's just over 11 years earlier.[201] *In other words, because ICT moves so rapidly, developing countries are only a decade "behind".*

Appendix G – Wireless/Mobile Phone Terminology

1G

"1G" refers to the first-generation of wireless telephone technology and mobile telecommunications. These are the analog telecommunications standards that were introduced in the 1980s and continued until being replaced by 2G digital telecommunications. The primary difference between 1G and 2G is that the 1G networks use analog signaling while 2G networks are digital.[202]

2G

"2G" is short for second-generation wireless telephone technology. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja in 1991. Three primary benefits of 2G networks over their predecessors were that phone conversations were digitally encrypted, 2G systems were significantly more efficient on the spectrum allowing for far greater mobile phone penetration levels; and 2G introduced data services for mobile, starting with SMS text messages. After 2G was launched, the previous mobile telephone systems were retroactively dubbed 1G.[203]

3G

International Mobile Telecommunications-2000 (IMT-2000), better known as "3G" or 3rd Generation, is a family of standards for mobile telecommunications fulfilling specifications by the International Telecommunication Union, which includes UMTS, and CDMA2000 as well as the non-mobile wireless standards DECT and WiMAX. While the GSM EDGE standard also fulfils the IMT-2000 specification, EDGE phones are typically not branded 3G.

Services include wide-area wireless voice telephone, video calls, and wireless data, all in a mobile environment. Compared to 2G and 2.5G services, 3G allows simultaneous use of speech and data services and higher data rates (at least 200 Kbps peak bit rate to fulfill to IMT-2000 specification). Today's 3G systems can in practice offer up to 14.0 Mbps on the downlink and 5.8 Mbps on the uplink.[204]

4G

"4G" refers to the fourth generation of cellular wireless standards. It is a successor to 3G and 2G standards. The nomenclature of the generations generally refers to a change in the fundamental nature of the service. The first was the move from analog (1G) to digital (2G) transmission. This was followed by multi-media support, spread spectrum transmission and at least 200 Kbps (3G) and now 4G, which refers to all-IP packet-switched networks, mobile ultra-broadband (gigabit speed) access and multi-carrier transmission. *Two primary standards for 4G are emerging: WiMax and LTE.*[205]

TTLTE

The pre-4G technology 3GPP Long Term Evolution (LTE) is often branded "4G", but the first LTE release does not fully comply with the IMT-Advanced requirements. LTE has a theoretical net bit-rate capacity of up to 100 Mbps in the downlink and 50 Mbps in the uplink if a 20 MHz channel is used - and more if Multiple-input multiple-output (MIMO), i.e. antenna arrays, are used. Most major mobile carriers in the United States and several worldwide carriers have announced plans to convert their networks to LTE beginning in 2009. The world's first

publicly available LTE-service was opened in the two Scandinavian capitals Stockholm and Oslo on the 14 December 2009, and branded 4G. The physical radio interface was at an early stage named High Speed OFDM Packet Access (HSOPA), now named Evolved UMTS Terrestrial Radio Access (E-UTRA).

Verizon Wireless has announced that it plans to augment its CDMA2000-based EV-DO 3G network in the United States with LTE. AT&T, along with Verizon Wireless has chosen to migrate toward LTE from 2G/GSM and 3G/HSPA by 2011.

LTE Advanced (Long-term-evolution Advanced) is a candidate for IMT-Advanced standard, formally submitted by the 3GPP organization to ITU-T in the fall 2009, and expected to be released in 2011. The target of 3GPP LTE Advanced is to reach and surpass the ITU requirements. LTE Advanced should be compatible with first release LTE equipment, and should share frequency bands with first release LTE.[206]

WiMAX

The Mobile WiMAX (IEEE 802.16e-2005) mobile wireless broadband access (MWBA) standard is sometimes branded 4G, and offers peak data rates of 128 Mbps downlink and 56 Mbps uplink over 20 MHz wide channels. The IEEE 802.16m evolution of 802.16e is under development, with the objective to fulfill the IMT-Advanced criteria of 1 Gbps for stationary reception and 100 Mbps for mobile reception.

Sprint Nextel has announced that it will be using WiMAX as its 4G network.[207]

Appendix H – Summary of the 2003 National Strategy to Secure Cyberspace[208]

Provided the initial framework for organizing and prioritizing efforts to protect our nation's cyberspace. Provided direction to federal departments and agencies that have roles in cyberspace security and identified steps that state and local governments, private companies and organizations, and individual Americans can take to improve our collective cybersecurity. (GAO-05-434, pg. 17)

Our nation's critical infrastructures are composed of public and private institutions in the sectors of agriculture, food, water, public health, emergency services, government, defense industrial base, information and telecommunications, energy, transportation, banking and finance, chemicals and hazardous materials, and postal and shipping. Cyberspace is their nervous system—the control system of our country. Cyberspace is composed of hundreds of thousands of interconnected computers, servers, routers, switches, and fiber optic cables that allow our critical infrastructures to work. Thus, the healthy functioning of cyberspace is essential to our economy and our national security. (pg. vii)

This *National Strategy to Secure Cyberspace* is part of our overall effort to protect the Nation. It is an implementing component of the *National Strategy for Homeland Security* and is complemented by a *National Strategy for the Physical Protection of Critical Infrastructures and Key Assets*. The purpose of this document is to engage and empower Americans to secure the portions of cyberspace that they own, operate, control, or with which they interact. Securing cyberspace is a difficult strategic challenge that requires coordinated and focused effort from our entire society—the federal government, state and local governments, the private sector and the American people. (pg. vii)

Strategic Objectives (pg. viii)
Consistent with the *National Strategy for Homeland Security*, the strategic objectives of this *National Strategy to Secure Cyberspace* are to:
• Prevent cyber attacks against America's critical infrastructures;
• Reduce national vulnerability to cyber attacks; and
• Minimize damage and recovery time from cyber attacks that do occur.

Critical Priorities for Cyberspace Security (pg. x)
The *National Strategy to Secure Cyberspace* articulates five national priorities including:
I. A National Cyberspace Security Response System;
II. A National Cyberspace Security Threat and Vulnerability Reduction Program;
III. A National Cyberspace Security Awareness and Training Program;
IV. Securing Governments' Cyberspace; and
V. National Security and International Cyberspace Security Cooperation.

The first priority focuses on improving our response to cyber incidents and reducing the potential damage from such events. The second, third, and fourth priorities aim to reduce threats from, and our vulnerabilities to, cyber attacks. The fifth priority is to prevent cyber attacks that could impact national security assets and to improve the international management of and response to such attacks.

Appendix I - Summary of the Cybersecurity Policy Review Near-term Action Plan[209]

The President directed a 60-day, comprehensive, "clean-slate" review to assess U.S. policies and structures for cybersecurity. Cybersecurity policy includes strategy, policy, and standards regarding the security of and operations in cyberspace, and encompasses the full range of threat reduction, vulnerability reduction, deterrence, international engagement, incident response, resiliency, and recovery policies and activities, including computer network operations, information assurance, law enforcement, diplomacy, military, and intelligence missions as they relate to the security and stability of the global information and communications infrastructure.
The Federal government has the responsibility to protect and defend the country, and all levels of government have the responsibility to ensure the safety and wellbeing of citizens. The private sector, however, designs, builds, owns, and operates most of the digital infrastructures that support government and private users alike. The United States needs a comprehensive framework to ensure a coordinated response by the Federal, State, local, and tribal governments, the private sector, and international allies to significant incidents.

Near-term Action Plan:

1.	Appoint a cybersecurity policy official responsible for coordinating the Nation's cybersecurity policies and activities; establish a strong NSC directorate, under the direction of the cybersecurity policy official dual-hatted to the NSC and the NEC, to coordinate interagency development of cybersecurity-related strategy and policy.
2.	Prepare for the President's approval an updated national strategy to secure the information and communications infrastructure. This strategy should include continued evaluation of CNCI activities and, where appropriate, build on its successes.
3.	Designate cybersecurity as one of the President's key management priorities and establish performance metrics.
4.	Designate a privacy and civil liberties official to the NSC cybersecurity directorate.
5.	Convene appropriate interagency mechanisms to conduct interagency-cleared legal analyses of priority cybersecurity-related issues identified during the policy-development process and formulate coherent unified policy guidance that clarifies roles, responsibilities, and the application of agency authorities for cybersecurity-related activities across the Federal government.
6.	Initiate a national public awareness and education campaign to promote cybersecurity.
7.	Develop U.S. Government positions for an international cybersecurity policy framework and strengthen our international partnerships to create initiatives that address the full range of activities, policies, and opportunities associated with cybersecurity.
8.	Prepare a cybersecurity incident response plan; initiate a dialog to enhance public-private partnerships with an eye toward streamlining, aligning, and providing resources to optimize their contribution and engagement
9.	In collaboration with other EOP entities, develop a framework for research and development strategies that focus on game-changing technologies that have the potential to enhance the security, reliability, resilience, and trustworthiness of digital infrastructure; provide the research community access to event data to facilitate developing tools, testing theories, and identifying workable solutions.
10.	Build a cybersecurity-based identity management vision and strategy that addresses privacy and civil liberties interests, leveraging privacy-enhancing technologies for the Nation.

Appendix J - Summary of the Comprehensive National Cybersecurity Initiative (CNCI)[210]

Launched by President George W. Bush in National Security Presidential Directive 54/ Homeland Security Presidential Directive 23 (NSPD-54/ HSPD-23) in January 2008.
President Obama determined that the CNCI and its associated activities should evolve to become key elements of a broader, updated national U.S. cybersecurity strategy. These CNCI initiatives will play a key role in supporting the achievement of many of the key recommendations of President Obama's Cyberspace Policy Review.

The CNCI consists of a number of mutually reinforcing initiatives with the following major goals designed to help secure the United States in cyberspace:

- **To establish a front line of defe nse against today's immediate threats** by creating or enhancing shared situational awareness of network vulnerabilities, threats, and events within the Federal Government—and ultimately with state, local, and tribal governments and private sector partners—and the ability to act quickly to reduce our current vulnerabilities and prevent intrusions.
- **To defend against the full spectrum of threats** by enhancing U.S. counterintelligence capabilities and increasing the security of the supply chain for key information technologies.
- **To strengthen the future cybers ecurity env ironment** by expanding cyber education; coordinating and redirecting research and development efforts across the Federal Government; and working to define and develop strategies to deter hostile or malicious activity in cyberspace.

CNCI Initiative Details:
Initiative #1. Manage the Federal Enterprise Network as a single network enterprise with Trusted Internet Connections.
Initiative #2. Deploy an intrusion detection system of sensors across the Federal enterprise.
Initiative #3. Pursue deployment of intrusion prevention systems across the Federal enterprise.
Initiative #4: Coordinate and redirect research and development (R&D) efforts.
Initiative #5. Connect current cyber ops centers to enhance situational awareness.
Initiative #6. Develop and implement a government-wide cyber counterintelligence (CI) plan.
Initiative #7. Increase the security of our classified networks.
Initiative #8. Expand cyber education
Initiative #9. Define and develop enduring "leap-ahead" technology, strategies, and programs.
Initiative #10. Define and develop enduring deterrence strategies and programs.
Initiative #11. Develop a multi-pronged approach for global supply chain risk management.
Initiative #12. Define the Federal role for extending cybersecurity into critical infrastructure domains.

Appendix K – Glossary of Acronyms

2G..... Second generation wireless telephone technology
3G..... Third generation wireless telephone technology
4G.....Fourth generation wireless telephone technology
5G..... Fifth generation wireless telephone technology
AFRICOM ..... United States African Command
AGOA .....African Growth and Opportunity Act
AMCHAM ..... American Chamber of Commerce
ASEAN ..... Association of Southeast Asian Nations
AT&T.....American Telephone & Telegraph
B..... Billion
BLS .....Bureau of Labor Statistics
CATR.....China Academy of Telecommunications Research
CIIP..... Critical Information Infrastructure Protection
CIKR..... Critical Information and Key Resources
CIO..... Chief Information Officer
CNCI.....Comprehensive National Cybersecurity Initiative
CSC..... Computer Sciences Corporation
CSL .....Subsidiary of Telstra Corporation Limited
CSO..... Chief Security Officer
CTIA ..... The Wireless Association
DoD..... Department of Defense
DSL .....Digital Subscriber Line
DVR .....Digital Video Recorder
EMP .....Electromagnetic Pulse
EU ..... European Union
EVN ..... Electricity of Vietnam Group
FCC.....Federal Communications Commission
FDI..... Foreign Direct Investment
FPT ..... FPT Corporation of Vietnam
FTTH..... Fiber to the Home
GDP..... Gross Domestic Product
H1-B..... United States non-immigrant visa for specialty occupations
L-1.....United States non-immigrant visa for transferring workers from overseas
HSPA .....High Speed Packet Access
IaaS ..... Infrastructure as a Service
IBM..... International Business Machines
ICSA .....International Computer Security Association
ICT..... Information and Communications Technology
IDI..... Information and Communications Technology Development Index
IEMI.....Intentional Electromagnetic Interference
IP .....Internet Protocol
IPEC.....Intellectual Property Enforcement Coordinator
ICI-IPC.....Information and Communications Infrastructure Interagency Policy Committee

IPR ..... Intellectual Property Rights
ITAR ..... International Traffic in Arms
ITES ..... Information Technology Enabled Services
ITIC ..... Information Technology Industry Council
ITIF ..... Information Technology and Innovation Foundation
ITU ..... International Telecommunications Union
LTE ..... Long Term Evolution
M2M ..... Machine to Machine
Mbps ..... Megabits per second
ME ..... Middle East
MHz ..... Megahertz
MMS ..... Multimedia Messaging Services
MTN ..... Mobile Telephone Networks
NAICS ..... North American Industry Classification System
NCTA ..... National Cable and Telecommunications Association
NEPAD ..... New Partnership for Africa's Development
NIPP ..... National Infrastructure Protection Plan
NIST ..... National Institute of Standards and Technology
NNI ..... National Nanotechnology Initiative
NRIC ..... Network Reliability and Interoperability Council
NSC ..... National Security Council
NTIA ..... National Telecommunications and Information Administration
PaaS ..... Platform as a Service
PCCW ..... Pacific Century Cable and Wireless
PCII ..... Protected Critical Infrastructure Information
R&D ..... Research and Development
SaaS ..... Software as a Service
SAP ..... System Analysis and Program Development
SIIA ..... Software & Information Industry Association
SSA ..... Sub-Saharan Africa
STEM ..... Science, Technology, Engineering, and Mathematics
TRIPS ..... Trade-Related Intellectual Property
U.S. ..... United States
UAE ..... United Arab Emirates
UMTS ..... Universal Mobile Telecommunications System
VoIP ..... Voice over Internet Protocol
WiFi ..... Wireless Fidelity
WiMax ..... Worldwide Interoperability for Microwave Access
WTO ..... World Trade Organization

End Notes

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