Design for Inclusion: Creating a New Marketplace

Industry White Paper

National Council on Disability

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National Council on Disability
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Designing with access in mind can significantly increase the size of targeted markets for electronic and information technology (E&IT). Good business practice dictates that designers and engineers avoid *unintentionally* excluding large populations of consumers from accessing and using the E&IT they develop and manufacture. People with disabilities are at the highest risk of exclusion. Other consumer groups are also at risk. They are—

- Individuals 65+ years old
- Consumers living in low-bandwidth information infrastructures
- People who never learned to read
- Users of English as a Second Language (ESL)
- Tourists and people living in multilingual societies
- Consumers living in high-density populations

Designing with access in mind can be accomplished through universal design (UD). Universal design is a process to ensure that E&IT is inclusive, accessible, and usable by everyone, including people with disabilities. Accessible design is a step forward when developing E&IT products, but it tends to lead to technologies that will be used separately, or in addition to, the main E&IT product, which diminishes the effectiveness of designing for all. Incorporating UD processes when developing E&IT is one solution to accommodating people with disabilities that also improves the usability of the products for the rest of the population.

The National Council on Disability (NCD) undertook this research to understand the market for universally designed mainstream consumer products and services, document successful UD development processes, understand consumer needs, understand UD facilitators and barriers, and identify and address current issues in universal design. This research comes at a time when understanding and incorporating UD into the development process are most crucial. We are in the window of opportunity for implementing section 508. If progress is not made quickly in improving the skills of government and industry employees on accessibility issues, the window will soon shut with little having been accomplished. If industry does not see that federal agencies are serious about implementing section 508 in a consistent manner, companies will shift the monetary and human resources needed for improving accessibility to product development opportunities that

offer a higher return on investment. Progress must be made now, and the purpose of this report is to present the information and recommendations that will guide this progress.

Through this research, NCD aims to educate designers and manufacturers about how electronic and information technology intersects with the needs of individuals with disabilities. In addition to providing knowledge about disabilities, we see the importance here and now of educating individuals on universal design. Currently, many business people have never heard of UD, and many of those who have do not understand that it is more than just a design for disability. This research aims to provide businesses with the knowledge of UD methods they need to clearly see how their complex products can be made accessible in a cost-effective way.

As part of this research, six product lines were analyzed from the telecommunications, software, consumer electronics, and digital services industries for both accessibility and usability. We estimated how useful these products are to people with disabilities and whether the products conformed to section 508 standards and section 255 guidelines. We were able to present recommendations for improving such products. At a time when the incorporation of universal design is crucial, NCD hopes that the information provided in this report will motivate and drive the development of more universally, accessibly designed E&IT.

Important Findings and Recommendations

User Study. The purpose of the user study was to document and understand user experiences with the six product lines under study. The experiences and thoughts of the consumer with a disability provided important insight into the future design of accessible products and can potentially influence the universal design process. The key findings of the user study are as follows:

- Users with disabilities are often asked to pay high prices for phones with feature sets that are not useful to them.
- Rapid changes in technology often cause decreases in accessibility.
- Users are reluctant to adopt technologies that have proven frustrating in the past.
- Users have difficulty finding devices that match their functional capabilities because of the lack of familiarity sales associates have with accessibility features.
- Users are reluctant to invest in technologies that have an unproven accessibility record.

- Accessibility solutions must consider the needs of the individual with disabilities.

Substantial increases in accessibility will be required before increased sales to members of the disability community are realized.

Product Analysis. A detailed product line analysis was conducted for each of the product lines selected for study. The purpose of this research was to document accessibility issues that prevent people with disabilities from fully accessing the selected products and to document accessibility features that either are currently offered or could be offered by manufacturers. The end result of this product analysis was the assignment of an accessibility grade to each product line for each disability group. These grades may be useful to designers and manufacturers to identify the target populations that should be consulted during the design process so that more accessible design features are incorporated into new products.

Industry Study. The purpose of the industry study was to document UD practices within industries represented by the six product lines selected for study. Five categories of facilitators and barriers to accessible design were examined: design, organizational, informational, financial, and legal. A discussion of these barriers and facilitators as experienced by the six companies is included in this section.

In addition, 11 business concerns were identified as having an influence on UD practices within an organization. Each business concern had a different level of influence, depending on the strength of the other factors. The factors influencing the adoption of UD practices included the business case, strategy and policy, demand and legislation, marketing and sales, research, design, testing, resource allocation and funding, organization and staff, training, and the customer and consideration of people with disabilities.

All the companies that participated in the industry study have made strategic decisions to address the accessibility of their products and services. A few of the companies had long-standing accessibility programs that were reinvigorated by the technical requirements of section 508. Other companies initiated their accessibility activities while planning for their response to section 508. In both cases, section 508 clearly has had an impact on the way accessibility and

UD are being addressed by industry. The industry study found that the most common approaches to addressing accessibility issues are—

- Increasing awareness of employees
- Integrating accessibility requirements into the design process
- Performing accessibility verification testing
- Establishing an accessibility program office

Discussion. Through this research, we have come to better understand the market for universally designed mainstream consumer products and services, documented successful universal design development processes, achieved a better understanding of consumer needs, analyzed UD facilitators and barriers, and identified and addressed current issues in universal design. This research program has found that—

- A market for universally designed products and services exists.
- UD principles can be easily incorporated into current design practices.
- Products designed to be accessible sometimes do not meet the needs of users.
- Legislation is currently both a facilitator and a barrier to UD.
- Many barriers to UD remain and must be addressed before significant progress can be made.

Several important recommendations can be made from this research for designers, developers, federal agencies, and companies striving to incorporate universal design into their development process:

Strategies for Government and Industry to Promote Universal Design

Recommendation #1. Use standards (government or industry) to prohibit nonessential features that pose accessibility problems unless an alternative interface that solves the problem is provided.

Recommendation #2. Use standards (government or industry) to eliminate interoperability problems that create accessibility problems.

Recommendation #3. Use market forces to regulate features that pose intermediate levels of accessibility problems. Require labeling and other

information to be provided, and allow recourse through tort (warranty) as well as through general demand, as reflected in consumer purchases.

Recommendation #4. Develop training materials and educational articles documenting the market potential for UD products and services.

Strengthening the Impact of Section 508

Section 508 was developed to govern the purchase of accessible electronic and information technology purchased by the Federal government. Despite having been in place for nearly three years, section 508 has yet to reach its potential. One of the greatest shortfalls of Section 508 is the lack of understanding of and attention to the functional performance requirements.

Recommendation #5. Institute procedures designed to ensure that due diligence is given to section 508 procurement requirements. Perform an internal analysis of the impact of section 508 on the procurement of actual products. Publish the results of the analysis as a way of convincing industry that the Federal Government is committed to section 508.

Recommendation #6. Consider requesting supporting evidence for claims made on voluntary product accessibility templates (VPATs) from all vendors responding to bid proposals.

Recommendation #7. Develop a quick accessibility checklist for specific product lines likely to be procured by the Federal Government. The quick accessibility checklist would assist procurement officials in market research by providing them with a list of items that they can inspect themselves when procuring products. The checklist would be tailored to specific product lines and would not require detailed expertise to evaluate.

Recommendation #8. Develop guidance for reporting conformance with functional performance criteria guidelines.

Recommendation #9. Support the coordination of state and local government adoption of section 508 technical requirements. Provide state and local governments with documents and training programs designed to ensure unification of technical requirements.

Recommendation #10. Study and document the nontechnical aspects of accessibility, including social, psychological, and organizational accessibility. Promote UD solutions that consider all aspects of accessibility.

Promoting the Inclusion of Universal Design in Industry Practices

Companies are not aware of the design process modifications needed to incorporate universal design principles. The Federal Government should support the refinement of specific design process interventions that can easily be incorporated.

Recommendation #11. Develop, test, and disseminate methodologies for integrating UD into existing design practices.

Recommendation #12. Support the development of university-level training materials that could be incorporated into the curriculums of existing design-oriented degree programs. The training materials should include awareness-expanding videos and other teaching resources that illustrate the potential impact of key design process interventions on the lives of people with disabilities and other beneficiaries of UD.

Recommendation #13. Develop, test, and disseminate design reference users to illustrate the range of functional capabilities and limitations typical among people with disabilities. Design reference users (popular in specifying the target population in Department of Defense acquisitions) is a set of descriptions of prototypical users who, taken together, express the range of functional capabilities and limitations of the population that must be accommodated by the design project. The use of design reference users would greatly simplify the need for designers to

research and integrate information pertaining to the functional limitations and capabilities of people with disabilities.

Recommendation #14. Develop a standard methodology for testing accessibility and comparing the accessibility of similar products.

Recommendation #15. Coordinate with industry to promote the integration of accessibility concepts, principles, and guidelines into the development tools used by designers to develop products.

Creating a New Marketplace

Consumers with disabilities find many E&IT products to be inaccessible. A sizeable un-tapped market for universal design products and services exists. However, few companies appreciate the size of the market or know how to tap its potential.

Recommendation #16. Develop an information clearinghouse where users can obtain information about accessibility issues and the features designed to address the issues for specific product lines. Educate consumers on how to shop for UD products and services. List vendor resources where consumers can obtain more information about UD products.

Recommendation #17. Develop marketing strategies and approaches that will facilitate a connection with people with disabilities.

Recommendation #18. Train people with disabilities to become subject-matter experts for the purpose of participating in design focus groups and accessibility evaluations.

Recommendation #19. Create job-related outcomes for bulk purchasers for the successful procurement of products and services with UD features.

Conclusions

People with disabilities want to use the same products that everyone else uses. They do not want to be limited to specialized products that are more costly. Implementation of UD is the best way to satisfy this desire of people with disabilities, while also providing more cost-effective products for all users. While it is impossible to satisfy the needs of all users, products and services that come closer to accommodating a variety of physical and cognitive differences will benefit both users and companies.

A full version of this report, including methodology, can be found online at www.ncd.gov.

II. Market Definition and Research

Electronic and information technology is driving the creation of new communities that are forever changing the way people live, learn, work, and play. Companies are increasingly expanding their presence in emerging markets. Businesses are serving populations they have never served before. Every consumer is different. No two people have the same set of characteristics, learning styles, abilities, experiences, or educational backgrounds. Developing products that accommodate the wants, needs, and preferences of as many individual consumers as is technically possible and economically feasible can greatly enhance a company's competitive advantage.

Designing with access in mind can significantly increase the size of E&IT markets on a global basis. Good business practices dictate that designers and engineers avoid excluding large groups of consumers from accessing and using E&IT. Groups at the highest risk of unintentional exclusion are

- People with disabilities
- Individuals 65+ years old
- Consumers living within low-bandwidth information infrastructures
- Users of English as a Second Language (ESL)
- Tourists traveling to nonnative language destinations
- Consumers living in high-density populations

This market analysis examined many aspects of manufacturing "more accessibly designed" E&IT. This analysis was intended to help answer questions like the following:

- Is there a market for more accessibly designed products?
- Does the capacity exist to develop more accessibly designed products in each of the presented product lines?
- What factors influence the market for more accessibly designed products for each of the product lines presented?

All of the product lines reviewed in this report are manufactured by members of the E&IT industry. Naturally, in order for these products to be manufactured, the E&IT industry must exist.

In order to exist, it must be profitable. A question often asked by the disability community is, "How can we ensure that the E&IT products and services being manufactured are accessible to people with disabilities?" E&IT manufacturers often pose this same question using different words. They ask, "How can we ensure that the E&IT products and services we manufacture are accessible and usable by as many people as is technically possible and economically feasible without the need for customization?" The questions are different. The motivations are different. The market drivers are different. The solutions can be remarkably similar.

Definition of the Market Environment

Historically, the primary forces driving the manufacture of more accessible E&IT products and services have been legal, moral, social, and ethical. The assumption was that if legal, moral, social, and ethical issues no longer existed, then the motivation to manufacture more accessible E&IT would all but disappear. The next two sections discuss the reasons why nothing could be further from the truth.

In contrast to the historical notion of the primary forces driving the manufacture of accessible E&IT, in actuality, a majority of the forces driving demand for more accessibly designed E&IT fall into the following five categories:

- Market forces
- Local environment
- Human condition
- Legal framework
- Standards and guidelines

Market Forces

Market forces consistently drive the demand for more accessibly designed E&IT. Market forces include the need to respond to consumer behavior, the work of federal agencies, legislation mandating developments in the accessibility of E&IT, changing marketing philosophies (from mass marketing to a one-on-one marketing philosophy), competition within the market, emerging technology trends, and economic expansion. These market forces are discussed below in terms of how they drive the markets for more accessibly designed E&IT products.

Consumer Behavior

E&IT is prevalent in schools, libraries, individuals' homes, work environments, places of recreation, banks, and even supermarkets. It is because of this widespread presence that consumers are more technically literate than they were five years ago. Devices such as cell phones, PDAs, voice recognition systems, and the wireless Web enable us to carry our offices with us when we travel. We are more mobile now than ever before. Consumers have become accustomed to getting the information they need *when* they need it and *where* they want it. This has created an expectation of immediacy. When consumers don't get what they want quickly, they become impatient. E&IT designers need to respond to consumer behavior by providing products and services that not only meet, but exceed the high expectations of a technically literate, mobile, consumer base. Increasing the accessibility of information services and mobile technologies increases access to the information demanded by consumers with high expectations.

Federal Government

The Federal Government serves as a catalyst for more accessibly designed E&IT products through its buying power, the development of legislation, and the support of assistive technology (AT) accommodation labs. Section 508 of the Rehabilitation Act amendments of 1998 mandates the purchase of accessibly designed E&IT. As a result, all federal agencies appointed Section 508 coordinators (Section 508, 2003). Those coordinators are responsible for organizing and supporting the implementation of Section 508 within their respective departments and agencies, and they serve as the central point of contact for information concerning accessibility issues and solutions. In addition to Section 508, other legislation provides guidelines for designing more accessible E&IT. The Access Board developed the ADA Accessibility Guidelines for Buildings and Facilities (ADAAG), and the Telecommunications Act Accessibility Guidelines (Section 255) mandate the design of more accessible E&IT products and services. Presidential initiatives also drive the design of more accessible E&IT. These initiatives include the President's New Freedom Initiative (White House, 2001), the No Child Left Behind Initiative (U.S. House of Representatives, 2002), and the disabilityinfo.gov Web site (DisabilityInfo.gov, 2003).

In addition to these acts and initiatives, many federal agencies have created AT accommodation labs. These labs serve as focal points for information regarding accommodations, disabilities, and AT.

Clearly, the Federal Government is an important market force for driving accessibility requirements.

Marketing Philosophies

Marketing philosophies have changed radically over the past 35 years. The marketing philosophy of the 1960s was mass marketing (Mass Marketing Definition, 2003), in which the seller views the market as a homogeneous whole and, therefore, has only one marketing program (the same product, the same price, the same promotion, and the same distribution system) for everyone in the population. This type of marketing is also referred to as unsegmented or undifferentiated marketing.

Marketing philosophies of the 1970s included product line extension (Product Line Stretching Definition, 2003) and market segmentation (Market Segmentation Definition, 2003). Product line extension adds depth to an existing product line by introducing new products in the same product category. Market segmentation is the division of a totally heterogeneous market into groups or sectors with relatively homogeneous needs and wants.

In the 1980s, the marketing philosophy shifted to one of niche marketing (Niche Marketing Definition, 2003). Niche marketing or concentrated marketing is a marketing segmentation strategy in which the firm concentrates all of its efforts and resources on serving one segment of the market.

In the 1990s, value-added marketing became popular. Value-added marketing is a strategy in which a company buys products, customizes them for a particular application, and then resells them. There was also a shift toward marketing to individual customers rather than the larger mass. Don Peppers and Martha Rogers invented the phrase “one-to-one” marketing (Peppers and Rogers, 1997) to illustrate the revolutionary concept of treating different customers differently. One-to-one marketing supports the establishment of permanent relationships with your

customers. One-to-one subscribes to providing products and services to customers according to their individual wants, needs, and preferences. “Share of customer” replaces market share. The marketing focus shifts from institutions to individual consumers.

Once a company acquires the knowledge and experience required to manufacture more accessibly designed E&IT, it can take an asset marketing approach (Asset-Based Marketing Definition, 2003) to providing their E&IT products globally. Asset marketing uses the knowledge and skills a company has already developed as the basis for growth. For example, a company that is skilled in developing kiosks that are accessible to people who are blind can market kiosks designed in a similar manner to countries that have high populations of people who never learned to read. This global marketing (Global Marketing Definition, 2003) philosophy enables companies to sell the same, or very similar, products to world markets with essentially the same promotion. This marketing approach is also commonly referred to as international marketing.

Competition

Competition in the E&IT industry is fierce. The industry is constantly looking for ways to increase efficiency, competitive advantage, sales, market shares, and profitability. It is also looking to cut costs. Businesses are constantly developing new and innovative products and services with the hope of achieving these objectives, and adding functionality that enhances the accessibility and usability of a product can be very beneficial. In extremely competitive markets, several companies have correctly identified UD as a potential market discriminator. When highly similar product lines are all competing for the same customer, a product designed with access in mind may have the needed advantage required to outbid the competitors.

Technology Trends

A variety of rising mainstream technology trends fuels the need for more accessibly designed E&IT. The functionalites of multiple individual devices are now being integrated into a single device, including pagers, cell phones, PDAs, palmtop computers, smart phones, and MP3 players. This is creating a dependence on one device to accomplish multiple functions. Thus, if not more accessibly designed, this multiple functionality precludes the use of such devices by

certain segments of the population, e.g., people 65+ years of age. Developing and manufacturing an accessible interface for a device that provides multiple functions is less expensive than developing and manufacturing an accessible interface for multiple, single-function devices.

Decreasing costs are making E&IT devices more affordable. Emerging markets have the greatest concentration of low-income individuals, as well as a greater concentration of people who are unable to read and write.

Increasing processing power, disk storage, memory capacity, and battery life are enabling developers to integrate advanced access technologies (speech recognition, text-to-speech synthesis, projected displays, etc.) into devices where it has not previously been technically possible to do so. In addition, the Internet and the World Wide Web are now being utilized as a primary infrastructure for education, government services, news, and business. Customers' technical knowledge and expectations are constantly increasing, along with the use of wireless Internet appliances and an increasing use of wireless infrastructures. Legal mandates to manufacture more accessibly designed E&IT in support of people with disabilities are also a major technological trend. In addition, E&IT needs to be marketed to emerging markets in order for E&IT manufacturers to increase sales and gain competitive price advantage through economies of scale.

Economic Expansion

The strength of our global economy is, to a great extent, the result of the investment in and application of new technologies by governments, businesses, and individuals. Technology is the foundation upon which developing countries can build thriving, financially independent, self-sufficient economies. The technologies that build this foundation include computers, networks, ATMs, wired and wireless information infrastructures, wireless handheld Internet appliances, and cellular telephones, to name a few. Applications include online banking, distance learning, e-government, and e-commerce (World Information Technology and Services Alliance, 2003).

Local Environment

Another force that drives the market for accessibly designed E&IT is the local environment. Below is a discussion of two environmental factors, variances in bandwidth and tourism.

Bandwidth

As of May 2004, more than half (51.39 percent) of home Internet users in the United States relied on dial-up modems of 56Kbps or less. Of all U.S. home Internet users, 42.53 percent used 56Kbps modems, 6.52 percent used 28/33.3Kbps modems, and 2.34 percent used 14.4Kbps modems (Nielsen/NetRatings, 2004).

Computers using dial-up connections cannot handle graphics as quickly and efficiently as computers connected via broadband. It is for this reason that users surf the Internet with graphics turned off. They do this to speed up downloads. In addition, low-bandwidth connections do not lend themselves to a lot of graphic images, video-based information, or streaming audio. Multimedia content can be problematic for users with slower connections. Wireless devices communicating with the Internet at slow connect speeds can also be a source of accessibility and usability problems.

There are solutions to dealing with these problems. Some companies have the ability to control the settings on the browsers used on their employees' personal computers (PCs). When available corporate Intranet bandwidth is at a premium, these companies can simply issue a central command to turn off graphics on all client PC browsers. This can immediately free up as much as 80 percent of available bandwidth. Designing Web sites for low-bandwidth access tends to increase accessibility for users with disabilities. For example, a graphics- or animation-intensive site often requires high bandwidth and is inaccessible to those who are blind. In contrast, a text-based site loads quickly and is accessible to screen readers. Dial-up environments will continue to drive the development of more accessible E&IT in the foreseeable future.

Tourism

During the first quarter of 2004, the United States welcomed 8 million international visitors. This was an increase of 12 percent compared with the first quarter of 2003.

Visiting tourists often make use of ATMs, self-service kiosks, ticketing kiosks, and other tourism-related information technologies. Many tourists only use English as a second language. Developing content written in simplified English makes it more understandable to users of ESL. In addition, using simplified English content has other significant benefits, including the following:

- It reduces the cost of language translation.
- It reduces ambiguity.
- It speeds reading.
- It reduces liability associated with misunderstandings.

The use of simplified content was originally included in various accessibility design guidelines in support of people with cognitive reading disabilities. Using simplified language has now evolved into a market force driving the design of more accessible E&IT.

Human Condition

Aside from forces stemming from the market and the environment, many of the forces driving the accessible design of E&IT fall under aspects of the human condition. E&IT products must be designed with people of different disabilities, various age groups, various levels of literacy, various languages, different learning styles, and different experience levels with activities such as using the Internet in mind. These aspects of the human condition bring with them the demand for accessible E&IT products that cater to not just one category, but to many different types of users. Below is a summary of the forces that drive the demand for E&IT that is accessible to a wide range of users.

Disability

Census 2000 counted 54 million people in the United States with some type of long-lasting condition or disability (NCD, 2004). These individuals represented 19.3 percent of the 257.2 million people who were age five and older in the civilian, noninstitutionalized population. This is nearly one in five people. This includes a wide range of disabilities, not all of which preclude the use of E&IT. Within this population, Census 2000 found

- 9.3 million (3.6 percent) with a sensory disability involving sight or hearing

- 21.2 million (8.2 percent) with a condition limiting basic physical activities, such as walking, climbing stairs, reaching, lifting, or carrying
- 12.4 million (4.8 percent) with a physical, mental, or emotional condition causing difficulty in learning, remembering, or concentrating
- 6.8 million (2.6 percent) with a physical, mental, or emotional condition causing difficulty in dressing, bathing, or getting around inside the home
- 18.2 million of those age 16 and older with a condition that made it difficult to go outside the home to shop or visit a doctor (8.6 percent of the 212.0 million people this age)
- 21.3 million of those age 16 to 64 with a condition that affected their ability to work at a job or business (11.9 percent of the 178.7 million people this age)

The design of E&IT products and services that are accessible to people with disabilities appeals to the wider population as well. Accessible design can significantly enhance the sales of a product. For example, all of the following commonly used products were first developed in support of people with disabilities and are now used by the wider population:

- Auto-dialers
- Flatbed scanners
- Microphones
- Speech recognition
- Speech synthesis
- Talking ATMs
- Talking caller-ID
- Vibrating pagers

Age

Thirty-six million consumers 65 years of age and older are living in the United States (Population, 2003). People 65+ years of age are often unable to see, hear, think, or move about as easily as they did when they were younger. In order to enable people 65+ years of age to access and use E&IT, these differences must be accommodated. In addition, 52 percent of people 65+ years of age have some type of disability. Thirty-three percent of persons 65+ years of age have a severe disability. By 2030, there will be about 70 million older persons. People 65+ are expected

to grow to 20 percent of the population by 2030 (Administration on Aging, 2002). Furthermore, individuals who are accustomed to operating IT will demand accessible IT as their functional capabilities diminish.

Language

Language is a driving force in today's market for more accessible E&IT. According to Global Reach, 262 million English-speaking people are online. Non-English-speaking populations online are 474 million. By the end of 2005, the ratio of English/non-English speaking users will decrease significantly (Global Reach, 2003).

Sixty-four percent of people who visit the Internet seek sites in languages other than English (Global Reach, 2003). In a world where International Data Corporation (IDC) predicted that Internet spending outside the United States would exceed $914 billion in 2003 (IDC, 2000), effective Web-site globalization is the next imperative of Internet enterprises. Despite the vast international opportunities projected, few U.S. companies appear poised to take advantage of them. More than half (55 percent) of U.S. companies do nothing to customize their Web sites for foreign visitors; less than one-quarter even allow a choice of language, according to recent IDC Internet Executive ePanel research. With such minor globalization efforts, it is not surprising that 72 percent of U.S. companies that are online currently draw 10 percent or less of their e-commerce revenue from outside the United States. To increase their e-commerce revenue, companies must strive to design Web sites that are accessible to the non-English-speaking population.

Literacy

The Workforce Investment Act of 1998 defines literacy as "an individual's ability to read, write, speak in English, compute, and solve problems at levels of proficiency necessary to function on the job, in the family of the individual, and in society."

The International Adult Literacy Survey (Adult Literacy Survey, 2003) was a 22-country initiative conducted between 1994 and 1998. In every country, nationally representative samples of adults between the ages of 16 and 65 were interviewed and tested at home using the same

literacy test. The main purpose of the survey was to find out how well adults use information to function in society. Another aim was to investigate the factors that influence literacy proficiency and to compare these factors among countries.

According to the National Institute for Literacy (n.d.), "Very few adults in the U.S. are truly illiterate. Rather, there are many adults with low literacy skills who lack the foundation they need to find and keep decent jobs, support their children's education, and participate actively in civic life." According to the National Adult Literacy Survey (NALS), between 21 and 23 percent of the adult population, or approximately 44 million people, scored at literacy proficiencies between 0 and 20 percent. Another 25–28 percent of the adult population, or between 45 and 50 million people, scored at literacy proficiencies between 20 and 40 percent. Literacy experts believe that adults with skills at these levels lack a sufficient foundation of basic skills to function successfully in our society.

Many factors help to explain the relatively large number of adults in the 0–20 percent category. Twenty-five percent of adults in this category were immigrants who may have just been learning to speak English. In addition, more than 60 percent didn't complete high school; more than 30 percent were over the age of 65; more than 25 percent had physical or mental conditions that kept them from fully participating in work, school, housework, or other activities; and almost 20 percent had vision problems that affected their ability to read print. A large percentage of the population in the United States are at literacy proficiency less than 40 percent. Design for individuals with limited literacy skills also accommodates individuals who have learning disabilities or cognitive disabilities that impact reading comprehension.

Learning Style

There are three major types of learning styles (Live Text, 2000). They are visual, auditory, and kinesthetic (tactile). Visual learners need to see a person's body language and facial expression to fully understand the content of what is being said. They tend to prefer sitting at the front of a classroom, play, or lecture hall to avoid visual obstructions (e.g., people's heads). They may think in pictures and learn best from visual displays, including diagrams, illustrated textbooks,

overhead transparencies, videos, flipcharts, and handouts. During a lecture or classroom discussion, visual learners often prefer to take detailed notes to absorb the information.

Auditory learners learn best through verbal lectures, discussions, talking things through, and listening to what others have to say. Auditory learners interpret the underlying meanings of speech through listening to tone of voice, pitch, speed, and other nuances. Written information may have little meaning until it is heard. These learners often benefit from reading text aloud and using a tape recorder.

Tactile/kinesthetic learners learn best through a hands-on approach, actively exploring the physical world around them. They may find it hard to sit still for long periods and may become distracted by their need for activity and exploration.

Enabling people to acquire information in the manner most appropriate to their learning style(s) enhances the effectiveness of E&IT and accommodates users with sensory disabilities.

Experience Level

Many people who are learning to use an application on the Web for the first time want all the help they can get. There will come a time, however, when the extra help is no longer needed or desired. One of the benefits of accessible design practices is having the ability to customize user interfaces based upon the wants, needs, and preferences of individual users.

Legal Framework

Below is a summary of key laws, statutes, and standards that have improved accessibility for individuals with disabilities in this country. Each law is summarized, followed by a discussion of who is primarily affected by the law and the approach toward addressing accessibility issues that has been undertaken through issuance of each law. These laws and standards are a driving force in the market for accessibly designed products, as they set the standards and guidelines for what must be done by the government and industry to accommodate the needs of individuals with disabilities.

Section 508 of the Rehabilitation Act

Section 508 of the Rehabilitation Act of 1973 requires that when federal agencies develop, procure, maintain, or use E&IT, they must ensure that federal employees with disabilities have access to and use of information that is comparable to the access and use by federal employees who do not have disabilities unless an undue burden (significant expenses or difficulties) is imposed on the agency. The law also requires that individuals with disabilities in the general public seeking information or services from a federal agency have access to information and services comparable to that provided to individuals without disabilities unless undue burden is imposed on the agency. When compliance does impose an undue burden, agencies must still provide disabled individuals with the information and data by allowing them to use it by an alternative means of access (e.g., captioning, audio description).

Section 508 covers E&IT such as computer hardware, software, networks, ancillary equipment, firmware, technology services, telecommunications products, information kiosks and transaction machines, World Wide Web sites, multimedia, and office equipment such as copiers and fax machines. Equipment that contains embedded information technology used as an integral part of the product—but the principal function of which is not the acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information—is not included under Section 508 (e.g., HVAC equipment and medical equipment). As a guideline, E&IT systems can be considered to be accessible to individuals with disabilities if they can be used in a variety of ways that do not depend on a single sense or ability.

Section 508 has the potential to greatly improve accessibility to E&IT for individuals with disabilities. The Federal Government will likely become a better employer to the many people with disabilities who work for it, as well as a model employer for industry. In addition, members of the public with disabilities will have greater accessibility to government information and services related to technology.

Those affected directly by Section 508 include federal departments and agencies and vendors who serve the Federal Government. The initial impact is at the procurement stage. Section 508 must be integrated into the procurement process by determining which technical provisions from

Section 508 apply in a given situation, performing market research to determine the availability of products and services that meet the applicable technical provisions, deciding which technical provisions (if any) do not apply due to an exception, and submitting technical specifications and minimum requirements to a contracting officer.

Private companies and software developers are also affected by Section 508. Although Section 508 does not require private companies to alter their products, full implementation of the law may provide an incentive for companies that want to do business with the government to build better accessibility features into their products. Currently, however, there is a perception by some in industry that Section 508 conformance is being "rubber stamped" by procurement officials and that the content of documents describing Section 508 conformance, such as voluntary product accessibility templates (VPATs), is not important as long as it is merely offered. If Section 508 is fully addressed by procurement officials, accessibility will become a key discriminator for federal sales. Increased competition will raise the bar for hardware and software vendors who want to create new and innovative solutions to addressing accessibility issues. Software developers are impacted by Section 508 in that they are now trying to integrate the applicable Section 508 provisions into their entire software development life cycle. Developers are faced with the challenge of either making their software compatible with assistive technology or making software products accessible without the aid of other AT.

In contrast to federal laws that take a *push* approach toward improving the accessibility of E&IT by mandating that new, better technologies are manufactured and adopted, Section 508 does not explicitly require the manufacturers to make their products more accessible. Rather, Section 508 follows a *pull* approach, in which the federal agencies are responsible for seeking better products to address accessibility problems by procuring products that comply with the provisions when such products are available in the commercial marketplace or when such products are developed in response to government solicitation.

Section 255 of the Telecommunications Act

Section 255 of the Telecommunications Act of 1996 requires telecommunications products and services to be accessible to people with disabilities. This is required to the extent that access is

readily achievable. If manufacturers cannot make their products more accessible, then they must design products to be compatible with adaptive equipment used by people with disabilities when it is readily achievable to do so.

Telecommunications products covered under this Act include wired and wireless telecommunication devices, such as telephones, pagers, and fax machines; products that have a telecommunication service capability, such as computers with modems; and equipment that carriers use to provide telecommunications services, which includes the software integral to that equipment. Also included are basic and special telecommunication services, including regular telephone calls, call waiting, speed dialing, call forwarding, computer-provided directory assistance, call monitoring, caller identification, call tracing, repeat dialing, interactive voice response systems, and voice mail.

The implementation of Section 255 of the Telecommunications Act stands to improve access and the number and range of accessible products in the telecommunications industry. Companies that manufacture telecommunications products or provide telecommunications services are expected to shift toward a more universal, inclusive design process in the development of new products and services. Those affected by Section 255 include manufacturers of telecommunications equipment and customer premises equipment, as well as the providers of telecommunications services. Companies must research ways to make their products more accessible and provide training for their staff on accessibility. Manufacturers must modify their design processes to ensure that accessibility and usability are considered in the earliest design phases of a product. The law has been beneficial to manufacturers and service providers in that they have found that in making products easier to use for people with disabilities, they often make them easier to use for everyone.

The implementation of Section 255 takes more of a push approach toward improving accessibility. The Act lays out a set of guidelines that manufacturers must follow in designing new products and services in this industry. Companies are advised to use these guidelines and implement training procedures as specified by the law. Section 255 is related to Section 508 of the Rehabilitation Act in that the U.S. Access Board has incorporated the language of the guidelines specified in Section 255 into the 508 standard. Using consistent language has enabled

companies to develop products that meet both the design requirements for manufacturers and the procurement requirements for federal agencies.

Hearing Aid Compatibility Act

The Hearing Aid Compatibility (HAC) Act of 1988 requires that the Federal Communications Commission (FCC) ensure that all telephones manufactured or imported for use in the United States after August 1989, as well as all "essential" telephones, are hearing aid compatible. "Essential" telephones have been defined as coin-operated telephones, telephones provided for emergency use, and other telephones frequently needed for use by persons with hearing aids. This includes telephones in the workplace, in confined settings like hospitals or nursing homes, and in hotel or motel rooms.

Telephone manufacturers are directly affected in that they must ensure that they design phones with volume control and other features for those users with hearing aids. Owners of hospitals, hotels, and other places with "essential" telephones must ensure that they purchase telephones for their buildings that are hearing aid compatible. Employers must ensure that all telephones in both common and noncommon areas in their workplace are hearing aid compatible and that any new telephones they purchase are hearing aid compatible.

Unlike Section 255 of the Telecommunications Act, under which companies must ensure that their products are accessible to hearing aid users only if it is readily achievable for them to do so, this requirement is absolute under the HAC Act. This law, like Section 255 of the Telecommunications Act, takes a push approach in mandating that corporations and business owners purchase telephones that are hearing aid compatible and that the FCC ensures that all essential telephones and telephones manufactured or imported for use in the United States are hearing aid compatible.

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) of 1990 recognizes and protects the civil rights of people with disabilities. It provides protection from discrimination of individuals on the basis of disability. Covered under ADA are a wide range of disabilities, and a person with a disability is

defined as anyone with a physical or mental impairment that substantially limits one or more major life activities. These include physical conditions that affect mobility, stamina, sight, hearing, and speech, as well as emotional illnesses and learning disorders. ADA addresses access of individuals with disabilities to the workplace (Title 1), state and local government services (Title 2), and places of public accommodation and commercial facilities (Title 3). In addition, phone companies are required under ADA to provide telecommunications services for people who have hearing or speech impairments (Title 4).

Title 1, which deals with employment of individuals with disabilities, requires that employers do not discriminate against qualified individuals with disabilities and that employers reasonably accommodate the disabilities of qualified applicants and employees by modifying work stations and equipment unless undue burden should result in doing so. Title 2, which deals with public services, requires that state and local governments do not discriminate based on disability and that they ensure that their buildings are accessible, that new and altered streets and pedestrian walkways contain curb cuts at intersections, and that each service or program is operated so that it is readily accessible to and usable by individuals with disabilities. In addition, this title requires that transit facilities, buses and rail vehicles, key stations in rail systems, Amtrak stations, and vehicles for demand response systems be made accessible unless certain exceptions are met. Title 3, which deals with public accommodations, requires that restaurants, hotels, theaters, shopping malls, retail stores, museums, libraries, parks, private schools, and day care centers, among other places of public accommodation, do not discriminate based on disability. Any alterations to existing places of public accommodation are required to be done in an accessible manner. In addition, new busses for specified public transportation must be accessible, and elevators must meet certain conditions. Title 4, which covers telecommunications, states that telephone companies must provide telecommunications relay services for hearing-impaired and speech-impaired individuals 24 hours per day.

ADA has had a significant impact on American society, allowing individuals with disabilities to pursue opportunities that were not available to them in the past. One of the largest groups affected by ADA are the employers of individuals with disabilities. If an employer fails to comply with ADA, the employee can sue, forcing the company to comply or pay damages. Thus,

employers face the pressure of ensuring that their workplaces are accessible and that they do not discriminate against any qualified applicants on the basis of disabilities. In addition, state and local government bodies, educational institutions, and virtually all places of public accommodation or employment are directly affected by ADA and must comply with the regulations. The Annenberg Washington Program, a nonprofit institution in communication studies, met in 1994 and expanded upon a previously published White Paper in which it stated in its initial findings that the average cost of most ADA accommodations is approximately $36, a much lower amount than many anticipated. It found that the impact of ADA on American businesses did not create onerous legal burdens, as many believed would be the case, but rather has provided a framework for employers and employees for dispute avoidance and resolution. Overall, ADA has had a positive impact on society.

ADA has also taken a push approach toward addressing issues of accessibility. The push is for the businesses and organizations themselves to devise solutions based on the requirements set forth in ADA.

Electronic Industries Alliance (EIA) Standards: EIA-608 and EIA-708

The EIA-608 standard specifies the use of closed captions in analog TV signals. EIA-608 arose to address the lack of standards for Line 21 closed captioning, to ensure that new decoders would all work the same way and that captioners could create captions that would appear in a consistent and predictable manner on every TV set. The Television Data Systems Committee of the EIA enhanced the Line 21 system by adding new characters and assigning codes that would allow the center of the screen to be used for captioning. It also allowed roll-up captions, for the first time enabling real-time captions to be placed somewhere other than the bottom of the screen. This work became known as the EIA-608 standard, with which all captioning software and all TV receivers built from July 1993 forward were required to meet and comply.

When digital television (DTV) was developed, a new need arose for the ability to change the size of the caption display—to make the captions either larger and more readable or smaller and less obtrusive. The conversion of closed captions for service with digital was necessary. This need could not be accommodated in the EIA-608 standard, and thus the EIA-708 standard was

introduced. The current version, EIA-708B, covers two areas. It defines how captioned data is to be encoded and transmitted, known as the transmission protocol or transmission layer. It also defines where in a DTV signal the caption data are to be placed, the bandwidth allocated, and the format of the data. The second area addressed is the display protocol, which determines how captions are displayed on the screen of a DTV. The 708 captioning format was designed to allow for the use of the entire unicode set, which includes every character in the alphabet in any language plus the complete range of symbols. Almost any program can thus be captioned.

Many groups are affected by the introduction of the EIA-708 standard. The Decoder Circuitry Act of 1990 stated that "[d]igital television receivers and tuners must be capable of decoding closed captioning information that is delivered pursuant to the industry standard EIA-708-B." This Act required the FCC to update its rules for decoders as new technologies like DTV developed. Television broadcasters are also largely affected by the new 708 captioning format because the pressure is building to produce new programming with digital closed captions based on this standard. Broadcasters and producers must begin devising plans to make this move and invest in the equipment they will need to do so. Also very largely affected are the viewers with auditory impairments who will benefit from much greater flexibility and a higher quality of captioning with the EIA-708 standard.

A push approach toward the development of a new standard was taken in the movement from EIA-608 to EIA-708 captioning. After developing the new standard, the EIA has put the responsibility on the broadcasters and producers to comply with these standards in their captioning. This push to move from EIA-608 (analog) to EIA-708 (digital) has brought many improvements to closed captioning. Television viewers can now control the size of the caption text. In addition, EIA-708 offers more letters and symbols, support for multiple fonts and text and background colors, and allows for the viewer to replace the traditional black box background with a colored box or do away with it entirely. Also, EIA-708 increases the data rate by 16 times over that allowed by EIA-608, permitting DTV captions to contain much more information. However, most DTV content currently still relies on the EIA-608 standard captions that have been converted to the EIA-708 format because the consumer base of DTV receivers is not high enough to justify the added expense of native EIA-708 encoding.

Individuals with Disabilities Education Act

The Individuals with Disabilities Education Act (IDEA) was first enacted in 1975. The Act was passed to ensure that students with disabilities receive free, appropriate public education and the related services and support they need to achieve in the least-restricted environment appropriate for their individual needs. IDEA was created to help states and school districts meet requirements for educating children with disabilities and to pay part of the expenses of doing so. IDEA consists of three parts: Part B provides grants to states for services for preschool and school-age children, Part C funds early intervention services for infants and toddlers, and Part D supports national activities to improve the education of children with disabilities, including research and professional development programs.

IDEA covers children with disabilities until they graduate from high school or until they are 22 years of age if graduation is delayed. Students who may fall under the Act are evaluated once the possibility of a disability is raised. If it is determined that the student does have a disability covered by IDEA, the school is required to annually develop an individualized education program (IEP) for the student, followed by placement in a regular classroom setting when possible. Since its initiation, a set of amendments made in 1997 has shifted the focus of IDEA from merely providing children with disabilities access to an education to improving results for all children in the education system.

The primary group affected and benefiting from IDEA is children with disabilities. As a result of IDEA, students with disabilities now learn among their peers. U.S. Senator Jim Jeffords reports that since the initiation of IDEA, dropout rates for students with disabilities have significantly gone down and graduation rates have gone up. The percentage of college freshmen with disabilities has tripled as a result of the improved education children with disabilities have available to prepare them for college. Teachers and parents of children with disabilities are also largely affected by IDEA. These two groups play a large role in the development of a child's IEP. Teachers have also had to adjust to having children with and without disabilities in the same classroom, learning together. Others involved in the public education system, including both state and local educators, are certainly affected as well.

The enactment of IDEA has followed a push approach in requiring that public schools make a free education available to students with disabilities that adheres to the provisions set forth in the Act. The legislation places the responsibility upon the schools and provides them with the requirements they must meet, while providing some of the monetary means to do so.

Instructional Material Accessibility Act

The purpose of the Instructional Material Accessibility Act (IMMA) of 2003 is to improve access to printed instructional materials used by persons who are blind and other persons with print disabilities in elementary and secondary schools. The Act accomplishes this through the creation of an efficient system for the acquisition and distribution of instructional materials in the form of electronic files suitable for conversion into a variety of specialized formats. The IMAA requires one national file format and a single national repository for files, which simplifies the process of obtaining materials for students with disabilities. Having a national file format will make the conversion process for producing specialized formats more efficient by reducing the amount of human intervention necessary. Having one national file format will make it easier for states, publishers, Braille software developers, and Braille transcribers to work with files. Braille transcribers will have more time to use their expertise in formatting and proofing files, leading to high-quality Braille. Students will directly benefit because the national file format will eliminate needless steps in scanning and reformatting files. Teachers will benefit as well by having materials available in specialized formats for their students who have disabilities at the same time they are available to their other students. State and local education agencies that receive federal funding under the IDEA play a large role under the IMAA. They are responsible for developing a statewide plan within two years of the enactment of the IMAA to ensure that printed materials required for instructional use in the classroom at elementary and secondary schools are available in specialized formats to individuals with disabilities at the same time they are made available to students without disabilities.

This Act is a push approach toward improving access to printed instructional materials for visually impaired students. The IMAA requires all the states to adopt the national file format.

Video Description Restoration Act

The Video Description Restoration Act (VDRA), currently pending in Congress, would restore the FCC's video description rules, which were overturned in federal court on November 8, 2002. The Act would guarantee TV access for individuals who are blind or visually impaired through video description. The FCC would be expressly granted authority to restore its minimum requirements, with increased access over time. Those minimum requirements were that the major networks and cable channels in the top 25 television markets present at least four hours of described programming per week, and that video-described programs be made available where TV stations not in the top 25 markets have the equipment to do so. The VDRA has been rigorously supported by the American Council for the Blind, as well as other blind and deaf organizations because they feel that in many ways video description is for people who are blind what closed captioning is for individuals who are deaf.

The community of people who are blind or visually impaired will benefit from the VDRA by once again having video description available to them, which affords them the same access to information on television as sighted viewers. Also affected would be the television program providers and owners, who would be required to offer video description for a portion of their programming. VDRA permits an exemption if the provision of video description would be unduly burdensome to the provider or owner, or if video description is not necessary to achieve video programming accessibility by persons who are blind or otherwise visually impaired.

The VDRA would restore the FCC's rule for the minimum requirements major networks and cable channels must meet in terms of the amount of video description they provide. This push approach taken by the FCC would ensure that at least a portion of programs would be made available for the visually impaired through video description. The number of hours of video description mandated by the FCC may grow larger, leading to increased access to television programming for the visually impaired over time.

Standards and Guidelines

In addition to the laws and statutes mentioned in the previous section, additional standards and guidelines are driving more accessibly designed E&IT. They are discussed below.

ADA Accessibility Guidelines

The Access Board's guidelines issued under ADA are to be completely updated and revised. The ADA Accessibility Guidelines (ADAAG) cover the construction and alteration of facilities in the private sector (places of public accommodation and commercial facilities) and the public sector (state and local government facilities). The accessibility guidelines issued under the Architectural Barriers Act (ABA) primarily address facilities in the federal sector and other facilities designed, built, altered, or leased with federal funds. The guidelines under both laws are being updated together in one rule that contains three parts: a scoping document for ADA facilities, a scoping document for ABA facilities, and a common set of technical criteria that the scoping documents will reference. As a result, the requirements for both ADA and ABA facilities will be made more consistent. The rule also includes new scoping and technical provisions for accessible housing that derive from requirements for "Type A" dwelling units contained in the 1998 edition of the ICC/ANSI A117.1 standard, "Accessible and Usable Buildings and Facilities." Of specific interest is 4.34.5, Equipment for Persons with Vision Impairments. Instructions and all information for use must be made accessible to and independently usable by people with vision impairments.

Telecommunications Act Accessibility Guidelines

On February 3, 1998, the Architectural and Transportation Barriers Compliance Board (Access Board) issued its final guidelines for the accessibility, usability, and compatibility of telecommunications equipment and customer premises equipment covered by Section 255 of the Telecommunications Act of 1996 (Telecommunications Act Accessibility Guidelines, 1998). The Act requires manufacturers of telecommunications equipment and customer premises equipment to ensure that the equipment is designed, developed, and fabricated to be accessible to and usable by individuals with disabilities, if readily achievable. When it is not readily achievable to make the equipment accessible, the Act requires manufacturers to ensure that the equipment is compatible with existing peripheral devices or specialized customer premises equipment commonly used by individuals with disabilities to achieve access, if readily achievable.

Web Content Accessibility Guidelines 1.0

The Web Content Accessibility Guidelines 1.0, 1999, explain how to make Web content accessible to people with disabilities. The guidelines are intended for all Web content developers (page authors and site designers) and for developers of authoring tools. The primary goal of these guidelines is to promote accessibility. However, following them will also make Web content more available to all users, no matter what user agent they are using (e.g., desktop browser, voice browser, mobile phone, automobile-based personal computer, etc.) or constraints they may be operating under (e.g., noisy surroundings, under- or over-illuminated rooms, in a hands-free environment, etc.). Following these guidelines will also help people find information on the Web more quickly. These guidelines do not discourage content developers from using images, video, etc., but rather explain how to make multimedia content more accessible to a wide audience.

Authoring Tool Accessibility Guidelines 1.0

The Authoring Tool Accessibility Guidelines 1.0, 2000, provides specifications for Web authoring tool developers. Its purpose is two-fold: to assist developers in designing authoring tools that produce accessible Web content and to assist developers in creating an accessible authoring interface. Authoring tools can enable, encourage, and assist users (i.e., authors) in the creation of accessible Web content through prompts, alerts, checking and repair functions, help files, and automated tools. It is just as important that all people be able to author content as it is for all people to have access to it. The tools used to create this information must therefore be accessible. Adoption of these guidelines will contribute to the proliferation of Web content that can be read by a broader range of readers and authoring tools that can be used by a broader range of authors.

User Agent Accessibility Guidelines 1.0

User Agent Accessibility Guidelines 1.0, 2002, is for designing user agents and is intended to lower barriers to Web accessibility for people with disabilities (visual, hearing, physical, cognitive, and neurological). User agents include hypertext markup language (HTML) browsers and other types of software that retrieve and render Web content. A user agent that conforms to these guidelines will promote accessibility through its own user interface and through other internal facilities, including its ability to communicate with other technologies (especially

assistive technologies). Furthermore, all users, not just users with disabilities, should find conforming user agents to be more usable. In addition to helping developers of HTML browsers and media players, this document will benefit developers of assistive technologies because it explains what types of information and control an AT may expect from a conforming user agent. Technologies not addressed directly by this document (e.g., technologies for Braille rendering) will be essential to ensuring Web access for some users with disabilities.

XML Accessibility Guidelines

The XML Accessibility Guidelines, 2002, from the World Wide Web Consortium (W3C) provides guidelines for designing extensible markup language (XML) applications that lower barriers to Web accessibility for people with disabilities (visual, hearing, physical, cognitive, and neurological). XML, used to design applications such as XHTML, SMIL, and SVG, provides no intrinsic guarantee of the accessibility of those applications. This document explains how to include features in XML applications that promote accessibility.

Customer Analysis

The purpose of this section is to highlight the consumer markets targeted by the industries being studied. A more detailed customer analysis can be found in the appendix to the online version of this report.

People with Disabilities

Estimates vary greatly on the number of persons with disabilities living within the United States and worldwide. The latest Census Bureau's disability statistics report, *Characteristics of the Civilian Noninstitutionalized Population by Age, Disability Status, and Type of Disability: 2000*, estimates that 49.7 million people with disabilities live in the United States (Age Structure, 2003). Applying the disability percentages presented in this report to the age structures categorized by the *World Factbook* (including populations less than 5 years of age) results in a figure of 54 million. This is often cited as the actual number of people with disabilities living in the United States, and it is the figure reported by NCD (2004). Comparing the U.S. disability statistics with those of other countries indicates that China, India, Russia, Mexico, and Turkey

have greater instances of disabilities for any age category because they have poorer health care than the United States. The market for universally designed products and services seems clear when global disability statistics (498 million people) are analyzed for these countries, which currently have the top five emerging markets. A detailed look at these emerging markets can be found in the appendix to this report online.

The specific customer populations of interest for the purpose of this study are people with the following disabilities or conditions:

- Low vision
- Blind
- Hard of hearing
- Deaf
- Upper-mobility impaired
- Lower-mobility impaired
- Cognitive

Each of the above conditions is defined in terms of a loss of functional capability that may be temporary, be permanent, or develop as a natural part of the aging process. The functional limitations may be caused by genetics, disease, traumatic injury, aging, environmental or situational factors or by some combination of multiple factors. In other words, the analysis is not restricted to functional limitations resulting from what is traditionally termed a disability. This approach, espoused by the functional model of disabilities (Kaplan, n.d.), allows us to consider a wide segment of the population who could truly benefit from UD.

It is important to understand the functional capabilities and limitations of the target population in order to properly access the impact of various accessibility features on mainstream products. Each of the target populations have different functional capabilities and limitations and thus experience different issues with the product lines under study.

Visual Impairments

Approximately 10 million people are blind or visually impaired in the United States, and about 6 million in the European Union (EU). Visual impairments include blindness, partially sighted, low vision, and color blindness. In addition to medical conditions that impact vision, visual perception may be affected by distraction from a busy, cluttered visual environment; visual fatigue; colored or high- or low-lighting conditions; and adverse weather conditions. Users with visual impairments may encounter great difficulty or find it impossible to complete the following types of tasks:

- Locating equipment
- Locating commands/devices
- Identifying commands/devices
- Using touchscreens
- Reading text on a screen
- Selecting objects on a screen
- Receiving graphics and video information
- Receiving visual alerts and signals
- Inserting cards/coins/media
- Reading printed material, including instruction manuals

In general, people with impaired vision may have difficulty perceiving visual detail, focusing on objects either close up or at a distance, separating objects that do not have sufficient contrast, perceiving objects in both central and peripheral vision, perceiving color and contrast brightness, adapting to different light levels, tracking moving objects, and judging distances (Story, Mueller, and Mace, 1998).

Hearing Impairments

More than 24 million people in the United States and about 22 million people in the EU have a significant loss of hearing. Hearing impairments include deafness, hard of hearing, conductive hearing loss, sensorineural hearing loss, and mixed hearing loss (both conductive and sensorineural). In addition to medical conditions that impact hearing, auditory perception may be affected by attending to multiple sound sources, functioning in loud environments, and using

headphones. Users who are deaf or hard of hearing may encounter great difficulty or find it impossible to complete the following tasks:

- Receiving audio information
- Understanding speech information
- Receiving acoustic alerts and signals
- Using speech input

In general, people who are deaf or hard of hearing may have difficulty localizing the source or direction of sound, filtering out background sound, perceiving both high- and low-pitched sounds, and carrying on a conversation (Story, Mueller, and Mace, 1998).

Mobility Impairments

More than 40 million people in the United States and about 32 million people in the EU have a significant loss of mobility. Mobility impairments can include the following symptoms: tremors and spasticity, paralysis and partial paralysis, amputation, and loss of coordination and strength. In addition to medical conditions that impact mobility, mobility may be affected by pain, fatigue, availability of only one hand or arm while the other is occupied with another task, wearing thick clothing or gloves, small hands, wet or oily hands, and adverse environmental conditions (e.g., bad weather or uneven terrain). Users with mobility impairments may encounter great difficulty or find it impossible to complete the following tasks:

- Using switches
- Lifting/holding devices and handsets
- Using dials
- Using numeric keypads
- Writing with a keyboard
- Handling a pointing device
- Using a touchscreen
- Inserting cards/coins/media
- Handling printed manuals and books
- Accessing equipment

In general, people with impaired mobility may have difficulty with tasks requiring range of motion, coordination, strength, and balance. More specifically, difficulties may be apparent in the following areas: reaching, pushing, pulling, lifting, lowering, carrying, grasping, squeezing, rotating, twisting, and pinching (Story, Mueller, and Mace, 1998).

People with Cognitive Disabilities

More than 12 million people in the United States and 9 million in the EU have a significant cognitive disability. Cognitive disabilities can include dyslexia, cerebral palsy, retardation, and severe learning disabilities. In addition to medical conditions that impact cognition, cognitive processing may be affected by a limited vocabulary or grammar, limited literacy, cultural or language differences, and fatigue or distraction. Users with cognitive disabilities may encounter great difficulty or find it impossible to complete the following tasks:

- Writing on a keyboard
- Reading text on a screen
- Reading printed material
- Understanding speech information
- Handling a pointing device, such as a mouse
- Navigating complex menu structures
- Responding quickly

In general, people with impaired cognition may have difficulty "…receiving, comprehending, interpreting, remembering, or acting on information." More specifically, difficulties may be apparent in the following areas: beginning a task without a prompt or reminder, responding within an appropriate time frame, concentrating, comprehending visual or auditory information, understanding or expressing language, following procedures or doing things in order, organizing information, remembering things, making decisions and solving problems, and learning new things or doing things a new or different way (Story, Mueller, and Mace, 1998).

Individuals 65+ Years of Age

Approximately 36 million people 65+ years of age are living in the United States (Population, 2003). In the top five international emerging markets, this number increases to 174 million

consumers. Aging populations cannot see, hear, think, or move about as easily as younger generations. Fifty-two percent of people 65+ years of age experience one or more of the following (U.S. Census Bureau, 1997 and Telecommunications Industry Association, 1996):

- Decreased visual acuity
- Reduced powers of accommodation
- Decreased contrast sensitivity
- Increased sensitivity to glare
- Longer dark-adaptation times
- Decreased color vision and discrimination
- Hearing impairments

Consumers Living in Low-Bandwidth Information Infrastructures

It is not uncommon for people living in the United States to take the Internet, and the bandwidth that comes with it, for granted. The United States and Canada have the technical capacity to provide bandwidth of 1,182 Mbps per capita (Haub, 2003). Developers of Web-based content targeted for use by U.S. and Canadian consumers do not necessarily need to concern themselves with limited bandwidth. In comparison, Asia only has 21 Mbps of bandwidth available per capita (Light Reading, 2002). Five billion consumers live within low-bandwidth infrastructures. This provides a significant business incentive to design Web-based content that is accessible, usable**,** and useful from within low-bandwidth infrastructures.

People Who Never Learned To Read

Seven million people who never learned to read live in the United States. Compare this to the 439 million consumers who never learned to read living in the five countries with the highest potential emerging markets. People who are not able to read cannot use automated teller machines (ATMs), personal digital assistants (PDAs), or the Web unless they are designed with access in mind. People who never learned to read can benefit significantly from voice dialing and talking ATMs (Literacy Demographic Data, 2003).

Users of English as a Second Language

The number of people believed to speak English as a second language is around 300 million. Users of ESL are individuals whose mother tongue is not English, but who live in countries where English has official or joint official status. In these instances, English is often used to conduct official business. English is the official or joint official language of more than 70 countries.

Approximately 375 million people speak English as a first language, and approximately 750 million speakers learned English as a foreign language (ESL Online Education and Training, 2000). In 2000, 28.4 million foreign-born people resided in the United States, representing 10.4 percent of the total U.S. population. ESL programs are the fastest growing component of the state-administered adult education programs. In 1997–98, 48 percent of enrollments were in ESL programs, compared with 33 percent in 1993–94. Of the 1997–98 ESL students in adult education, 32 percent were in beginning ESL classes, 12 percent in intermediate, and 4 percent in advanced classes (National Institute for Literacy, 2003). As evidenced by these statistics, the needs of users who are not native-born English speakers must be considered when designing accessible products.

Consumers Living in High-Density Populations

Population densities were calculated by dividing the area of land of a given country (Area, 2003) by that country's population (Population, 2003). People per square kilometer is one of the factors considered when calculating the average number of people that will have to wait in line to use any given ATM, self-service kiosk, or self-checkout point-of-sale device in a country. Canada has three people per square kilometer of available land space. The number of people per square kilometer living in the United States is 31. This is 10 times that of Canada. On average, the transaction time required when using an ATM or other self-service device needs to be faster in the United States than in Canada if the ratio of the number of self-service devices to size of geographical area is the same. Designing for access can reduce transaction times and increase customer satisfaction. Designing ATMs for faster use can be a competitive advantage in emerging markets, where population densities skyrocket. For example, in China there are 138 people per square kilometer. In India, this number rises to 352.

High-Language-Density Populations

Large numbers of people live in areas where a large number of languages are spoken, increasing the complexity of delivering more accessibly designed interfaces. Twenty-five languages are spoken by a minimum number of 750,000 people living in China. In India, there are 54 languages (SIL, 2003). This poses a challenge to accessible design. Companies must devise solutions to designing accessible products for high-density-language populations that meet the needs of all speakers.

Consumers in Situations That Reduce Sensory or Visual Capabilities

Designing for access does more than just benefit users with disabilities who desire accessibility features: UD practices also benefit all consumers when they find themselves in various situations that reduce their sensory or visual capabilities. For example, one accessibility feature for cellular phones that is rated as very important by users who are blind is voiced menu options. In addition to making cell phones more accessible to individuals who are blind, this feature benefits users driving in their cars who would rather focus their visual attention and capabilities on driving than on navigating through their cellular phone menus to find a phone number or make a call. This feature also is important in increasing the user's safety in such situations.

Adjustable volume control is another important accessibility feature for cellular phones that was designed with hard-of-hearing users in mind and benefits all consumers. When a consumer is navigating through a noisy environment such as a mall, construction site, or airport, it is often hard to hear a phone ring or to hear the person you're talking to on the other end of the line. The volume-control feature, initially marketed to a specific disability group, also benefits all consumers, with or without a disability, who find themselves in such a situation.

As another example, consider the design of buttons for ATMs, cellular phones, and PDAs. Larger keypad buttons are an important accessibility feature for individuals with low vision or upper-mobility impairments. However, this feature has also appealed to consumers whose dexterity is limited when they are wearing winter gloves, for example. Larger keypad buttons make it easier for them to withdraw money from an outdoor ATM or to make a phone call while wearing gloves. In addition to larger buttons, larger displays on cellular phones and PDAs, an

accessibility feature marketed to users with low vision, is another feature that benefits all consumers who are, for example, operating a device at night or in a foggy environment.

Accessibility features of televisions, such as closed captioning, can be beneficial to any consumer who is at a noisy party or watching a sports match in a restaurant, where their auditory capabilities are limited.

These are just a few examples of situations in which features that are designed with users with disabilities in mind actually increase the accessibility and appeal of products for the wider population. Companies should consider that when they design for accessibility, they benefit from offering products that will appeal to the general population as well as users with disabilities.

Analysis of the International Market

The scope of this analysis includes countries in addition to the United States. While it is natural for one to think locally (the United States), industry is global. International (including U.S.) business drivers for accessible design have far more impact. The business justification for this approach lies in the fact that, according to the Department of Commerce's (DOC's) Economic and Statistics Administration, more than 95 percent of the world's economic activity takes place outside of the United States, and the majority of the world's market is untouched by most U.S.-based businesses. Only 12 percent of U.S. businesses export their products, although a much greater percentage of them are able to do so (Czinkota, 2001).

Information provided in this section of the report was taken directly from 2004 country commercial guides (CCGs) prepared by U.S. embassy staff. This section specifically focuses on the section of each county's guide that identifies the leading sectors for U.S. exports and investments. CCGs are published once a year and contain information on the business, economic situation, and political climate of foreign countries as it affects U.S. business. Each CCG contains the same chapters and an appendix that includes topics such as marketing, trade regulations, investment climate, and business travel.

Economic activity is not the same as gross domestic product (GDP). The term economic activity, as used by the DOC, represents the value of total imports and exports for a given country for a given year. Total U.S. imports plus total U.S. exports for 2002, expressed as a percentage of GDP, was less than 5 percent. U.S. imports for 2002 totaled $1.165 trillion. Total exports were $682 billion. The combined total was $1.847 trillion. Divide this by $49 trillion, the world's GDP, and that is how DOC expresses this particular metric. If you compare apples to apples, world economic activity for 2002 was $12.6 trillion. Divide this into $1.84 trillion, and U.S. economic activity was 14.7 percent of world economic activity in 2002.

The countries targeted for this study were not selected based upon market potential alone. They were also selected based upon the level of U.S. corporate investment in each of the five emerging market countries covered in this report; that is, investments that support the establishment of long-term business relationships. Between 1990 and 2002, foreign direct investment (FDI) in the five emerging market countries exceeded US$614 billion (Kearney, 2002). Four-fifths of the world's population lives in developing countries. The top 15 highest potential emerging markets account for 28.6 percent (US$14 trillion) of the world's gross domestic product (US$49 trillion). The door to emerging trade opportunities is being opened by the increasing need for high-technology products and other capital equipment. Supporting the growth, prosperity, and independence of developing countries implies the use of information technology. These technologies include telecommunication, education, and banking infrastructures. According to Subhash Bhatnagar (n.d.) of the World Bank, technology is a critical success factor in enabling developing governments to reach out to their citizens for the following purposes:

- Improving delivery of services to citizens
- Improving communications between government and industry
- Empowering citizens by providing access to knowledge and information
- Making the workings of government more efficient, cost-effective, successful, and self-sustaining

If the people living in developing countries are not able to access and use the technologies fundamental to that country's growth and prosperity, that country will not succeed in achieving acceptable qualities of life, independence, or employability for its citizens.

The emerging markets selected to be part of this analysis are made up of the top five developing countries, with the highest populations, determined by GlobalEDGE (2003) as having the highest overall market potential. These countries are China, India, Russia, Mexico, and Turkey.

China (China, 2003)

China: Information Technology (IT)

China is home to one of the largest and fastest growing IT markets in the world. According to statistics released by the Ministry of Information Industry (MII), the 2002 total sales value for E&IT products was US$169.5 billion, an increase of 17.8 percent over the previous year. This statistic refers to Chinese imports. China imported approximately US$74 billion worth of IT products in 2002. The total market size is estimated to be US$215 billion.

According to both government and private sector sources, the demand for IT products is expected to maintain a high growth level due to rapid economic development in China and high demand driven by favorable national policy and growing consumer power.

The Chinese government is now pursuing a national development strategy of "using informatization to drive industrialization and using industrialization to promote informatization." Current national development policies give top priority to development of the IT industry and encourage wide application of IT in all economic and social fields. According to MII, in 2002, the domestic E& IT industry output was US$206.98 billion, up 20.9 percent over the previous year, which is almost three times the growth rate of China's GDP in the same period. This statistic refers to industry output.

As China continues to develop as a center for manufacturing, and as foreign investment, the strength of local companies, and the affluence of local consumers all continue to increase, information products and services—ranging from business applications to digital consumer products—will drastically increase in the next 5 to 10 years. Major drivers of growth include China's e-government initiative, e-commerce development, and "two pillars of the economy" initiative (i.e., the development of national software and integrated circuit [IC] industries), as well as China's need to enhance its competitiveness across all industrial sectors due to the rapid

pace of globalization as a result of its access to the World Trade Organization (WTO). The 2008 Olympic Games will also provide a strong impetus for growth in demand of IT products and services in the next five years. It is estimated that Beijing will spend close to US$3.6 billion on IT infrastructure and systems to meet the needs of the Olympic Games.

As a concrete measure to implement its strategy of using informatization to drive industrialization, the Chinese government initiated an ambitious e-government program in 2001. According to the China Center of Information Industry Development (CCID), a local consulting firm, the Chinese government has thus far spent a total of US$4.2 billion on e-government projects. In the next two to three years, the compound growth rate of government spending on IT will be 25.7 percent. More than US$12.1 billion will be spent on e-government over the next five years.

Since the bursting of investment bubbles in dot-com ventures, China's Internet business market seems to have recovered its vigor for growth. The three major portals, Sina.com, Sohu.com, and Netease.com, all claimed to have made profits since the second half of 2002. With short messaging service (SMS), online advertisement, online gaming, and online trade, these major portals are finding their way to sustainable and profitable business models. The progress made by these portals is encouraging to e-commerce development, which will create a huge demand for IT products, from hardware to software and from system software to innovative applications and services.

Driven by huge demand and facilitated by favorable investment policies, China's IC industry returned to a fast track of growth in 2002. The growth in China's IC market seems to have caught the world's attention. According to CCID, China's 2002 IC market size reached US$21.54 billion, accounting for 15.3 percent of the world market. That said, currently, 85 percent of China's domestic IC demand is met by imports.

Although China is now playing a significant role in electronics and information products manufacturing (total production volume is believed to have surpassed that of Japan to become the world's second largest producer), it still lacks core technologies for almost all the products it produces. For instance, China is the top producer of mobile handsets, but core chips needed to

produce the phones must be imported. The same is true for other products, including DVDs, high-end color TVs, computers, and monitors. Although the government has promulgated policies to encourage the development of IC and software, China's heavy reliance on imports for high-end chips, parts, and components for most of the electronics and information products is not expected to significantly change for as long as a decade. With leading technologies in almost all fields of information technology, U.S. companies have a great advantage in meeting the increasing market demand for high-valued-added chips, devices, and components.

Other best prospects include production lines and equipment for the manufacture of E&IT products, including semiconductors. More and more world manufacturing capacity is moving to the country where demand for highly sophisticated modern manufacturing lines almost solely relies on imports from developed countries. For instance, China is currently not capable of producing critical semiconductor equipment for processing 0.18-micron chips. In this area, China is two generations behind the latest world technological levels. Demand for equipment and instruments for processing, packaging, and testing chips will be met only by imports. Moreover, software tools and intellectual property cores for designing chips appear to provide good sales opportunities for U.S. companies.

Consumer electronics is another area of high growth. According to CCID, China's 2002 sales of digital cameras, mobile storage devices (flash memory), MP3 players, and digital video cameras increased more than 100 percent from 2001. PDAs are also an area with deep potential for growth. U.S. companies have a big role to play in supplying the operating system, core chips, and production expertise for these products.

However, the key to succeeding in any of the above "best prospects" markets is to localize your products. Although there is great demand, U.S. suppliers are not the only source. European and Asian competitors (e.g., Japan, Taiwan, and Korea) are also trying to meet the demand. It is imperative that U.S. companies understand the market and the specific needs/demands of Chinese customers in order to take full advantage of the market.

Although U.S. companies still dominate much of the high-end hardware market in China's fast-growing computer market—such as high-end servers, printers, routers, and network equipment—

their dominance is severely challenged by fledgling local players such as Lenovo (the new brand name for Legend Corp.). CCID's 2002 statistics show signs of a maturing market, with emphasis of demand shifting toward software and IT services. U.S. companies such as IBM and HP and software giants Microsoft, Oracle, Sybase, and BEA keep dominance on China's system software, platform software, applications, and IT consulting services market.

Table 1: China's Information Technology Market

	2001 (actual)	2002 (actual)	2003 (estimated)
Total Market Size	178,052	215,045.6	258,054.7
Total Local Production	178,028	215,496.4	258,595.6
Total Exports	5,449.1	7,844.7	9,413.6
Total Imports	5,473.1	7,393.9	8,872.7
Imports from U.S.	705.9	642.2	706.4

Notes: The above figures are calculated in millions of U.S. dollars and represent unofficial estimates. Trade numbers are based on Chinese customs figures for the HTS codes 8470–8473, 8517–8534, and 8540–8542. Local production figures are from MII. The MII figures for export in 2002 were US$92.1 billion and US$65.2 for 2001; domestic sales figures were US$162.79 billion for 2002 and US$143.88 for 2001.

China: Telecommunications Equipment

China's telecommunications industry continued the momentum of rapid growth in 2002, despite the downturn in the industry worldwide. At the end of May 2003, the total absolute number of telephone users in China reached 462 million, among which 232 million were landlines subscribers and 230 million were cell phone users. However, the penetration rates of fixed lines at 17.5 percent and mobiles at 16.2 percent clearly indicate room for further growth. In the five years since 1997, China's telecommunications industry registered an average annual growth rate of 20 percent.

In 2002, Chinese telecommunications carriers invested US$25.4 billion in telecom infrastructure, compared with US$29 billion in 2001. As a result, carriers were able to recruit 95.45 million new telephone subscribers that year. Their aggregated revenue reached US$55.36 billion, with China Telecom having a 32.5 percent share, China Netcom 16.6 percent, China Mobile 37.4 percent, China Unicom 12.1 percent, and others (China Railcom and ChinaSat) 1.4 percent.

China's MII, the most important government regulator in the telecommunications industry, projected that Chinese telecommunications carriers would invest US$25.5 billion in 2003 to recruit 33 million fixed line telephone subscribers and 52 million cellular phone users. MII expects the fixed line penetration rate to reach 19.4 percent by the end of 2003 and cellular penetration rate to reach 20.1 percent.

The Chinese government is expected to grant third generation (3G) licenses to four Chinese telecom operators in the first half of 2004. Besides China Mobile and China Unicom, which are the two incumbent mobile communication service providers, fixed line operators China Telecom and China Netcom are also likely to obtain such licenses.

A competitive market environment is taking shape in China's telecommunications sector. In 2004, China's six licensed basic telecom operators—China Telecom, China Netcom, China Mobile, China Unicom, China Railcom, and ChinaSat—are expected to expand and optimize their networks in order to meet the growing need for telecommunications services. Moreover, they are expected to compete against each other as well as potential competitors from multinational companies that are planning to explore business opportunities in this lucrative market.

It is important to recognize that, while the Chinese government appears committed to fostering a more competitive telecommunications service environment, this commitment does not necessarily mean that equipment vendors with the best technology and/or lowest prices will succeed in the Chinese marketplace. China's telecommunications equipment market is characterized by intense competition and a multitude of complex, multilayered political and economic factors that must be carefully and appropriately evaluated in order to achieve success.

MII is subject to oversight by the State Council. MII was created in March 1998 by merging the Ministry of Posts and Telecommunications with the Ministry of Electronics Industry (MEI). Other influential government agencies in China's telecommunications industry include the State Council Informatization Office (SCITO) and the National Planning and Reform Commission (NPRC). SCITO was set up in August 2001 as an interagency coordinating body to oversee China's regulatory and commercial developments in the IT and telecommunications sectors and

implement the central government's policies and measures that drive information technologies. NDRC is the approver of important and large projects.

In March 2003, former Party Secretary of Hebei Province, Wang Xudong, replaced Wu Jichuan as the minister of MII. In May, Minister Wang was also appointed the director of SCITO, replacing Zeng Peiyan, who was promoted to serve as a State Councilor. Having Wang as head of both MII and SCITO is a sign that the Chinese government is moving to integrate its policies and strategies on telecommunications and information industries.

China does not yet have a telecommunications law in place. However, MII has promulgated telecommunications regulations and regulations on foreign investment in the telecommunications industry based on its WTO commitments. MII requires that most telecom equipment, including terminal devices such as cellular phones, fixed line phones, and fax machines and network products like switches and base station equipment, be tested and certified. There are two kinds of certificates: (1) type of approval (TA) for radio products, and (2) telecom equipment network access license (NAL) for all other products. MII's Radio Regulatory Department tests radio products and issues TA certificates, while MII's Telecom Administration Bureau issues telecom equipment NALs.

In addition, certain telecom products may also need to obtain a CCC (China Product Compulsory Certification) mark from China's State General Administration of Quality Supervision and Inspection and Quarantine (AQSIQ). For more information, please visit AQSIQ's Web site, www.aqsiq.gov.cn or www.cnca.gov.cn, or go to the following Web page for frequently asked questions on the CCC mark: http://www.mac.doc.gov/China/Docs/BusinessGuides/CCCFAQ.htm.

Testing of products by the carriers is a must, even if these products will be sold to local operators. Larger vendors are advised to work directly with the carriers to sell their products, while smaller firms may want to start with agents and distributors that have the necessary resources, connections, and technical support.

China: Telecommunications Sub-Sectors

Mobile communications include the following 3G and value-added service platforms:

1. Value-added capabilities for email and Web browsers and the ability to download ringing tones, logos/images, music, videos, games, and stock market quotations

2. Broadband access network equipment, including wireless LAN, LMDS, and ADSL

3. Operational management systems like BOSS and multiple-service platforms

Table 2: China's Telecommunication Equipment Market

	2001 (actual)	2002 (actual)	2003 (estimate)
Total Market Size	21,398	19,645	20,500
Total Local Production	13,430	19,115	18,000
Total Exports	2,032	3,460	4,500
Total Imports	10,000	4,000	7,000
Imports from the U.S.	1,100	724	900

Note: The above figures are calculated in millions of U.S. dollars. They are taken in part from MII's reported top 15 Chinese telecom vendors sales estimates and represent unofficial estimates.

China: Software Market

China's general computer market revenues increased 16 percent in 2002, totaling US$28.5 billion in sales. Of the overall computer market revenues, hardware accounted for 67.2 percent, software accounted for 14.6 percent, and information services accounted for 18.2 percent. According to February 2003 reports in the CCID *Consulting News,* the software market will continue to post strong growth as a result of a favorable domestic economy and the trend of industries and enterprises toward China's informatization.

Within the software market, applications software accounted for 64.5 percent of the total market; middleware accounted for 6.6 percent, representing a 2.9 percent increase compared with same period last year; and platform software accounted for 28.9 percent. In line with China's overall rapid development in the IT sector, market competition has become more intense.

China: Best Prospects in Software

For the applications software market, China's domestic products are the fastest-growing segment.

- For the middleware market, the domestic products and foreign products have an equal share.
- Foreign products monopolized the system software market. In 2002, foreign products accounted for a 95.3 percent market share. Foreign products should continue to monopolize the high-end operating system, high-end server system, database management system, and system networking management software markets. These products will continue to be the leading sector in the coming year.

China's tenth five-year plan indicates that the following software projects are the priorities:

- To develop security operation systems, security authentication systems, and advance China's e-commerce solutions
- To develop information security software packages that are based on LINUX operation systems
- To develop production platforms that are based on the software structure and middleware structure

China's successful bid for the 2008 Olympic Games as well as its membership in the WTO will be the main drivers for growth in the software market and industry over the next several years. In 2003, the software tariffs were eliminated (reduced to zero). Furthermore, China issued a number of policies ranging from export incentives to value-added tax rebates and financial assistance to small businesses, as well as laws addressing intellectual property rights protection. If U.S. companies can gain good access to the China market, the software market should have positive opportunities.

Table 3: China's Packaged Software Import and Export Market

	2001 (actual)	2002 (actual)	2003 (estimate)	2004 (estimate)
Total market size	9,538	13,864	16,635	18,899
Total local production	9,077	13,253	15,903	18,289
Import	781	847	954	900
Export	320	236	222	290
Import from U.S.	223	195	198	200

Notes: The above figures are calculated in millions of U.S. dollars and are representatives of estimates from the China Customs Import and Export data.
The above table is calculated based on HS codes 8524.31, 8524.39, 8524.40, 8524.91, and 8524.99; software downloaded from the Internet is not included in the above table.

India (India, 2004)

India: Telecommunications Equipment

India's 48 million-line telephone network is among the top 10 networks in the world and the second largest among the emerging economies, after China. India has one of the fastest-growing telecommunications systems in the world, with system size (total connections) growing at an average of more than 20 percent per annum over the last four years. The network consists of more than 26,300 telephone exchanges, equipped with a capacity of nearly 48 million lines and nearly 36 million working telephones. According to the government of India telecom plan (1997–2007) prepared by Bharat Sanchar Nigam Limited (BSNL), the demand for new telephone lines during the period up to 2007 is estimated at 81.8 million. This projected demand will necessitate approximately 64 million telephones during the next eight years. BSNL and Mahanagar Telephone Nigam Limited (MTNL) will provide about 43 million telephones, and private operators will provide 21 million telephones. The industry is considered as having the highest potential for investment in India. The growth in demand for telecom services in India will be highest in basic services, followed by national long distance, international long distance, and the cellular services sectors.

India has a relatively low density of telephones, 4 per 100 persons, with plans to increase to 7 by 2005 and 15 by 2010. Tele-density in India rural areas is 0.5 per 100 people, and the government plans to increase this to 4 per 100 by 2010. A total of 500,105 out of 607,491 villages have been provided with a village public telephone (VPT), i.e., one telephone per village. Considering

India's population of 1 billion, it is estimated that to achieve these objectives, approximately 78 million telephone connections will be required by the year 2005, and 175 million telephone connections by the year 2010. At current prices, this translates to an additional investment of approximately $37 billion by 2005 and $68 billion by 2010.

The total subscriber base of cellular phones is currently at 13 million, up by 80 percent from the previous year. According to Cellular Operators Association of India, it is estimated that the subscriber base will reach 40 million by 2006 and 300 million by 2010, thus resulting in huge opportunities for U.S. telecom equipment vendors.

The installation base of direct exchange lines (DELs) was at 37 million DELs in 2002 and is expected to grow to 82 million DELs by 2007. DoT/MTNL will provide about 80 percent of DELs of the additional DELs. It is estimated that each DEL will cost about $900.

India has created a strong manufacturing base for producing telecom products. Indian firms typically manufacture telecom switches with technical and financial collaboration from foreign firms. Around 19 Indian firms manufacture small- and medium-sized switches, and 7 joint ventures produce large capacity switches. Bharat Sanchar Nigam LTD (BSNL) and government-owned MTNL are the largest end-users of telecom switches.

The annual growth rate of net-switching capacity of the recently privatized BSNL for the period 1992–97 was around 16–18 percent. However, the growth rate speeded up after 1997, registering 22–24 percent annually.

Value-added service providers are growing by the day and are demanding good infrastructure. Email, Internet services, frame relay services, video conferencing, electronic data interchange, and voice mail have been accorded value-added services status. These value-added services interface with basic telecom services and increase telecom traffic several fold. With the increased investment in the value-added services, the demand for other switching products—such as cellular switches, ISDN switches, gateway switches, and ATM switches—is bound to grow sharply.

Digital switching system technologies of multinational companies—Alcatel, Siemens, Fujitsu, Lucent, Ericsson, and NEC—have been introduced in India. In addition, switching systems based on the indigenous technology developed by the state-owned Center for Development of Telematics (C-DoT) are also used.

The other promising sub-sectors, are shown in Table 4:

Table 4: Other Promising Telecommunication Equipment Sub-Sectors

Sub-Sectors	2003 Demand (Units)
Telephone Instruments	600 million
Cellular Mobile Phones	10 million
Optical Fiber Cable	24,000 route kilometers
Radio Trunk Line Hand Sets	1 million
V-SAT Terminals	58,000
Internet Equipment	3.6 million

Table 5: Total Combined Market for Telecommunications Equipment in India

	2001	2002	2003 (est)
Total market size	6,016	7,289	8,154
Total local production	2,745	3,125	3,541
Total exports	35	52	83
Total imports	3,306	4,216	4,696
Imports from the U.S.	1,170	1,570	1,704

Notes: The data are in millions of U.S. dollars, based on an exchange rate of $1 = INR 47.5.
The data are unofficial estimates.

India: Computers and Peripherals

The Indian computers and peripherals market is expected to continue to expand to meet local demands. Private sector firms, government offices, small- and medium-sized enterprises (SME's), and small office–home office (SOHO) users continue to computerize their operations, contributing to the growth of the computer hardware market.

The Indian software industry is enjoying a global leadership position in software development and exports. Indian software exports reached sales revenues of $10 billion, reflecting 30 percent

growth over the previous year. Domestic IT sales revenues also expanded during 2002–03, reaching $6.67 billion. The growing Indian software and services sector continues to support growth in the computer hardware sector.

IT-enabled services is another sector that witnessed impressive growth. Existing projects are expanding and new ventures are being established in India to capitalize on the highly skilled, cost effective manpower. This sector witnessed impressive sales revenue growth from $1.49 billion in 2001–02 to approximately $2.46 billion in 2002–03. These developments continue to support hardware sales in the country.

India: Information Technology

The Indian IT industry is moving toward embedded technology requiring software and hardware codesign. Multimedia, workflow automation, virtual reality, and machine learning are some of the latest developments requiring embedded hardware. Personal computers and servers continue to dominate for office automation purposes.

A study conducted by Manufacturers Association of Information Technology (MAIT) and Ernst & Young found that the Indian hardware sector has the potential to grow to 12 times its present size, reaching a sales turnover of $62 billion by 2010 with the domestic market accounting for $37 billion and the balance for exports (source: The Hindu Survey of Indian Industry).

More than 135 small, medium, and large firms manufacture computers in India. Many multinational companies (MNCs), such as HP, IBM, Siemens, Dell, and ACER, have a strong presence and manufacturing facilities in India. Lesser-known branded/unbranded locally assembled PCs and Indian-branded PCs compete with MNC products. The market shares of each element in this segment vary from year to year. During the first six months of 2002–03, the locally assembled PCs had a share of 48 percent; Indian brands had 22 percent, and MNC products had a market share of 30 percent.

India imports most of the high-performance computers and peripherals from the U.S. and Asian countries. Major Indian and U.S. software and services companies such as CISCO, Cognizant Technologies, IBM, Microsoft, Oracle, and Texas Instruments import and use high-performance

computer systems for their development projects. In addition, major Indian and international banks, insurance companies, Indian stock markets, Indian railways, and airlines also use high-performance computers, including mainframes and mid-sized computers.

The national government of India and Indian state governments encourage new investments in computer hardware projects. The market size in 2003 of the various segments is given below:

Desktops: $1,198 million
Notebooks: $86 million
Servers: $215 million
Peripherals: $440 million

The above estimates are based on the literature from the following sources:

- Manufacturers Association of Information Technology (MAIT), www.mait.com
- National Association of Software and Service Companies (NASSCOM), www.nasscom.org
- The Hindu Survey of Indian Industry, 2003
- India Infoline, www.Indiainfoline.com

Table 6: Computers and Peripherals in India

	2001 (estimates)	2002 (estimates)	2003 (estimates)
Total market size	4,600	4,900	5,610
Total local production	3,980	4,200	4,830
Total exports	300	500	600
Total imports	920	1,200	1,380
Imports from the U.S.	370	500	550

Notes: The data are in millions of U.S. dollars, based on an exchange rate of $1 = INR 47.5.
The data are unofficial estimates.

India: Computer Engineering Software and Services

The Indian software and services industry continues to show impressive growth rates. The software industry grew at a compounded annual growth rate (CAGR) of more than 50 percent

during the last five years. Even though the global economy slowed down, Indian computer software exports jumped to $9.7 billion during 2002–03, from $7.68 billion in 2001–02, reflecting growth of more than 26 percent. Domestic software and services also grew from $2.08 billion in 2000–01 to $2.45 billion in 2001–02.

The government of India aggressively supports this industry, which is projected to reach exports of $50 billion by 2008. The Indian government has undertaken initiatives such as simplification of policy procedures, manpower development, venture capital support, and infrastructure development to help promote the software industry. International Data Corporation, India (IDC-India), a premier research firm monitoring the IT industry worldwide, estimated the Indian IT engineering services market at $442 million in 2001, $566 million in 2002, and $633 million in 2003. IDC-India, in its report *Directions 2003* for India, has estimated that the computer software engineering sector grew by 18 percent in 2002–03 (April–March) and is projected to grow at a CAGR of 11 percent during the years 2003–06.

Present and projected increased uses of IT applications in state and central governments, e-governance applications, e-banking, elimination of import duty on software, enhanced enforcement of antipiracy laws, and the increased maturity of end-user organizations in using legal software have all contributed to the rapid growth of the Indian software industry. According to India's Department of Information Technology, Indian IT spending as a percentage of GDP should reach 7 percent by 2008, from the present 3 percent.

U.S. software and IT services companies have found opportunities by providing products and expertise that help to accelerate the market's growth. Notably, companies that provide tools and systems for IT-enabled services, such as call centers and business process outsourcing, have found good prospects in India. Likewise, companies that provide Web based e-governance and e-commerce solutions will find interest from the Indians. The growing Internet service provider (ISP) market will also demand leading-edge ISP operations and user interface software. Appropriate software for vertical markets such as banking, health care, textiles, and telecommunications will also see an increase in demand.

The most promising IT sub-sectors had the following market sizes in 2003, based on estimates in U.S. dollars:

Systems and Packaging: $252 million
Professional Services: $170 million
Processing Services: $75 million
Maintenance Services: $151 million

Table 7: Information Technology in India

	2000–01	2001–02	2002–03 (est.)
Total market size	442	566	632
Total local production	1355	1781	2181
Total exports	1157	1536	1941
Total imports	244	320	392
Imports from the U.S.	146	192	235

Note: The data are in millions of U.S. dollars, based on an exchange rate of $1 = INR 47.5.

The above estimates are based on the literature from the following sources:

- Electronics and Computer Software Export Promotion Council, http://www/escIndia.org/export_statistics.html
- National Association of Software and Service Companies (NASSCOM), http://nasscom.org
- Dataquest India, http://www.dqIndia.com
- Industry source and newspapers, http://economictimes.Indiatimes.com/cms.dll/xml/uncomp/articleshow?msid-20231

Russia (Russia, 2004)

Russia: Telecommunications Equipment

The Russian telecommunications market has demonstrated strong growth over the last year, driven by Russia's continuing strong economic performance and the pressing need to upgrade the generally inadequate telecommunications infrastructure throughout the country. In 2002, the

Russian market for telecommunications services grew 30 percent to $8.6 billion, and it is expected to top $10 billion in 2003. Meanwhile, the number of cellular phones increased by 130 percent in 2002 to 17.7 million and reached 24 million in June 2003. Internet subscribers doubled in 2001 and 2002 and reached a 10 percent penetration rate in 2003.

Telecommunications equipment sales are running at around $2 billion per year. At the beginning of 2003, Russia had more than 32 million telephone lines, up from 29.7 million on January 1, 2002, and the waiting list has 5 million names. However, more than 50,000 small rural communities are without a single phone line. An objective of the Russian government is to place a telephone in every community or within an hour's walk. Given Russia's vast size, this is ambitious, indeed.

Svyazinvest, the state-owned major fixed-line carrier, has been tasked by the government to increase the number of fixed lines to 45 million by 2010. As tariffs are regulated at a low level, and increases are likely to be quite gradual, much of the capital expenditure budget is expected to come from outside investment. In part to increase its attractiveness to investors, Svyazinvest has completed a reorganization under which it has consolidated 70 regional phone companies into 7 super-regional telecom providers. In the process, its market capitalization rose from $1 billion at the initial phase of the reform in January 2001 to $1.8 billion by early 2003. There has been some discussion over a potential sale by the government of its 75-percent share in Svyazinvest.

Over the next three years, the highest growth rate is expected in the broadband segment (xDSL, cable TV, and BWA). Dial-up Internet access should grow by 20 percent per annum, and the Internet segment should average 25-percent growth. Sales of packet switching gear will grow by 55 percent per year, and the virtual private network (VPN) market may triple. The cellular market, which represents about 35 percent of the Russian telecom market by value, is expected to maintain its market share, growing at the average rate of the industry in general.

Continued growth in the Russian telecommunications services market will yield business opportunities for competitive U.S. telecommunications equipment suppliers. The best sales prospects are digital switching equipment; high-speed, broadband Internet access technologies; multiservice and multimedia solutions, including SDH, xDSL, ISDN, DWDM, and BWA; and

call-center equipment. Companies entering the market should be prepared to compete with major foreign equipment manufacturers and deal with a complex regulatory environment.

Table 8: Russia's Telecommunications Equipment Market

(US$ millions)	2001 actual	2002 actual	2003 estimate
Total Market Size			2000
Total Local Production	n/a	n/a	n/a
Total Exports	216	275	275
Total Imports	1,430	1,500	1,725
Total Imports from U.S.	139	200	500
Total Services Market Size	6,620	8,600	10,000

Note: The above figures are based on Russian Customs statistics and may be an underestimate of U.S. imports. Due to their corporate structures, some U.S. equipment manufacturers ship product from their European warehouses. Russian Customs may attribute such shipments to Europe rather than the United States, despite the U.S. origin of the product.

Russia: Computers, Peripherals, and Computer Software

The Russian computer market represents one of the promising emerging markets for U.S. firms and has solid potential to grow. Industry sources estimate the IT market at $4.7 billion in 2002. Many major U.S. companies are already present in the market, and their products are available either directly or through representatives or distributors. However, Russian consumers are, of necessity, extremely price-sensitive and generally prefer a low-cost computer to a globally recognized brand name.

The main trends in 2002 were a sizable increase in government purchases, expansion to Russia's regions, and strong growth in laptop and server sales. Imports account for 15 percent of Russia's personal computer market, while peripherals, networking, and larger system hardware are dominated by imports.

The total number of computers in Russia exceeded 12 million by January 2003, with a penetration rate of 9 percent. It is estimated that by 2004 the number of Internet users will reach 15 million, and in the following seven years will grow to more than 35–40 million. The software market was estimated at $450 million in 2002 and growing at an annual rate of 25 percent; it was predicted to grow up to $600 million in 2003. The true demand for software, though, is difficult

to determine, due to the high level of pirated software. Some industry sources estimate that piracy is up to 85 percent, but legislation (on patents and trademarks) and enforcement (e.g., a new arbitration code) should improve that situation. In 2002, the market for outsourcing software services was estimated up to $300 million. Total annual turnover of the systems integration market grew to $840 million in 2002 and is projected to continue its growth. This market sector is maturing, and new entrants will likely face serious competition from long-established companies.

Continuing growth in the number and purchasing power of SMEs is driving demand for legally imported operating systems, software application packages, and enterprise management software. The best opportunities for sales of U.S.-manufactured hardware computer products in Russia appear to be peripherals, networking equipment, and Internet technology.

Table 9: Computers, Peripherals, and Software in Russia

(US$ millions)	2001 Actual	2002 Actual	2003 Actual
Total Market Size	n/a	n/a	n/a
Total Local Production	n/a	n/a	n/a
Total Exports	45	49	54
Total Imports	480	580	700
Total Imports from U.S.	65	70	77

Note: The above figures are based on Russian Customs and U.S. Department of Commerce data and unofficial estimates.

Mexico (Mexico, 2004)

Mexico: Electronic Components

The electronics industry in Mexico is evolving. Fueled by the North American Free Trade Agreement (NAFTA), the industry has moved into new product lines, including automotive electronics, network equipment, game consoles, printers, high-capacity servers, storage media, and even semiconductor design. As the second most important export industry in Mexico, the electronics industry imports 92 percent of the electronic components it requires, 85 percent of which come from U.S suppliers. However, more and more components are being imported from other areas of the world, mainly Asia and Eastern Europe.

Mexican electronic firms enjoy competitive advantages for importing components from U.S. suppliers under NAFTA, including short lead times in transportation, virtually 100 percent duty-free electronic components, and streamlined customs procedures. In addition, NAFTA has led to increased foreign direct investment, and many of the original equipment manufacturers are U.S. investment operations that utilize U.S. components in their designs. U.S. market share has declined, however, due to the Mexican government's program of sectoral promotion (PROSEC) program, which established most-favored nation (MFN) tariffs of zero or 5 percent for many categories of industrial inputs, thereby eroding the value of NAFTA duty-free entry for U.S. suppliers.

As a result of the slowdown of the U.S. consumer electronics market, Mexican imports of U.S. components for assembly and reexport decreased significantly in 2002. This trend is expected to continue in the near future until the U.S. economy recovers.

The two main centers for the electronics industry in Mexico are Baja California (Tijuana) and Guadalajara.

Baja California

Electronics is one of Baja California's most important industries, with 180 plants (approximately 26 percent of Mexico's total electronics *maquiladoras*). The great majority of these plants are of Asian origin, and they employed more than 60,000 workers and produced nearly 19 million television sets and computer monitors in 2002. Among the most important purchasers of electronic components in the border region are Sony, Panasonic, Thompson, Hitachi, JVC, Matsushita, Sia (Sanyo), Samsung, and Sharp. This industry has been severely affected by the global economic slowdown and other factors that have caused the closure and relocation of more than 50 companies in the electronics sector. Nevertheless, there have been recent signs of recovery, such as an important Japanese firm inaugurating a new plant to manufacture plasma television sets. The electronic products that continue to have the best prospects are monolithic integrated circuits, hybrid integrated circuits, circuit selectors, tuners, diodes, transistors, and electronic micro assemblies. More than 35 percent of these components are imported from Asian

countries, a characteristic purchasing pattern from Asian investors, who favor sourcing from their countries of origin.

As is happening in other parts of the country, the electronics industry in the region is evolving, shifting production lines to new products such as cellular phones, game consoles, and automotive electronics, among others.

Guadalajara

Located in western Mexico, Guadalajara has experienced important growth in the electronics sector and is considered Mexico's Silicon Valley. Original equipment manufacturers (OEMs) that formed the initial base of the city's electronics industry, including Hewlett Packard, IBM, Siemens, and Kodak, are now contracting out more of their production to local contract manufacturers (CMs), such as Flextronics, Solectron, and Jabil Circuit, to manufacture parts for final products manufactured in Guadalajara—computers (mainly laptops), computer peripherals (mainly printers), game consoles, and telecommunication equipment. Texas Instruments and Siemens represent the growing specialty sector within automotive electronics. New practices being adopted by local industry include the ability to respond to requests from customers (located mainly in the United States) with very short lead times (usually 48 hours), and the custom manufacture of complex devices such as servers or routers.

Guadalajara's electronics sector is closely tied to that of the United States: 80 percent of electronic components are imported from the United States under NAFTA, and 91 percent of local production is exported to the United States. Therefore, the downturn in the U.S. economy and decrease in demand for electronic products has impacted Mexico's economy. Mexico's highest-value import category, the semiconductor sector, is increasingly shifting in origin from the United States to Japan, Taiwan, Malaysia, Korea, and Singapore. In just the last year, U.S. semiconductor imports fell from US$4.3 billion to US$3.3 billion.

Manufacturers have become even more cost conscious and are looking for additional ways to reduce costs. Some have moved parts of their operations to lower-cost countries. As more and more OEMs look to their contract manufacturers for low costs, CMs have more freedom to

choose suppliers and negotiate price, therefore transferring electronic component supplier control to CMs.

Table 10: Electronic Components Imported from the U.S. in 2002 (US$ millions)

	2000	2001	2002	2003/e
Import Market	42,347	30,010	26,852	25,000
Local Production	438	501	402	500
Total Market	42,785	30,510	27,254	25,500
Imports from U.S.	33,071	26,650	21,803	20,000

Table 11: Electronic Components Imported from the U.S. to Mexico in 2002

Product	HS Code	US$ Millions
Integrated circuits	8542	3,333
Cathode-ray tubes	8540	1,815
Printed circuits	8534	1,063
Switches, relays, and plugs	8536	3,112
Capacitors	8532	640
Wire and cable	8544	2,303
Switchboards and panelboards	8538	939
Antennas	8529	842
Resistances	8547	476
Batteries	8507	214

Source: Banco de Mexico, Secretary of Economy, and National Chamber of Electronics and Telecommunications. Figures are considered from April 2002 to March 2003, due to a lack of information from the Secretariat of Economy.

Mexico: Internet and E-Commerce

The Internet market is the fastest growing segment within Mexico's telecommunications sector. According to the consulting firm Select, the number of Internet users reached approximately 10 million in 2002 and was expected to reach 12.25 million by the end of 2003.

Internet penetration is limited by a low PC-penetration rate and a lack of fixed-line capacity, which prevents potential customers from gaining access. The installed base of PCs in 2002 was estimated at 8.1 million, of which 54 percent had Internet access. The drivers for the Internet

growth include the interest in fixed broadband access, Internet/PC bundle packages offered by most service providers, the popularity of Internet cafes, and the initiatives of the government and carriers for increasing Internet adoption by residential, business, educational, and government users.

The potential number of Mexican Internet users is primarily limited by income distribution patterns, limited investment in IT by SMEs, limited Internet content in Spanish, and the high prices of fixed broadband connectivity. However, Wi-Fi solutions are being looked at to overcome these limitations. Wi-Fi commercial systems are currently in place in some restaurants, coffee shops, hotels, and other commercial establishments, primarily in metropolitan and tourist areas. Techtel International and Intel have been very active in this regard. In addition, Telmex has installed 100 "hot spots" in Sanborns, a chain of retail/pharmacy stores with coffee shops, as well as in convention centers and airports.

According to Pyramid Research, the revenues generated by Internet services grew from US$138 million in 1998 to US$535 million in 2001 and will continue to grow at an annual rate of 20 percent over the next five years. Currently, revenues from fixed narrowband access account for 72 percent of the market, due to the large number of dial-up connections. However, it is estimated that broadband services will gradually gain market share and will generate approximately 52 percent of Internet services revenues in 2007.

Over the long term, Internet use is expected to increase as the process of technology diffusion continues, with computer/Internet access moving from larger companies to their suppliers, from institutions of higher education down to secondary and primary schools, and from the Mexican federal government to local governments. Wireless Internet use may become more widespread in the future as a result of the serious infrastructure problems with the fixed-line Internet.

The relatively fast expansion of the Internet in Mexico, growing interest in e-commerce, and the increasing use of business applications are creating a need for hosting services with large storage capabilities. Companies that are capable of offering bundled packages for connectivity, hosting, and storage will eventually displace companies currently offering simple colocation and basic storage solutions for Web sites.

According to Pyramid Research, e-commerce in Mexico is expected to reach approximately US$47 billion by 2005, up from US$1.1 billion in 2001, making Mexico a leader in Latin America in terms of potential for future growth in this area.

International trade in 2002 accounted for US$873 million of e-commerce transactions and forms the largest component of the US$1.5 billion in e-commerce revenues. Business-to-business (B2B) is more prevalent than business-to-consumer (B2C) e-commerce. In 2002, B2B reached US$523 million, and B2C accounted for US$131 million. The main issues affecting B2C e-commerce include low Internet penetration, a low level of consumer purchasing power, a low penetration of credit cards, an underdeveloped market for consumer credit, and IT education and awareness.

Most signs indicate that B2B will continue to thrive as increasing resources are invested in the development of online supply chains by both the private sector and the government of Mexico. B2B is projected to reach US$1.9 billion by 2005. This growth will also result from declines in B2C transactions that are likely to occur in both the short- and medium-term. However, as the Internet penetration rate continues to grow, so will B2C in the long term.

Large companies and financial institutions are working to change their procurement processes to electronic means. An A.T. Kearney survey indicates that for this year, 27 percent of the IT investment in Mexico will be for e-business solutions, compared with 18 percent in 2002.

According to Mexico's banking association and Select, the number of registered e-banking clients rose from 700,000 in 2001 to 2.4 million in 2002. This number should reach 4.5 million by 2005. Banking operations increased from US$96 million to US$280 million over the same time period.

One the most promising developments related to Mexico's e-commerce future is the government of Mexico's commitment to making Mexico a digital economy. The development of the e-Mexico program is the most obvious manifestation of this commitment. E-Mexico's main goals are to develop Mexico's IT industry, foster an internal market for IT products, promote an adequate regulatory framework for the use of electronic media and e-commerce, and digitalize

government services in order to create a model for the private sector. The e-Mexico initiative promotes the use of information technologies in education, health, commerce, and government.

In July 2002, the Mexican government created a trust fund to begin providing points of Internet access to more than 2,000 rural communities. Leaders of e-Mexico claim that by 2025, 98 percent of Mexican citizens will be online. As of June 2003, the e-Mexico project was clearly a reality. The majority of the 3,200 digital community centers have been constructed, and a national satellite network to provide connectivity is already launched and in operation. These digital community centers have been installed in 2,429 municipalities and 16 delegations within the Federal District (Mexico City).

Another positive development in this area is the work that is being done on the e-commerce legal and regulatory framework. Both the government and the private sector have been committed to revamping laws that pertain to or affect e-commerce. In 2000, the government of Mexico began this undertaking with the passage of the e-Commerce Law. As a consequence, electronic contracts are recognized legally, information transmitted online is accepted in judicial proceedings, and consumer protection laws apply to the online world.

Last year, the Mexican government created a standard (Norma Oficial Mexicana—NOM-151-scfi-2002) on conservation of messages of data. Also, the Federal Law of Transparency and Access to Government Public Information came into effect in June 2003. This year, the Digital Signature Law was also approved.

While e-commerce legislation is gradually evolving, a number of additional laws and regulations have been proposed to make Mexico's laws related to e-commerce "interoperable" with other digital economies. Perhaps the most important is the e-invoice legislation, which will eliminate the requirement that businesses provide hard copies of invoices in electronic transactions.

Additional legislation related to consumer protection and data privacy are pending in the Mexican Congress. Many companies and financial institutions are concerned that the government's interest in passing laws related to data privacy could hinder the transformation of Mexico into a digital society. It is widely felt that B2B and B2C e-commerce in Mexico will be

advanced only to the extent to which proponents of the free flow of information and a self-regulatory approach prevail on these issues. On June 6, 2003, the Mexican Congress passed the flawed data privacy legislation, which would negatively impact Mexican, U.S., and other foreign business interests. This legislation is being monitored closely by the U.S. Government.

Table 12: Mexican Internet and E-Commerce Revenues

(In US$ Millions)	2001	2002	2003e
Internet Services Revenue	535	710	919
e-Commerce Revenue	1,094	1,527	2,201

Source: Pyramid Research
In U.S. $Millions

Table 13: Mexican Computers

	2001	2002	2003e
PC Installed Base	7.0	8.1	9.1
PC with Internet Access	3.6	4.4	5.3

Source: Select Mexico

Turkey (Turkey, 2004)

Turkey: Telecommunications Services

In 2004, full liberalization of the market will increase the size of the market. The private sector has obtained and will obtain licenses for the introduction of new telecommunications services in competition with Turk Telekom. The competition will create more business, both for the private sector and Turk Telekom.

Turk Telekom is the main fixed-line telecommunications operator with a subscriber number exceeding 19 million. The government of Turkey, in privatizing Turk Telekom, is considering the sale of some of Turk Telekom's shares as bonds, convertible to potential shares of Turk Telekom. The Turkish government will convert these bonds into shares of company stock when the market conditions are right.

Turkey has four cellular service operators, Turkcell, Telsim, Aria, and Aycell. Turkcell has approximately 15 million subscribers. Telsim's subscriber estimate was 8 million by the end of

2002. Aria has approximately 1 million subscribers. Aycell's subscriber estimate was 400,000 by the end of 2002. Turkcell and Telsim operate on 900 MHz Global System for Mobile Communications (GSM) systems. Aria and Aycell operate at 1800 MHz GSM frequency. The government of Turkey may consider issuing third-generation GSM licenses in 2004.

Best prospects for U.S. export and investment will be voice and data transmission services through fiber optic networks and voice over internet protocol (VoIP). High-speed data and leased-line services have a promising future in Turkey. More than 40 private sector companies have already obtained licenses. Additional opportunities exist for the Turkish market in international traffic, either originating or terminating in the country. Due to the widely dispersed Turkish population around the world, a large number of international calls are placed, primarily from Western Europe and the United States to Turkey.

Turkey will play an important role in providing telecommunications traffic access to Iraq. Satellites covering Turkey and Iraq can play an important role in the reconstruction of Iraq in the telecommunications services sector. Networks in Turkey can tie Iraq to the Internet world and participate in establishment of Internet backbones. Following is the market size estimates for the Turkish Telecommunications Services sector:

Table 14: Market Size Estimate for the Turkish Telecommunications Services Sector

US$ millions	2002	2003 (Estimated)	2004 (Estimated)
Total Market Size	5,200	6,000	7,000
Total Local Production	4,700	4,900	5,500
Total Exports	910	930	1,300
Total Imports	1,410	2,030	2,800
Imports from the U.S.	140	160	250

Note: The above statistics are unofficial estimates. Exchange Rate used: 1$ = TL 1,600,000

Turkey: Telecommunications Equipment

The telecommunications industry will be liberalized in 2004. The new investors will be the major equipment buyers alongside Turk Telekom, Turkcell, Telsim, Aria, and Aycell. The existing telecommunications laws specify that the telecommunications services sector will have full liberalization starting from January 1, 2004.

The private sector may make major investments on establishment of new fiber-optic networks, VoIP equipment, and wireless local loop networks. Depending on the timing of license tenders, the other best prospect can be the third-generation GSM networks. Due to the proximity of Turkey to a liberated Iraq, Turkey can be a hub-market for the telecommunications equipment needed in the Iraqi reconstruction and improvement of the existing telecom network in Iraq.

Turk Telekom, being the incumbent fixed-line operator with more than 19 million subscribers, may invest in new technologies in 2004. Turk Telekom may consider procurement of an intelligent network management center. Turk Telekom, together with Koc Holding, can be a good client if their consortium wins the Bulgarian Telekom privatization. Most probably Bulgarian Telecom networks will require further digitalization. The four GSM cellular operators, Turkcell, Telsim, Aria, and Aycell, may also further invest to improve their networks and services in 2004.

Table 15: Market Size Estimate for the Turkish Telecommunications Equipment Sector

US$ Millions	2002	2003 (Estimated)	2004 (Estimated)
Total Market Size	2,530	2,650	3,200
Total Local Production	1,110	1,150	1,250
Total Exports	320	450	500
Total Imports	1,740	1,950	2,450
Imports from the U.S.	330	370	520

Note: The above statistics are unofficial estimates based on an exchange rate of $1 = TL 1,600,000.

Turkey: Information Technology

The IT market in Turkey had been growing at an annual rate of 25–30 percent since 1997. However, due to the economic crises in 2001, this rate fell to 22 percent, with the total IT market valued at US$2.8 billion (excluding telecommunications equipment and services). The overall industry size, inclusive of telecommunications equipment and services, reached US$9.6 billion in 2002. Presently, Turkey has nearly 4 million Internet users. IT hardware is the leader in IT market sales, mainly driven by PC sales. Analysts estimated inflation in Turkey to be 48.9 percent in 2002 and that Turkey can realize a 5.3 percent actual growth rate between 2003 and

2006. Market analysts anticipate a 30.9 percent market increase as the Turkish economy continues its postcrises economic rebound.

The government of Turkey is in the final stages of the passing the E-Commerce Regulatory Law, which will enable official legal acceptance of electronic signatures as well as regulate e-commerce and tax issues. The proposed e-commerce law is based on the European model with influence from U.S. regulations.

The best prospect sub-sectors remain as follows: PC sales, data storage, digital photography, and generic printer cartridges.

Table 16 shows the market size estimate for the IT sector, excluding telecommunications equipment and services.

Table 16: Turkey's Information Technology Market

(US$ Millions)	2001	2002	2003 (estimated)	2004 (estimated)
Total Market Size	2,800	2,900	3,400	3,700
Total Local Production	260	320	340	350
Total Exports	65	72	75	79
Total Imports	2,475	2,508	2,985	3,271
Imports from the U.S.	250	278	300	320

Note: The above statistics are unofficial estimates based on an exchange rate of $1 = TL 1,600,000.

Analysis of Market Trends

The market for E&IT products is constantly changing and evolving as new product trends arise. New trends in cellular phones, ATMs, PDAs, televisions, speech-recognition technology, and distance learning are changing the way we learn, do business, store data, bank, communicate with others, and entertain ourselves. Many market forces result from the desires on the part of the E&IT industry, such as gaining a competitive advantage and complying with U.S. laws, and on the part of the consumer, such as a preference for more easy-to-use, efficient, and safe products; these forces create the demand for more accessibly designed products. New products are

consistently emerging with the aim of serving a wider population of users, including users with various disabilities, and increasing the overall ease of use for everyone. Current trends in the industries for the six product lines presented in this report are discussed below, along with the market forces that create the demand for those products. Information in this section of the report comes from many different sources, all of which are cited in the text.

Cell Phones

Scarborough Research, the nation's leader in local, regional, and national consumer information, estimates that "almost two-thirds (62 percent) of American adults own a cell phone" (McFarland, 2002). The majority of cell phones are used to make telephone calls, surf the Web, and receive messages. Cell phones are invaluable when it comes to dealing with an emergency. They have helped save people's lives, whether locating people involved in an airplane crash or calling for help when faced with a medical emergency. Many people use them for long-distance calling instead of signing up for a long-distance plan through their home telephone service provider. Cell phones give people the ability to surf the Web without a computer, take a photo and immediately send it to someone else, and receive messages, stock quotes, news, and other information anywhere, anytime.

Market Forces Creating Demand for More Accessibly Designed Cell Phones

1. The desire on the part of the E&IT industry to achieve competitive advantage and increase profits. Desire on the part of consumers to purchase the most convenient and easy-to-use cell phone. Examples of these market forces include the following innovations:

    - **Easier data entry:** The desire to enter text into a cell phone easily was a major market driver in making cell phones more accessible. Until recently, entering a single character (i.e., A-Z) into a cell phone required up to *six key presses*. For example, you would have to press the #2 key six times and then the #key to select and enter a capital C. Here is, in order, what each key press would do. First press = a, second press = A, third press = b, fourth press = B, fifth press = c, sixth press = C, and # enters the character. This consumer demand led to the development of new cell phone keypads. For example, the Fastap™ keypad is an example of a simple,

intuitive, and powerful computer interface that fits in a small mobile phone. Modern phones offer a lot more than just voice communication. Mobile phones are data devices with the ability to write messages, collect and store information, and buy things. They are essentially networked computer terminals. Alphanumeric keypads make a cell phone easier to use for people with low vision (Fastap, n.d.).

- **Voice dialing:** Voice dialing is a common feature on most digital cell phones. The technology has gone even farther. iVoice, Inc., recently released a new hands-free feature to its Speech Enabled Auto Attendant that allows an outbound caller to speak the number they wish to dial (iVoice, Inc., 2003).

- **Talking caller-ID:** Most people would like to know who is calling them before answering their cellular phone, especially if they are occupied in an eyes-busy, hands-busy environment. Lucent Technologies offers this service in support of helping wireless network operators rapidly deploy new features and generate new revenues (Cambridge Telecom Report, 2000).

- **Automatic ring mode adjustment:** A cell phone that is aware of where it is and adjusts its ring mode accordingly is being patented by IBM's research lab in Winchester, MA. The new system uses the global positioning system (GPS) technology to switch the phone's ringing modes. In "region definition" mode, the phone stores its current GPS coordinates while the owner tells it whether to ring loudly, quietly, vibrate, or divert to an answering service. This can be done separately in several locations—home, work, church, and your favorite bar, for example—so the phone knows exactly how to behave at that location. (Note: The cell phone industry is already building GPS receivers into handsets so that emergency services can locate where the caller is.)

- **Large fonts:** Samsung's SCH-T300 can display numbers in a large font (Samsung, n.d.).

- **Bluetooth communications:** Bluetooth is chip technology that comes built into products consumers use every day, like cell phones, headsets, PDAs, laptops, and

cars, and it allows devices that have Bluetooth built-in to "talk" to each other without a wire connection. If a cell phone and headset both have Bluetooth built in, the user could put the headset on and leave the phone in his or her pocket. Bluetooth can also connect a car to the driver's Bluetooth-enabled cell phone. The phone in this scenario connects to the car's audio system, and dash-installed controls take over the function of the phone. Calls are made and retrieved using voice recognition, and the user never has to even touch the actual phone (Auto Channel, 2003).

2. The desire on the part of the E&IT industry to comply with federal laws. The desire on the part of consumers to be safe, get help in case of an emergency, and maintain contact with young children, aging parents with Alzheimer's, or others at risk of wandering off. Examples of these market forces include the following advancements:

   - **Global positioning system feature:** Facing a federal requirement to provide location data to 911 dispatch centers by 2005, cell phone carriers have developed a GPS system to track wireless calls. A special chip in the phone times the signals from three satellites to calculate its position, which is relayed to the nearest 911 center (LaGeese, 2003). GPS equipped cell phones can also be used to track young children, aging parents with Alzheimer's, or others at risk of wandering off, or to find out if your children are where they say they are when you call them.

   - **Cellular phone with built-in optical projector for display of data:** A patent for a cellular phone that is compact in size and weight includes a mechanism for displaying received wireless data in its original page format, as sent from the original source. This allows for viewing each original page as a whole page, rather than as a series of partial pages. The phone also allows the display of received wireless visual data with characters in their true original size, thus allowing for ease of reading and use.

Market Forces Reducing the Accessibility of Cell Phones

1. The desire on the part of the E&IT industry to achieve competitive advantage through innovation. Desire on the part of consumers to purchase distinctive cell phones suited to a personal sense of style. Examples include the following:

    - **Miniaturization.** Many cellular phones are being designed to be more portable and less obtrusive. As a result, keypads have shrunk, making it difficult for users who are blind to tactilely identify keys. In addition, users without fine motor control skills have difficulty activating the smaller keys.

    - **Non-standard keypads.** Some stylized phones have keypads arranged in a circular pattern or other nonstandard layout. Users who are blind find if difficult to identify the keypad keys because they are not arranged in the familiar layout.

2. The desire on the part of the E&IT industry to achieve competitive advantage and increase profits. Desire on the part of consumers to purchase the most advanced, feature-rich cell phone. Following is an example:

    - **Smart phones.** There is a trend to integrate PDA functionality with cellular phones. The complexity of the user interface and the dexterity required to operate the smart phone may place the phone beyond the capabilities of some users.

ATM Machines

The classic definition of an automated teller machine (ATM) is an unattended machine, external to some banks, that dispenses money when a personal coded card is used. More than 200 million people use ATMs in the United States. Billions of transactions are processed in the United States yearly. According to Grant Thornton LLP, 350,000 ATMs are in the United States; 250,000 are in nonbank locations, and 150,000 of these ATMs are owned by nonfinancial companies (Grant Thornton, 2003).

ATMs have revolutionized the way most people do their banking. Customers can take care of financial transactions at any time of the day or night without having to go to a bank building per

se, since ATMs are readily available at supermarkets, convenience stores, shopping malls, hotels, and many other public places. ATMs are used for cash withdrawals, transferring money between accounts, looking up account balances, depositing cash and checks, purchasing money orders, obtaining credit-card advances, and purchasing stamps. Talking ATMs have enabled people who are blind to also experience the convenience of anytime banking. In the future, ATMs will be able to send person-to-person "cash" payments, cash checks, deposit cash immediately into your account, and be accessed by a cell phone or PDA.

Market Forces Creating Demand for More Accessibly Designed ATMs

1. The desire on the part of the E&IT industry to comply with U.S. and international laws. Examples of legal requirements that have prompted accessibility include the following:

   - **United States:** ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) as amended through September 2002: Section 4.34 Automated Teller Machines [4.34.5] Equipment for Persons with Vision Impairments states, "Instructions and all information for use shall be made accessible to and independently usable by persons with vision impairments" (Access Board, n.d.).

   - **United States:** Section 707 of ICC/ANSI A117.1 Standard on Accessible and Usable Buildings and Facilities is entitled, "Automatic Teller Machines (ATMs) and Fare Machines." Although the 2003 version of this document has not yet been finalized or published, following is an example of preliminary wording (in part): "Speech Output Machines shall be speech enabled. Operating instructions and orientation, visible transaction prompts, user input verification, error messages, and all displayed information for full use shall be accessible to and independently usable by individuals with vision impairments. Speech shall be delivered through a mechanism that is readily available to all users including, but not limited to, an industry standard connector or a telephone handset. Speech shall be recorded or digitized human, or synthesized" (International Code Council, n.d.).

   - **Australia:** The Australian Bankers' Association (ABA), the Human Rights and Equal Opportunity Commission (HREOC), and the Accessible E-Commerce Forum

worked with representatives from member banks, other financial institutions, community groups, suppliers and retailers, and the National Office for the Information Economy's (NOIE) Access Branch to develop a set of voluntary industry standards that aim to improve the accessibility of electronic banking (Australian Bankers' Association, n.d.).

- **United Kingdom:** UK design guidelines provide research-based information to ensure that ATMs meet the needs of all users. UK design guidelines are based on ergonomic research and testing, offering design principles and guidance for those who design, manufacture, install, and maintain ATMs. The 2002 edition reflects and builds on the experience gained from advances in the design of ATMs and the practical application of the 1999 edition (Feeney, 2003).

2. The desire on the part of the United Nations and the World Bank to reduce poverty in developing countries by helping those countries grow and prosper. The desire on the part of the E&IT industry to achieve competitive advantage and generate revenue from emerging markets. The desire on the part of consumers in developing countries to have the basic necessities of life. Examples of these market forces at work include the following:

   - **The unbanked:** ATMs can be a channel for the flow of money that is being kept "under the pillows" of billions of people living within emerging markets who do not have a bank account. About 11 million consumers in the United States do not have bank accounts (Cipherwar.com, 2000). Delton Yuen, NCR's vice-president, Financial Solutions Division, Asia-Pacific, stated, "If every household saves money in pillow cases or a cookie jar, the economic system is going to have less money to go around to fund capital investments. For countries to ensure that the economy grows, they need capital. And when the money within a country is not channeled into the financial system or banking system, that capital is circulating less and less" (McGill, 2002).

   - **Talking ATMs:** Although these devices are being developed for people who are blind, they can also accommodate people who cannot read. Four hundred and forty million people who cannot read live in the top five emerging markets.

Personal Digital Assistants

PDAs store, analyze, and retrieve needed information on demand, anytime and anywhere. They can be used as a calculator, address book, calendar, memo pad, expense tracker, and an electronic information storage device. They serve as a portable personal computer and augmentative communications device. Some of the many industries using PDAs are health care, building/construction, engineering, restaurant, and sales. PDAs are useful for dispatching crews and managing mobile personnel. While they are particularly useful in the business world, they serve as an excellent memory aid for any individual. Information can be transferred between the PDA and a personal computer, providing portable access to information. PDAs are also being used for leisure-time activities. They can provide golfers with distance measurements and scorecards. It is also possible to watch a movie on your PDA. Gartner Group predicted worldwide PDA revenue would be $3.53 billion in 2003, or approximately 10 million new units shipped worldwide (Directions Magazine, 2003a).

Market Forces Creating Demand for More Accessibly Designed PDAs

The primary force is the desire to minimize the cost of doing business. PDAs are now replacing what were once expensive, proprietary, industry-specific telecommunication devices. Another force is the desire of consumers to maximize the ease of use of PDAs in eyes-busy, hands-busy environments. Professionals using PDAs in eyes-busy, hands-busy environments are more likely to find PDAs more user-friendly and easier to use if they are equipped with voice recognition and text-to-speech technologies. Examples of improvements resulting from these market forces include the following:

- **Health care:** Wireless-equipped PDAs have been embraced by the medical community to access medical records, write electronic prescriptions, and use as a portable nursing-unit terminal. PDAs are also replacing high-cost medical devices. CardioNet developed a proprietary PDA-type electrocardiogram monitoring device connected to electrodes on a patient's chest. The PDA receives signals from the electrodes and transmits data to the PDA device (CardioNet, n.d.).

- **Public safety:** Field officers use Internet-ready PDAs to access remote records from management databases. This helps to improve the efficiency of creating incident reports. It also optimizes the transfer of queries and responses (Directions Magazine, 2003b).

- **Workforce management:** Cobb EMC is an electric cooperative serving more than 170,000 customers in five metropolitan Atlanta counties. Cobb EMC uses PDAs to dispatch crews. They claim that this has helped to streamline work processes and increase service reliability (Directions Magazine, 2003c).

- **Military:** Applications and devices developed for use by the military include the V3 Rugged PDA; industry-leading handheld capabilities; integrated Bluetooth for wireless link to phones, printers, and PCs; TFT screen with 64K colors; Windows CE-based Pocket PC with IBM ViaVoice, MS Pocket Office, and other applications (General Dynamics, n.d.).

- **Multimedia industry:** Pocket PC Films, in Sherman Oaks, California, uses PDA technology to distribute video content for Pocket PC and Palm OS devices. Film fans can buy CD-ROM titles, load them on their computer, and sync them into their handheld device. Pocket PC Films now distributes 25,000 titles. The huge potential market to use PDAs to view high-quality multimedia has led manufactures to equip them with high-quality audio capabilities. For more information, access the following Web site: http://store.yahoo.com/pocketpcfilms/xsxtremwinsp.html.

- **Assistive technology industry:** In order to reduce the cost of their products, several AT vendors are replacing their proprietary augmentative communications device hardware with PDAs. The touchscreen, text-to-speech, and voice recognition capabilities of PDAs make this possible. Two vendors in particular are pioneering this trend: Enkidu Research with their Palmtop Portable and Saltillo with their ChatPC.

- **Simplified writing interfaces:** Written Chinese has 6,000 characters. A computer keyboard has 47 character keys. Chinese data entry is so difficult that an entire

> industry of people makes their living as typists. Someone who is really good with the Chinese version of Microsoft Word, which takes the simplified "pinyin" transliteration and guesses at the character the writer means, can type maybe 20 words a minute. To improve this, PDA manufacturers have started to equip PDAs with better chips and faster algorithms. Voice interfaces are becoming so powerful that the Mandarin-PDA-based language recognizer can distinguish about 40,000 words and still not tax the memory or processing power of the PDA (Kumagai, n.d.).

Televisions

A television is technically described as a telecommunication system that receives, decodes, and displays images and plays audio of objects, stationary or moving, broadcast from a separate transmitter. Television is the medium that entertains, informs, and educates; it can also serve as a companion to people who, due to circumstances beyond their control, are limited to their homes. Traditionally, people have used TVs to get news reports and watch movies, sports events, and sitcoms. Cable TV is a telecommunication system that receives, decodes, and displays images and plays audio of objects, stationary or moving, broadcast over cable directly to the receiver. With cable TV, people have many more options of channels to watch, often devoted to a particular subject of interest, such as HGTV for the home and garden enthusiast, or news broadcasts 24 hours a day. In addition, movies can be purchased on a pay-per-view basis. Technologically advanced TV systems allow viewers to play interactive games, take a distance learning course, send instant messages, surf the Web, send an email, and shop for and purchase products, including movie tickets and CDs from talk shows and concerts.

High-definition television (HDTV) is a system that has more than the usual number of lines per frame, resulting in pictures that show more detail. Interactive television (iTV) provides richer entertainment, interaction, and more information pertaining to the shows, props, and people involved in its creation. In a sense, it combines traditional TV viewing with the interactivity enjoyed by those communicating through a network, such as the Internet. According to Disney, their iTV program, "Disney Active Portal on Sky Digital," is a major step forward. It offers Disney more flexibility and control of their interactivity in terms of design and dynamic update.

The new application empowers kids, giving them the opportunity to participate in shows while still being able to watch the action on screen.

Market Forces Creating Demand for More Accessibly Designed Televisions

1. The desire on the part of the E&IT industry to comply with U.S. laws. Examples of how these market forces resulted in enhanced products and services include the following:

    - **Emergency programming:** FCC rules require broadcasters and cable operators to make local emergency information accessible to persons who are deaf or hard of hearing and to persons who are blind or have visual disabilities. This means that emergency information must be provided both orally and in a visual format. Video programming distributors include broadcasters, cable operators, satellite television services (such as DirecTV and the Dish Network), and other multichannel video programming distributors (FCC, 1999).

    - **Captioning:** Congress first instituted the requirement that television receivers contain circuitry designed to decode and display closed captioning. As of July 1993, the FCC required that all analog television sets with screens 13 inches or larger sold in the United States contain built-in decoder circuitry that allows viewers to display closed captions. Beginning July 1, 2002, the FCC also required that digital television (DTV) receivers include closed caption display capability. As part of the Telecommunications Act of 1996, Congress instructed the FCC to require video program distributors (cable operators, broadcasters, satellite distributors, and other multichannel video programming distributors) to phase in closed captioning of their television programs. In 1997, the FCC implemented rules to provide a transition schedule for video program distributors to follow in providing more captioned programming. The rules require that distributors provide an increasing amount of captioned programming according to a set schedule. All English language programming prepared or formatted for display on analog television and first shown on or after January 1, 1998, as well as programming prepared or formatted for display on digital television that was first published or exhibited after July 1, 2002, is considered “new programming” and must be captioned according to benchmarks

set by the FCC. The following benchmarks establish how much new programming must be captioned each calendar quarter:

January 1, 2000, to December 31, 2001: 450 hours of programming per channel per quarter

January 1, 2002, to December 31, 2003: 900 hours of programming per channel per quarter

January 1, 2004, to December 31, 2005: 1,350 hours of programming per channel per quarter

January 1, 2006, and thereafter: 100 percent of all programming, with some exemptions

- **Digital television mandate:** The FCC has issued a ruling that requires DTV licensees to simulcast 50 percent of the video programming of their analog channel on their DTV channel by April 1, 2003. This requirement increases to 75 percent on April 1, 2004, and 100 percent on April 1, 2005. The simulcasting requirement was intended to ensure that consumers enjoy continuity of free, over-the-air video programming service when the analog spectrum is reclaimed at the end of the transition. With digital transmission, a TV broadcaster will be able to

  Send multiple programming at the same time over the same channel

  Improve the quality of the transmission with options not available with analog transmission

  Offer digital data services, which will allow the TV broadcaster to send out virtual newspapers and other types of services directly to your TV

2. The desire, on the part of the E&IT industry to achieve competitive advantage and generate revenue.

- **Word-search videos using the closed captions:** The need to produce "just-in-time" news stories used to cause problems for broadcasters. When a major event occurred, news programs would have to scramble around looking for some footage that supported the subject of the news story. For example, when an entertainer passes away, news programs might show a clip or two of their last interview with that individual. It used to be very time consuming to search through logs and libraries to find the appropriate footage until broadcasters gained the ability to both store digital copies of their broadcasts on computers and conduct word searches on them using the captions. Captioning their programming has enabled many news broadcasters to achieve a competitive advantage in the marketplace by being the first to announce a breaking event with the appropriate video content.

Voice Recognition

Voice recognition technology (VRT) by itself is neither accessible nor inaccessible. It is the integration of VRT into other products and services that can help to make those products and services more accessible and usable. VRT, also referred to as speech recognition technology (SRT), provides telecommunications and computing devices with the ability to recognize and carry out voice commands or take dictation. VRT is generally identified as either being speaker dependent or speaker independent. Speaker-dependent systems recognize only a particular individual's voice and are often used in dictation products. Speaker-independent systems can recognize multiple voices. Speaker-dependent systems are better able to process an individual's quirky speech patterns, but they can take a significant amount of time to train. There are also continuous versus discrete speech recognition systems, in which, respectively, the user can talk at a normal rate or is required to talk with pauses between words.

Voice recognition enhances quality of life and independence for many people. Users do not have to use their hands when operating a telecommunications device that incorporates VRT. This technology is also useful in a hands-busy environment, such as when a radiologist analyzes x-rays by holding them up to the light and verbally dictates the results to a computer. It is also helpful when operating small devices like cell phones and PDAs.

Many industries are adding VRT to their communication systems as a way to lower operational expenses by cutting the costs of call handling. In 1996, Charles Schwab became the first major consumer company to offer voice recognition for its customers to get stock quotes and other information at the customer's convenience. In addition to brokerage houses using VRT, the banking, health care, law enforcement, travel, transportation, and entertainment industries, to name just a few, are incorporating the technology.

The Market Forces Creating Demand for More Accessible and Usable VRT

1. The desire on the part of the E&IT industry to achieve competitive advantage. The desire of consumers to purchase easy-to-use and convenient products. Following is an example of an innovation resulting from these market forces:

    - **Voice Dialing:** People trying to operate a cell phone in an eyes-busy, hands-busy environment might experience difficulty. This market factor led to the incorporation of VRT into cell phones and the development of hands-free accessories for cell phones. People with upper-mobility disabilities, people with low vision, and many senior citizens can also benefit from voice dialing. Voice dialing is a common feature on most digital cell phones. PCS-Direct, an Internet-based phone store, carries nine different cell phones equipped with voice dialing (PCS-Direct, n.d.).

2. The desire on the part of the E&IT industry to reduce cost and employee turnover. The desire on the part of call-center agents to make their jobs as pleasant and nonrepetitive as possible. Examples of innovations resulting from these market forces include the following:

    - **Interactive voice response systems (IVR):** To date, companies have attempted to handle interactions with their customers using touch-tone IVR systems, but the companies have realized that their customers are not entirely satisfied with this form of interaction. Touch-tone interfaces are both frustrating and ineffective. In order to support customer interactions more quickly and efficiently, companies are beginning to move to speech recognition systems. Many call centers use systems that combine digitized speech and speech recognition. Using IVR systems costs

much less than using call-center agents. Thanks to IVR, customer requests can be handled with little human intervention. Call-center agents can then become more productive doing other things. Another benefit of IVR is that agents no longer need to repeat the same information to each caller, over and over again. This tends to increase employee satisfaction and reduce turnover. "Following this, the market is believed to be on its way to being worth $43 billion by 2007" (Telecomworldwire, 2002).

- **Web-based voice portals:** VRTs can be used to enable people to access a Web site using a telephone. Extending access to a commercial Web site to telephones can attract new customers who may not be in a position to use a computer connected to the Internet. There are many instances of this, including the following:

  People operating from within low-bandwidth infrastructures

  People who never learned to read

  Mobile professionals who need quick access to information while on the go

  Senior citizens who recognize the value the Internet but are simply more comfortable using a telephone

  People who are blind or visually impaired

  People who are traveling and don't have access to their PCs

- **VoiceXML standards:** The VoiceXML Forum is an industry organization established to promote VoiceXML as the universal standard for speech-enabled Web applications. The VXML Forum "aims to drive the market for voice and phone-enabled Internet access by promoting a standard specification for VXML, a computer language used to create Web content and services that can be accessed by phone." Following standards breeds success and enhances the compatibility and interoperability of your system with others. Systems that have been developed according to standards are easier and less expensive to maintain.

- **Dictation, voice recognition, and transcription:** Many professions require the transcription of voice-recorded data. These professions include law enforcement, medicine, and the legal profession. The financial pressures to drive transcription costs down and productivity rates up helped to fuel our $8 billion speech recognition industry.

Distance Learning

"Distance learning is used in all areas of education including pre-K through grade 12, higher education, home school education, continuing education, corporate training, military and government training, and telemedicine" (USDLA, n.d.). Students participating in distance learning can use the learning style of their choice. Audio-based classes could consist of recordings, synthesized speech, and audio-conferencing. Video-based learning includes video, videoconferencing, and Webcasting. Print-centered techniques include online text, books, and handouts. Employers also benefit when their employees participate in distance learning courses. "Travel expenses are reduced or eliminated, there is increased productivity since employees don't need to leave the office for extended periods of time, teams are brought together without restrictions on schedule or location, and it provides the ability to reach geographically dispersed populations with a uniform and consistent approach" (Thunderbird, n.d.). Also, higher education facilities are finding that distance learning is less expensive to support than traditional classroom learning.

The types of technologies for implementing distance learning include the following (Tabs, 2003, p. 11):

- Two-way video with two-way audio (two-way interactive video)
- One-way video with two-way audio
- One-way live video
- One-way prerecorded video, including prerecorded videotapes provided to students, and TV broadcast and cable transmission using prerecorded video
- Two-way audio transmission (e.g., audio/phone conferencing)

- One-way audio transmission, including radio broadcast and prerecorded audiotapes provided to students
- Internet courses using synchronous (i.e., simultaneous or "real time") computer-based instruction (e.g., interactive computer conferencing or Interactive Relay Chat)
- Internet courses using asynchronous (i.e., not simultaneous) computer-based instruction (e.g., email, listservs, and most World Wide Web-based courses)
- CD-ROM
- Multimode packages (i.e., a mix of technologies that cannot be assigned to a primary mode), and other technologies

Online education is now offered at more than 56 percent of the nation's two- and four-year colleges and universities, with distance learning beginning to extend to high schools and lower.

Market Forces Creating Demand for More Accessibly Designed Distance-Learning Technology

1. **The World Bank and its members want to reduce poverty and strengthen emerging economies:** American businesses have invested more than $250 billion in the top 15 emerging markets with the sincere belief that it will yield significant returns on their investment. Distance education is a critical success factor in human development in emerging markets. Some call it the "foundation of business success" in emerging markets. Education provides the high-level skills necessary to establish a growing, self-sustaining E&IT labor market. It can also provide the training required by engineers, doctors, teachers, nurses, business entrepreneurs, social scientists, and many other professionals critical to the success of maturing a developing economy.

   The information infrastructures supporting a majority of distance-learning activities in emerging markets are low-bandwidth environments. Many of their resources will need to operate over wireless devices. This means that the content will need to be developed in an accessible manner.

   Billions of workers live in emerging markets. They are the individuals who ultimately benefit from an effective distance-learning infrastructure. However, in the top five

emerging markets, 440 million people can't read. In order to benefit from distance learning, the materials need to be provided in alternate formats.

2. **Corporations want to educate their employees more effectively and less expensively:** Distance learning produces a 60-percent faster learning curve than traditional instruction. More than 6,000 U.S. companies offered distance-learning courses to their employees in 2003. This was up from 391 in 1998. The U.S. corporate business skills training market is projected to reach $18.3 billion by 2006 (CAGR of 13.3 percent). Worldwide, the distance-learning IT education and training market is projected to reach $28.6 billion by 2006 (CAGR of 7.1 percent).

3. **Universities want to reduce costs and increase enrollment and still offer a quality education.** Conservatively, 45 million people use online higher education. By 2025, the global demand for online education is forecasted to reach 160 million students. For every foreign student studying in the United States, three to five more students would consume U.S. education online if they had access to it (Moe, 2002).

4. **The law:** Many countries have policies relating to Web accessibility. They are Australia, Canada, Denmark, Finland, France, Germany, Hong Kong, India, Ireland, Italy, Japan, New Zealand, Portugal, Spain, the United Kingdom, and the United States of America. The European Union also has Web-access policies. Distance learning usually takes place via the Web (Web Accessibility Initiative, n.d.). Several countries have detailed policies that specifically apply to education as described here:

   - Australia has a Disability Discrimination Act (1992) that applies to education.
   - Canada's Charter of Rights and Freedoms guarantees the basic rights and freedoms important to Canada as a free and democratic society. The Canadian government has also established a Common Look and Feel for Canadian government Web sites, which includes accessibility provisions.
   - The UK's Special Educational Needs and Disability Act took effect on September 1, 2002. The Act removes the previous exemption of education from the Disability

Discrimination Act (1995), ensuring that discrimination against students with disabilities will be unlawful. Institutions incurred additional responsibilities in 2003, with the final sections of legislation coming into effect in 2005.

The following U.S. policies make accessibility a requirement for distance learning.

- ADA and Section 504: Two federal laws govern accessibility of education—Title II of ADA and Section 504 of the Rehabilitation Act of 1973 (as amended in 1998). All elementary, secondary, and postsecondary educational institutions are regulated under these laws. A useful legal analysis of these requirements is provided in the California Community Colleges' Distance Education Access Guidelines (California Community College, 1999).

- Section 508: In order to ensure that its technology is accessible to its own employees and to the public, the Federal Government has created regulations based on Section 508 of the Rehabilitation Act that require that E&IT developed, procured, maintained, or used by the Federal Government be accessible to people with disabilities. These regulations apply to all federal purchases of technology. Requirements in Section 508 may also impact state colleges and universities, pending policy decisions from the Department of Education's Office of Civil Rights.

- California higher education requirements: The California Community College system has released Distance Education Access Guidelines and Alternate Media Access Guidelines. The Alternate Media Access Guidelines serve as a guide for the implementation of California Law AB422, requiring publishers to provide textbooks in electronic format to the three systems of higher education in California (the University of California, the California State University, and the California Community Colleges). The Distance Education Access Guidelines include a summary of legal requirements as well as access guidelines for specific modes of distance education instructional delivery. These documents and other resources are available from the High Tech Center Training Unit of the California Community Colleges.

- Texas K–12 textbook adoptions: Texas has for several years been studying the issue of access to electronic books and educational software for students with disabilities. Two reports, one issued in 1997 and one in 1999, provide information on how educational materials can be made accessible. Texas requires publishers to provide electronic files for adopted print materials and is in the process of incorporating the federal Section 508 requirements as an optional part of their adoption process for interactive educational software and electronic textbooks. Further information about Texas textbook accessibility is available from the Texas School for the Blind and Visually Impaired.

III. Industry Study

The purpose of the industry study was to document universal design practices within industries represented by the six product lines selected for study. Six different companies, representing each of the six product lines, were selected as industry partners. Selection of industry partners was primarily based on their leadership in the marketplace and ability to deliver candid representations of their experiences with UD. During data collection, every effort was extended to foster an environment in which companies would be able to deliver documentation of actual processes and experiences.

Each company was individually approached by Georgia Tech and asked to participate in the research program. Nondisclosure agreements (NDAs) were signed in order to ensure the companies that Georgia Tech would protect any proprietary data disclosed during the course of the study, as well as to foster a general environment of open and frank discussions. Full disclosure was critical to the success of the industry study because it was important that actual experiences be documented as opposed to ideal situations or marketing hype. The NDA restricts Georgia Tech from releasing any proprietary information belonging to the industry partners. Therefore, it is not the intent of this study to provide detailed descriptions of experiences recorded as part of the research. This section documents the general experiences of companies that are representative of the six product lines selected for analysis and provides a basis for identifying candidate interventions or approaches for the promotion of UD.

As part of the industry study, we investigated the presence of barriers and facilitators to accessible design. When an industry partner indicated experiences with a particular barrier, key personnel were interviewed to determine the policies and procedures that were used to overcome the barrier. Prior to interviewing the industry partners, a candidate list of facilitator and barriers was identified.

Analysis of Facilitators and Barriers to Accessible Design

Source materials, generated as part of the Information Technology Technical Assistance and Training Center (ITTATC), were reviewed in order to identify potential facilitators to accessible design. Facilitators are defined as concepts, procedures, or actions that may be employed by

industry that might result in the development of accessible technologies. We read the needs assessment literature review, a survey of ITTATC National Advisory Committee participants, and a survey of accessibility visionaries in order to create the initial list of facilitators. The list was supplemented by our experience consulting with industry and our preliminary findings from the ITTATC case studies project.

Facilitators

The list of facilitators is divided into five categories: design, organizational, informational, financial, and legal facilitators. Design facilitators are methods or tools that may be implemented in the design process and result in achieving a more accessible design. Organizational facilitators include augmentations to communications and infrastructure that may enhance the effectiveness of an accessibility program within a company. Informational facilitators address the lack of knowledge in accessible design and the continuation of common misperceptions. Financial facilitators include items that make accessibility appear to be fiscally attractive. Finally, legal facilitators include legal positions that make accessibility easier to achieve.

Design Facilitators

- Integrate accessibility into engineering processes. Often, product accessibility may be improved by integrating the consideration of the product's accessibility as a formal step in the engineering design process. The most desirable outcome is usually observed when accessibility is addressed very early in the design process.
- Develop standardized mechanisms for connecting assistive technologies. A common complaint from industry is that it is difficult to ensure that their products successfully interface with AT because not enough is known about the detailed interface requirements of the variety of AT products on the market.
- Make technological advancements for handling adaptive devices and flexible design. For example, develop smaller components for connecting assistive devices so that products can be smaller and lighter.
- Develop innovative strategies to promote awareness and understanding of UD issues. For example, a company could sponsor a design challenge contest to address a specific

accessibility concern or award bonuses to those who significantly contribute to the design of a more accessible product.

- Share ideas, concepts, and research with other organizations, including encouraging peer-reviewed research. Two possible means to accomplish this are hosting a conference or creating a journal of accessible design.
- Develop awareness of competing companies' efforts in accessible design.
- Develop accessible design standards and guidelines.
- Develop a tool to help individuals understand their role in universal design.
- Provide training for understanding accessible design, including demonstrations of why a particular approach may not work for an individual with a particular limitation. This will assist the designers in adjusting their approach to thinking about accessible design and to developing accessibility in the early phases.
- Fund the acquisition of ergonomic and human performance data of people with disabilities.
- Develop methods for measuring accessibility and comparing the accessibility of two similar products. One approach to address these issues would be to start and/or participate in a working group to develop standardized measurement methods.
- Develop a working group to formulate a clear definition of design goals related to accessibility.
- Promote the benefits of UD. Accessible design is likely to benefit a much larger population than the target group.
- Perform accessibility evaluations on new and existing products and services.
- Include elderly individuals and individuals with disabilities in the design process. Get input from them early and recruit them to participate in evaluations. This can be done through prototype and product testing, focus groups, direct contact with the designers, discussion forums, or other mechanisms.
- Test for product compatibility with assistive technologies.
- Hire product designers with disabilities or with experience in creating universally designed products.
- Hire support personnel with disabilities to work directly with designers.

- Designate an accessibility coordinator to monitor accessibility issues and become familiar with related standards and guidelines.
- Provide concrete design examples of universally designed products.

Organizational Facilitators

- Share accessibility information companywide and make it part of the culture. Ensure that all departments have the same understanding of accessibility requirements.
- Educate the company on the tangential benefits of accessible design. While most recognize that increased accessibility will result in an increase in the user base, some do not realize the benefit of UD for the existing user base.
- Increase diversity in the workforce.
- Develop brown-bag and discussion groups regarding accessibility efforts so that upper management has the opportunity to learn about and factor this information into corporate decisions.
- Ensure that the personnel responsible for making marketing, product development, and design decisions are educated about accessibility and accessible design.
- Educate middle management that accessible design can be made part of the design process, and it will not burden schedule and budget requirements.
- Recognize accessibility as a necessity for the general population, rather than as an exception.
- Incorporate accessibility standards into quality assurance programs.

Informational Facilitators

- Educate employees that people with disabilities have the same wants and needs as people without disabilities (e.g., communication, bill paying, travel, etc.). Remind them that the general population suffers from a number of temporary disabilities as well as disabilities that are related to aging.
- Recognize that relatively small changes can have a large impact on accessibility. Something as simple as reducing the force required to press a button can greatly increase the usability of a product for all potential users (without taking away from design creativity).

- Provide accessibility training for managers, designers, sales representatives, customer service personnel, and any other groups that may benefit from the knowledge.
- Advertise accessibility features of products, and emphasize the benefits to everyone.
- Gather as much information about accessibility and disabilities as possible. Survey employees, canvas disability groups for information, hold community meetings to get direct input from people familiar with disabilities, and provide a Web link and/or phone number dedicated to obtaining feedback on product accessibility.
- Form partnerships/relationships with organizations devoted to promoting accessibility.
- Provide information to consumers about their rights under Section 508 and Section 255 and the company's efforts to comply with those regulations. Complete voluntary product accessibility templates (VPATs) for products so that consumers can make informed decisions.
- Purchase assistive technologies for designers to work with, and train them to use the devices properly.
- Increase exposure of engineers and designers to accessible design. Train them when they're hired, develop a short course that can be made available through local universities, or encourage someone in the company to teach at local universities to increase exposure at the university level.
- Seek employees who have a background in UD.
- Ask employees—particularly those with temporary or permanent disabilities—to comment on the usability of products that they use and to provide design suggestions. Establish a mechanism for employees to provide feedback, and possibly develop a discussion forum from which additional informal feedback can be acquired. Use the people already in the company, as many of them may have experiences with others who have limitations.

Financial Facilitators

- Recognize accessibility as a product enhancement, not as a cost-prohibitive retrofit.
- Market products with accessible features to a large population, not just the target market for which they are believed to be appropriate.
- Use employees to reduce costs associated with funding research in accessible design.

- Include accessible design as a regular part of the design process, rather than as a feature that needs to be addressed separately at added cost.
- Factor accessibility upgrades into the cost of other important upgrades.
- Study the cost of not designing accessible products. For example, revenue may be lost because of the inability to effectively market to a federal customer.

Legal Facilitators

- Demonstrate efforts to comply with Section 508. Create VPATs.
- Review consumer complaints received by legislators and industry.
- Designate an accessibility expert to monitor government regulations.
- Pressure the government for more detailed requirements that industry must meet or guidelines for satisfying the regulations.

Barriers

The process used to identify candidate barriers was similar to the process used to identify candidate facilitators. Source materials, generated as part of ITTATC, were reviewed in order to identify potential barriers to accessible design. Barriers are defined as potential roadblocks to a successful accessibility program. We read the needs assessment literature review, a survey of ITTATC National Advisory Committee participants, and a survey of accessibility visionaries in order to create the initial list of barriers. The list was supplemented by our experience consulting with industry and our preliminary findings from the ITTATC case studies project.

Similar to the list of facilitators, the list of barriers is divided into five categories: design, organizational, informational, financial, and legal barriers. Design barriers are obstacles in the design process that may result in difficulty in achieving an accessible design. Organizational barriers include impediments to communications and infrastructure that may serve to limit the effectiveness of an accessibility program within a company. Informational barriers have to do with the lack of knowledge in accessible design and the continuation of common misperceptions. Financial barriers include items that make accessibility appear to be fiscally unattractive. Finally, legal barriers include items that make accessibility difficult to implement because of litigation concerns.

Some of the barriers are merely *perceived* barriers, due to a lack of knowledge of or insufficient experience in accessibility. Other barriers represent more significant challenges to the accessibility community in general.

Design Barriers

- Marketing and technology trends sometimes run counter to accessibility requirements. For example, the cell phone industry has followed a trend of miniaturization that has resulted in the creation of a smaller keypad, which is difficult for individuals with some types of upper-mobility impairments to use. Furthermore, the font size used for the labels on these keypads has been reduced as well.
- There is a general lack of peer-reviewed research in accessible design. Many human factors professions complain of the lack of human performance research to support design in general. Even fewer studies focus on human performance issues for people with disabilities. In addition, there is little information about standard practices and methods of accessible design in the open literature. Designers simply do not have access to information they need to create accessible products.
- There is a lack of realistic standard guidelines and principles of accessible design.
- Designers lack an understanding of accessible design and what can be achieved if products are designed with accessibility in mind from the beginning. Very few products that represent successful exercises in accessible design are commercially available.
- Designers do not have access to information about people with disabilities in a format usable to them. Designers often require human performance and ergonomic data in an easy-to-use format to support design decisions. Unfortunately, human performance and ergonomic data for special populations, including people with disabilities, are not a part of the standard data sets. Designers must consult outside sources and attempt to compile the necessary data from a wide variety of technical reports and published articles. The compilation of this data is extremely time consuming and is often unfeasible.
- A standard accessible design process has not been documented, tested, or verified.
- Implementation of multiple methods of display and control may make it difficult to create a streamlined user interface. Many feel that the addition of accessibility features creates an unwieldy user interface.

- There is no standardized method of measuring accessibility or comparing the accessibility of two similar products. Designers do not have a way of determining if their designs have met their accessibility goals.
- Many feel that there is no clear definition of how accessible a product has to be in order to be considered an accessible design.
- Many designers equate accessible design with designing products for the lowest common denominator.
- Individuals with disabilities are not integrated into the design or evaluation process.
- There is a lack of tools and resources useful for efficiently creating accessible products.

Organizational Barriers

- Often, there is a lack of communication across departments about accessibility requirements. A few pockets of accessibility awareness seem to exist within many companies, but there is a lack of structure integrating a comprehensive accessibility program.
- Many companies lack accessibility champions who are in a position to influence company decisions. In many cases, personnel responsible for a company's accessibility efforts come from human factors, usability, or disability support groups. In general, these groups do not have a large amount of input in corporate decisions.
- Often personnel responsible for making accessibility decisions have little knowledge about accessibility or accessible design.
- Middle management often perceives accessible design to be in direct conflict with schedule and budget requirements.
- Accessibility is often a minor concern when compared with other corporate issues, especially in today's economy.
- There is a lack of infrastructure to support accessible design.

Informational Barriers

- Some view people with disabilities as not having the same wants and needs as people without disabilities.

- Sometimes designers fail to consider the possibility that someone with a disability would attempt to use the products they design.
- Sometimes accessibility features are poorly communicated to the consumers who require the features.
- For the most part, specific information about accessibility and disabilities is not easy to obtain.
- Companies often do not know how to market to people with disabilities.
- Consumers are not familiar with their rights under Section 508 and Section 255.
- Some designers do not have sufficient access to assistive technology interface requirements.
- Engineers and designers are not sufficiently exposed to accessible design at the university level.
- Accessibility is often interpreted narrowly to only include physical access to the technology.

Financial Barriers

- The cost of developing new technologies associated with accessibility is often seen as prohibitive.
- The target market for accessible design is not well understood or defined.
- There is a general lack of sources of funding for research in accessible design.
- Some people feel that the business case for accessibility is weak.
- It is difficult for companies to market to consumers with disabilities.
- The cost associated with retrofitting existing products is significant.
- The cost associated with purchasing accessible products is not affordable by people with disabilities.
- The technology required to produce accessible products is not available at a reasonable cost.

Legal Barriers

- Some companies feel that they are under pressure to self-certify compliance with Section 508 in order to compete.

- Some feel that federal regulation does not go far enough in detailing the requirements that industry must meet. Others feel that the regulations unnecessarily restrict creative design and innovation.
- Exploration of the federal requirements through litigation is both time consuming and costly.
- Some companies believe their competition is incorrectly representing their product's accessibility.
- Procurement officials do not understand accessibility requirements to a sufficient degree. Officials may not be able to recognize when an accessibility claim is false.
- Section 508 is either not being adhered to or is being adhered to inconsistently.

Industry Study Data Collection Methodology

Six companies or industry partners were selected for participation in the study. Once the companies were identified and the points of contact (POCs) established, each was given a list of topics related to accessibility in the company. Georgia Tech requested initial reactions during preliminary phone interviews and then conducted onsite visits and in-person interviews with various individuals involved in the accessibility program. Some industry partners chose to provide detailed documentation and formal responses to our initial inquiries before the interviews. The purpose of the in-person interview was to obtain additional information and documentation to enhance the initial responses provided on the topics of interest.

The data collected were based on a series of topics related to accessibility in each company. The type and format of data requested in response to each of the 10 topic areas is listed below:

1. Documentation of current design practices, with emphasis on user interface design and other aspects of products related to accessibility and UD.

2. Documentation of current product evaluation practices, with emphasis on accessibility and UD.

3. Key personnel who make decisions about product design, product selection, and/or marketing related to accessibility and UD.

4. Current products (fielded or in development) with specific accessibility features or other direct relationship to accessibility.

5. Lessons learned in developing accessible products. Focus on: organizational barriers encountered, technical challenges, financial barriers, informational barriers, and legal challenges.

6. Company forecasts of demand and requirements for products with accessibility features.

7. Company training materials related to accessibility and UD.

8. Company-funded research into accessibility and UD.

9. Company contact with members of the disability community relevant to product accessibility and usability by individuals with disabilities.

10. Company position on product accessibility and UD.

Georgia Tech scheduled an initial meeting with the company POC, during which time the industry study objectives and data requirements were reviewed in detail. Any readily available information was collected, and the company POC was charged with identifying sources for archival data and arranging personal interviews with individuals qualified to supply the required information. The data analyzed in this summary is based on materials provided directly from the company, notes from the in-person meeting, and publicly available materials.

Analysis of Industry Data: Factors Influencing Adoption of UD Practices

As defined by Tobias and Vanderheiden (1998), the primary factors that influence the adoption of UD principles are government regulation (or the threat of regulation) and profitability. The purpose of the industry study was to build upon previous work and understand how the perception of profitability impacts UD.

Eleven business concerns have been identified as having an influence on UD practices within an organization. Each business concern has a different level of influence, depending on the strength of the other factors. The factors influencing the adoption of UD practices include the business case, strategy and policy, demand and legislation, marketing and sales, research, design, testing, resource allocation and funding, organization and staff, training, and the customer and consideration of people with disabilities. Detailed descriptions of the impact of each business concern on UD are described below.

Business Case

The business case is the financial justification and plan for including accessibility in product design. Central to consideration of the adoption of UD principles for all six industry partners was the identification of a compelling business case to justify committing the required resources to the effort. Someone at a company wishing to add accessibility features to an existing product or to add schedule and budget to accommodate building accessibility into the design of a new product is often required to justify the added expense by producing either a formal or informal business case for accessibility.

Several methods might be used to construct a business case. Each method relies on the interpretation of market forecasts and sales data and is, therefore, somewhat subjective. For example, a senior manager might look at federal sales data and determine that the number of sales at risk because of the production of inaccessible products is negligible; therefore, it produces a very weak business case for accessibility. A second senior manager might look at the same data and see great potential for increasing the market share of federal sales by enhancing accessibility; therefore, he or she might determine that the business case for accessibility is strong.

The industry study identified the following primary justifications for the business case for UD:

- Increase market share to include people with disabilities
- Increase federal sales market share
- Reduce risk of losing market share
- Increase overall usability of the product or service
- Reduce risk of costly legal action
- Increase status as a corporate citizen

While increasing market share in general is traditionally regarded as a strong justification for a business case, the potential to increase market share by extending the market focus to cover people with disabilities is often seen as a relatively weak business case, primarily for two reasons. First, the market for people with disabilities is highly segmented. The cost associated with developing a product for users with various disabilities and levels of functional capabilities is not justified by the potential of direct sales to people with disabilities. Second, the amount of disposable income available to people with disabilities is not perceived to be great. The additional cost associated with producing accessible products cannot be passed along directly to consumers with disabilities.

Companies do not appear to fully appreciate the potential value of extending their market share to nontraditional markets through UD. UD is generally associated with design for inclusion of people with disabilities. The market analysis documented elsewhere in this report illustrates that this view of the market for UD products is unnecessarily restrictive. Companies representing the six product lines selected for analysis have failed to embrace the extended market perspective for UD products.

The introduction of Section 508 of the Rehabilitation Act, which requires federal agencies to consider accessibility in the procurement of most products and services, should have had a direct impact on the calculation of the market size of UD products. Sales to the Federal Government represent a significant portion of sales for many companies producing E&IT products and related services. Based on the face value of Section 508, businesses wishing to increase federal sales might do so by developing a more accessible product than the competition and using

accessibility as a key discriminator on competitive bids. However, many of the industry partners failed to recognize the potential increase in federal sales as a strong business case, perhaps because of the perception that procurement officials are not consistent in enforcing Section 508.

Possibly more compelling than the potential increase in federal sales is the threat of loss of Federal Government market share to a competitor. A company that enjoys a large share of the federal market potentially could lose market share if a competitor creates an accessible product that federal procurement officials choose over the traditional supplier in an effort to conform to the requirements of Section 508. In reality, none of the companies participating in the industry study were aware of any lost sales that could be attributed directly to a procurement official's attempt to conform to the requirements of Section 508.

Business cases are sometimes generated in response to less tangible benefits and threats that are not directly related to a company's market position. For example, one of the companies in the industry study referred to corporate citizenship as a justification for research into accessibility and UD. Another company perceived accessibility as clearly being related to usability, which had been identified as a key market discriminator. Finally, one company mentioned a concern about avoiding future legal actions as a motivator for accessibility.

Strategy/Policy

Strategy is the high-level plan for UD or the implementation of accessible design features. A policy is a written statement that is a reflection of corporate strategy. Most industry partners had an informal or formal policy statement approved by senior management; however, they differed widely in their content and implementation. External policy statements tended to be used primarily for marketing and had little overall impact on processes and procedures. When an internal policy statement was drafted and issued to employees, it usually had the effect of temporarily increasing awareness of accessibility; but a sustained, corporatewide commitment is rare without the dedication of resources. Internal policy statements that lack an associated commitment of resources are rarely enforced.

An effective policy must reach the level of a corporate instruction or directive and must address inclusion of people with disabilities in design and evaluation of products, increased training, incorporation of documented standards and guidelines, increased research and development, increased marketing of accessibility features and efforts, and lowered costs for products with accessibility features. The policy must also be associated with an implementation plan and a commitment of needed resources.

Corporate culture had a strong influence on accessibility. In two of the six companies in the industry study, employees reported that the corporate culture was such that accessibility was just expected to be considered when making design decisions. A strong corporate culture was generally associated with a strong customer voice requiring that accessibility be considered. Accessibility will be considered, independent of policy, if the customer demand is great. Policy tended to be more entrenched in corporate culture if someone from senior management experienced a disability or had a close relationship with someone with a disability.

Resource Allocation/Funding

Resource allocation and funding was the single most frequently identified reason for the failure of accessibility policy. Four of the six companies had money earmarked for staffing accessibility program offices; however, the program offices were often underfunded and did not have sufficient resources to effect change within the corporation. In some cases, the accessibility program office consisted of only one or two individuals who served as the focal point for accessibility concerns throughout the company. Only one company earmarked money specifically for accessibility research. Outreach to employees was also severely limited. The accessibility program offices often developed plans for implementing universal or accessible design but lacked funding to appropriately implement the plan.

At least one company that decided to commit to accessibility and establish an accessibility program office was reevaluating the commitment of resources because of an inability to demonstrate return on investment (ROI). The company sighted a lack of impact of accessibility features on federal procurement decisions as the primary motivator for reconsidering its

commitment to accessibility. Companies spending less money on accessibility were not perceived to suffer decreased sales as a result of Section 508 procurement regulations.

Organization/Staff

Several methods of staffing for accessibility issues were observed. The most common staffing organization, utilized by four out of the six companies, involved the development of an accessibility program office responsible for UD and accessibility issues throughout the corporation. The size of the accessibility program offices varied from a single member to a staff of five or six with a background in accessibility issues. In other cases, responsibility for accessibility was integrated into existing groups, such as marketing or human factors.

Two staffing trends were noticed. First, the presence of a single accessibility champion or a small number of accessibility champions was very common among the industry partners. The success of the accessibility program within a company that must rely on the work of a very small number of accessibility champions was directly related to the workload or attrition of the champions. Loss of an accessibility champion could result in a major setback of accessibility objectives. Second, the accessibility program office may become a place to assign nonproductive personnel. While the majority of accessibility program offices are staffed by competent individuals capable of advancing UD principles if given adequate resources, some companies have assigned accessibility to individuals who are either transitioning between departments or are experiencing difficulty marketing themselves within the company.

The missions of the accessibility program offices also varied widely. In some cases, the program offices were mostly reactive, responding to requests for information or to solve particular accessibility concerns. In other cases, the accessibility program offices were very proactive and focused on developing and testing new technologies that might be integrated into future products. In reality, a balanced approach is required. The group charged with accessibility should be able to respond to the immediate needs of the corporation as well as contribute to future planning and development of universally designed products.

Unfortunately, the accessibility program office in the four companies that had program offices demonstrated very little control over design decisions that directly impacted the accessibility of the final product. The accessibility program office should be constructed to include groups or individuals who have decision-making responsibilities to influence accessibility within the products. This may include a human factors or accessibility group, or even an oversight group that can serve as a resource for other groups within the company. It also helps for accessibility awareness to be widespread throughout the company. One method of accomplishing this is to have staff in each group or available to each group who have more extensive training and who can advocate for inclusion of accessibility features.

Another staffing mechanism for enhancing accessibility practices within the company is to hire people with various disabilities and ensure that they are involved with design and evaluation of products. However, this mechanism can be used inappropriately. For example, it would be inappropriate to send a new product to a single employee with a disability and ask the employee to quickly review the product rather than conducting more extensive product testing. This approach is especially problematic if the employee has other responsibilities, has little experience with product evaluations, and is not prepared to comment on the accessibility of the product beyond his or her own personal experiences.

Training/Awareness

Some corporate accessibility training was offered to employees; however, training relating to UD and accessibility is not widespread. The most common type of training was aimed at increasing employee awareness of Section 508, accessibility policy, people with disabilities, and the specific accessibility issues associated with the products that the company produces. An important function of several accessibility program offices was to provide targeted training to key decision makers as needed. The targeted training was largely informal and usually conducted on a rather limited basis. The training offered is generally focused on program managers and design teams. Very little training is offered to sales or marketing teams.

Typically, accessibility awareness is made available on an as-needed basis and is specific to a project. In some cases, a brief introduction is provided to all employees regarding the importance

of UD, but sometimes it is simply awareness through diversity training. Training materials may include an overview of the range of disabilities (including situational disabilities), assistive technologies, principles of UD, minimal design requirements, business and consumer arguments for addressing accessibility, consequences of not addressing accessibility, a review of accessibility features, legal requirements, and barriers and lessons learned.

Staff training is one of the best mechanisms for getting accessibility included in product design. Oftentimes accessibility is overlooked because of a lack of awareness of the issues. People do not realize how inaccessible products can be to individuals with disabilities, and they do not understand how much an individual's life can be improved with the availability of more accessible products. Training can greatly impact accessibility practices through increasing awareness of disability issues, increasing awareness of standards and guidelines, and providing tools (processes and checklists, for example) to facilitate accessibility implementation.

Companies should be aware of hidden messages within corporate training. For example, if a company emphasizes Section 508 conformance over accessibility in general, employees may come to view UD and accessibility as a federal sales issue. Designers may choose to ignore accessibility requirements if they know that their product is not likely to be marketed to the Federal Government.

To be effective, training should be tailored for the decision makers who routinely impact accessibility in the corporation. Technical staff might like to consider the needs of people with disabilities, but they are junior staff members who do not have the power to implement major design decisions. Technical staff training is effective if concrete design examples and information about integrating UD guidelines into the design process are offered. However, changes to the design process are often resisted by middle managers, who argue that extra development time would be required, that money must be expended, or that these changes are not relevant to the target market. The key decision makers are the key product team members and the personnel who are responsible for defining the products' functional requirements.

One successful method of providing UD and accessibility awareness training is to incorporate basic constructs into employee induction training. Other successful training methods include

alternate delivery methods, such as a video on the importance of UD and the impact of inaccessibility on the lives of people with disabilities. Computer-based training materials have also been used to increase general awareness of accessibility issues.

Research

With one notable exception, the accessibility program offices of the four companies participating in the industry study were not directly linked with corporate research. One company was able to successfully integrate personnel with research experience into the accessibility program office. This integration allowed the program office to offer design solutions to the accessibility problems that it identified through testing. However, most accessibility program offices were not in a position to influence research priorities or review research before it was integrated into a product development cycle.

Several companies successfully employed external consultants to assist with UD or accessibility research. However, externally funded research tended to be more exploratory in nature and less focused on design-oriented solutions.

Research into accessibility issues is dependent on available funding. Much design work is dependent on research into the best way to implement accessibility features, compatibility with assistive technologies, and development of emerging technologies. Advanced and ongoing research can influence accessibility implementation through identification of features that are useful for the disability community, cost effective, and appealing to a wide population.

Design

In many cases, accessibility processes are in place for both design and quality assurance, including user-centered design, but are either not documented or not followed consistently. Accessibility requirements are not well integrated into existing design processes. For those companies that do include accessibility requirements in the design process, the requirements are typically tailored to the specific product line or range of product lines produced by the company.

Design decisions are made by a range of personnel. Industrial designers or a design management team typically handles display and control layout. Product managers or core team members detail the design and ensure manufacturability. Design decisions are also made at the engineering level. Typically, decisions about trade-offs are made at an upper management level. Decisions about product requirements are typically handled at the marketing level. Accessibility champions can have some influence over the design, independent of the above-mentioned roles.

All six companies participating in the industry study adopted some variant of a product development or life cycle design process. However, each company varied in the extent to which engineering process manuals were followed. Smaller projects and internal research and development projects tended to operate outside of the formally defined development process. None of the companies reported immediate changes to the development process in response to Section 508. Rather, UD and accessibility requirements have slowly been integrated into the development process, mainly in response to efforts from members of the companies' internal accessibility program offices. Three of the six companies reported that accessibility was addressed in its formal engineering product manuals. However, two of those three companies reported that their formal engineering process simply required that accessibility be considered at some point in the design process. In general, detailed requirements or checklists relating to accessibility were not found in formal design documents.

The product life cycle design process is designed to manage the product from its inception through its retirement and eventual cessation of support. Although different companies have different names for their individual design processes, the processes all generally follow these steps:

- Product planning
- Requirements definition
- Product specification
- Development
- Verification and testing
- Manufacturing
- End-of-life management

In order for UD principles to be incorporated into the final product, the principles must be considered at the very beginning of design. Accessibility simply must be considered during product planning. Companies that relied solely on accessibility testing after product development were unable to have a substantial impact on the overall accessibility of the product. Product planners must decide very early on whether accessibility will be considered in the design of the product and to what extent the product will meet or exceed accessibility technical guidelines. Companies that failed to consider accessibility early in product development often failed to have a significant impact on the accessibility of the final design.

In the requirements definition phase, it is important to define objectively testable requirements for accessibility. It is not sufficient to require that the product be accessible because doing so provides little information to designers and prevents accessibility verification testing. Vague accessibility requirements are more likely to be ignored in both the development and the verification and testing phases of design. Proper accessibility requirements should be defined in the form of the incorporation of relevant Section 508 technical requirements or specific functional performance requirements. For example, the requirements document could incorporate specific paragraphs from Section 508 technical requirements that apply to the specific product under development, or it could require that specific user tasks must be able to be performed by a given population of users with specified functional capabilities and limitations.

During the product-specification phase, the functionality and appearance of the product is defined in accordance with the definition of product requirements. Personnel with expertise in UD must be available to assist in defining the specifications, reviewing the product specifications that impact accessibility, and determining if the accessibility-related product requirements are met by the product specification. Major changes to the product design are unlikely after the product specification has been produced, so it is critical that accessibility be considered before moving on to the design phase.

During development, the design is conceptualized, produced, and prototyped. Typically, a project leader will arrange a multidisciplinary team that might involve members of engineering, computer science, industrial design, human factors, quality assurance, and marketing. At least one member of the development team should have an understanding of the accessibility issues

related to the product under development. Iterative testing and development are important during this phase.

Testing

Companies participating in the industry study routinely performed usability testing, but they rarely included users with disabilities in usability testing and rarely conducted user testing for accessibility. Accessibility evaluations are different from standard usability evaluations in at least three ways. First, accessibility evaluations measure the degree to which a specific impairment restricts the operation of a device. In addition to measuring how effective a device is, usability evaluations also tend to measure customer satisfaction and efficiency. While satisfaction and efficiency data may be collected during an accessibility evaluation, this type of data is not the primary focus. A device may have usability issues and still remain accessible, as long as usability problems of the device do not disproportionably affect the ability of a user with an impairment to accomplish a given task. Second, accessibility evaluations are, in general, performance based rather than subjective. The focus of an accessibility evaluation is generally on measuring functional performance. Finally, the primary motivation for performing an accessibility evaluation is compliance with government regulations. While technical standards and guidelines for usability certainly exist, few legal requirements must be met in order for a device to be considered usable.

Federal procurement officers, in an attempt to comply with Section 508, routinely request information about the accessibility of a product prior to a purchase. All of the companies that participated in the industry study reported some level of UD or accessibility testing. However, the depth and breadth of the testing varied widely. Most testing was performed in order to fill out a voluntary product accessibility template. One company's engineering process required that a VPAT be constructed prior to launching the product. Although it is unlikely that an unfavorable evaluation would delay product launch, requiring the VPAT prior to product launch does force the design team to consider accessibility. VPATs are often requested by federal procurement officers as part of their required market research. Two of the six companies performed quality assurance or requirements-verification testing as part of the normal design process.

Testing was generally restricted to an inspection for conformance with the technical requirements of Section 508. Notably, the functional performance requirements of Section 508 were often overlooked. The functional performance requirements are perceived as being difficult to test. The most effective method of testing the functional performance requirements of Section 508 involves user-in-the-loop testing with representative members of the disability community. Use of a task-based approach is critical to accurately measuring accessibility and directly comparing the accessibility of more than one similar product. None of the industry partners routinely performed user testing for the purpose of measuring conformance with the functional performance requirements of Section 508.

The industry partners were split regarding a preference for internal or independent, third-party testing. Three companies preferred to keep testing in-house, and three companies preferred to contract an independent lab to perform testing.

As with any kind of testing, accessibility evaluations are more effective if they are conducted in conjunction with an iterative design process. Testing can have the greatest impact on accessibility if people with disabilities are included in the evaluation process and have the opportunity to do early testing to facilitate design changes.

Demand/Legislation

Demand is impacted by consumer need and interest as well as legislation requiring accessibility. Demand can influence the presence of UD features in three ways. First, consumers may voice their interest in products with accessibility features. If customer demand is great enough, companies are likely to address accessibility issues. Second, some companies primarily market to other companies. For example, cell phone manufacturers market their products to cellular network providers. The purchaser, the cellular network provider in this example, is in a strong position to pass along requirements for UD to the manufacturer. Finally, if enforceable legislation requires the government to purchase accessible products or requires a minimal level of accessibility, industry will not be able to ignore the need to incorporate accessibility features into their products.

However, legislation has not been effective in increasing demand for accessible products. Many problems stem from conflicting requirements. Local and global requirements may differ. The business customer's requirements may differ from other requirements that support accessibility for the end-user. In addition, the regulations do not change as quickly as technology does, limiting the development of enhanced capabilities. Not all consumers have the latest version or model, rendering some applications inaccessible for those using older technologies. To complicate the issues further, the federal requirements are too general to be particularly useful and lend themselves to various interpretations. Some companies even misrepresent accessibility of their products, claiming to be 100-percent accessible, but fail to deliver an accessible product or deliver only a partially accessible product.

Marketing/Sales

One method of increasing demand involves adequate marketing of products with accessibility features. Often, companies develop products that have accessibility features, but they are not marketed as features that support the needs of a particular disability population. Unless the consumer does extensive research, it may not be evident that the features exist. Consumers do not always know what to ask for or how to ask, so unless the products are marketed appropriately or the sales staff is trained to identify features that may benefit a particular user, awareness of those features will remain low. Sales staff should be trained to discuss accessibility features with consumers, to spot consumers who may benefit from particular features, and to relay customer requests back to designers or some other appropriate department within the company who will get those requests factored into design considerations.

Some companies do not have any forecasts for accessibility marketing. There is considerable recognition that the aging population is increasing and will need to be accommodated, though this is not addressed in the current marketing strategy. There is also an increased recognition for accommodation of temporary disabilities resulting from a physical or mental impairment or from an environmental or situational limitation.

Customers/People with Disabilities

The final influences on accessibility are the customer—whether a business customer (for example, the carrier in the case of cell phones) or the end-user. When a business customer is the major driver of product requirements, UD solutions are not likely to be integrated into a product if they are not requested.

End-users, including people with disabilities, can influence the design process by supporting companies in their efforts to generate products that include accessibility features. Customers can also influence the design process by making their problems and successes known to the companies so that the designers can build on that knowledge and improve the process for future product development. However, there were few examples of how customer feedback resulted in a change to the design of a product.

Many companies shy away from direct interaction with people with disabilities and disability advocacy groups. Companies often perceive that inclusion of people with disabilities is complicated, perhaps even aversive in nature. As an alternative, they sometimes have phone contact with various accessibility organizations that assist them in understanding the needs of users with various functional limitations. The quantity and quality of the guidance received from the advocacy group is perceived to be largely dependent on who happens to answer the phone on a given day.

Companies are often hesitant about interaction with disability advocacy groups unless the technology that they are developing is perceived to be accessible. Companies often seek an advocacy group's "stamp of approval" but rarely interact directly with the group to improve the accessibility of an inaccessible product. Some companies interact specifically with employees with disabilities, but do not involve outside individuals. Other interaction is through conferences, workshops, or trade shows. Some companies perform user testing internally or through outside consultants, and this occasionally involves people with disabilities.

Analysis of the Industry Study Findings

All of the companies that participated in the industry study have made strategic decisions to address the accessibility of their products and services. A few of the companies had long-standing accessibility programs that were reinvigorated by the technical requirements of Section 508. Other companies initiated their accessibility activities while planning for their response to Section 508. Regardless, Section 508 has clearly had an impact on the way accessibility and UD are being addressed within industry. The most common approaches to addressing accessibility issues were the following:

- Increasing the awareness of employees
- Integrating accessibility requirements into the design process
- Performing accessibility verification testing
- Establishing an accessibility program office

All six companies in the industry study provided training, formally or informally, to a subset of their employees. Three of the companies in the industry study have integrated accessibility guidance, particularly the technical requirements of Section 508, into their design process. Four of the six companies performed accessibility verification testing for the purpose of generating a VPAT for federal procurement officials. Finally, three of the industry study partners established accessibility program offices in order to coordinate accessibility activities within the company.

The industry study has identified a number of situations where UD principles have been successfully integrated into corporate culture; however, there are still numerous opportunities for improvement. First, legislation has had an impact on the accessibility of E&IT, but it has fallen far short of its potential to inspire universally designed products. Second, the industry study identified a number of barriers to accessibility experienced by the industry study participants. Some issues were associated with specific industries; however, the vast majority of barriers are common to all industries represented by the six product lines selected for study. The potential to develop interventions that are likely to have a profound effect on a large number of companies producing E&IT products and services is significant.

A research project studying the barriers to UD was conducted from 1996 to 1998 by Dr. Pieter Ballon, Dr. Gerd Paul, Dr. Leslie Haddon, and Dr. Monique van Dusseldorp under the European Union's Telematics Applications for the Integration of Disabled People and the Elderly (TIDE) program. The team interviewed 68 managers from telecommunications, computer hardware, software, electronic commerce, public information services, Internet, broadcast, and interactive services. The interviewees were middle- and high-ranking managers from marketing, product management, design, and usability departments, primarily in the Netherlands, Germany, and the United Kingdom. Ballon's team found that a low awareness of UD was present among these upper- and mid-level managers. Few of them believed that UD would improve industry's development practices.

The researchers did find a number of positive factors. Many of the managers understood and appreciated the concept of UD because it fits with their existing criteria for good design. At the same time, UD is compatible with trends within the IT industry to offer solutions that adapt to users' preferences, experience levels, and task requirements. Finally, the researchers found interest in the possibility of expanding markets to include older people and people with disabilities.

The researchers felt that the quality of marketing information concerning the needs of real and potential users was comparatively low in the E&IT industry when compared with other, more mature consumer goods industries. In most E&IT industry sectors, information and guidelines on inclusive design are lacking. They found that larger companies have more means and procedures with which to consider the user and his or her needs in the design process than small enterprises, especially start-up firms in software and Web design.

The research identified nine types of barriers to the implementation of UD principles. At the most general level are barriers relating to a failure to sufficiently consider or involve any end-users in the design process. More important, companies fail to consider or involve older and end-users with disabilities in the design process. Some general developments in the E&IT industry also have a negative impact on implementation: the speed of product development, market trends, and industry organization.

For the industry study, a list of potential barriers to UD was reviewed with each of the industry partners. The industry partners were asked to comment on their experiences and report methods, if any, that were used to overcome the barriers. The purpose of the study was to build upon the findings of the TIDE program by reviewing an extensive list of accessibility barriers with E&IT companies competing in the U.S. market. The following barriers were common to most of the companies participating in the industry study:

- Section 508 is either not being adhered to or is being adhered to inconsistently.
- Some people feel that the business case for UD and accessibility is weak.
- A standard accessible design process has not been documented, tested, or verified.
- There is a lack of realistic standards, guidelines, and principles of accessible design.
- There is no standardized method of measuring accessibility or comparing the accessibility of two similar products.
- Many feel that there is no clear definition of how accessible a product has to be in order to be considered an accessible design.
- Often there is a lack of communication across departments regarding accessibility requirements.
- Many companies lack accessibility champions who are in a position to influence company decisions.
- Middle management often perceives accessible design to be in direct conflict with schedule and budget requirements.
- Individuals with disabilities are not integrated into the design or evaluation processes.

Common barriers identified during the industry study are discussed in detail in the following paragraphs:

Section 508 is either not being adhered to or is being adhered to inconsistently. Inconsistent application of Section 508 by federal procurement officials was the most commonly heard complaint among the industry partners. As might be expected, the industry partners that did not market to the Federal Government were less concerned about Section 508 issues.

Two of the industry partners did not market to the Federal Government, and four of the partners produced products that were directly marketed to the Federal Government. The industry partner representing a distance learning software company markets its products mainly to universities. The company perceived that it must conform with the technical requirements of Section 508 because its customers were demanding conformance; however, the company was technically not obligated to develop products in conformance with Section 508. The company made a decision to design to Section 508 because its customers incorrectly assumed that Section 508 applied to them because they received federal funding as public universities. The company representing cell phone manufacturing had little experience with Section 508 mainly because it marketed its products almost exclusively to the cellular network carriers and did not feel much pressure to conform to Section 508 requirements.

The four remaining companies that did market to the Federal Government expressed discontent with the way federal procurement officials have procured products and services under Section 508. In general, companies responded to Section 508 in one of two ways. Some adopted a "wait and see" attitude while minimally responding to the requirements of Section 508. Such companies might produce VPATs, but they were unlikely to invest resources in developing products to conform to Section 508 until the cost could be justified. Companies in this category have yet to experience either lost or increased sales to Federal Government customers because of Section 508. There is a perception by some in industry that Section 508 conformance is being "rubber stamped" by procurement officials and that the content of the VPAT is not important as long as a VPAT is offered.

Other companies have been very proactive in their response to Section 508. Two of the companies in the industry study have incorporated Section 508 requirements into their design process. However, at least one company is currently reconsidering its accessibility program investment in response to Section 508 because it has not

realized increased federal sales from its increase in overall accessibility. Furthermore, the company did not observe a reduction in federal sales for competitors that were perceived as producing less accessible products. In short, accessibility seems to have failed to become a key discriminator, as promised under Section 508.

Some people feel that the business case for UD and accessibility is weak. All six companies reported that they struggled with the business case for universally designed products and services. Most companies could not report specific instances in which accessibility was a key discriminator in a federal procurement. In the absence of data suggesting that federal sales could be increased with UD or data suggesting that federal sales were at risk because of nonconforming products, companies were reluctant to use federal sales figures in developing a business case for UD.

A standard accessible design process has not been documented, tested, or verified. Several companies have attempted to integrate UD into their standard product development process. Process interventions typically include prompts to consider accessibility during design, the addition of accessibility requirements to requirements definition documents, and limited testing with users with disabilities. However, no one has been able to determine if the interventions are sufficient or if additional interventions are required in order to produce accessible products and services. The impact of the integration of candidate accessibility interventions into the design process has not been studied extensively.

There is a lack of realistic standards, guidelines, and principles of accessible design. Accessibility design guidelines that are currently available are not sufficiently detailed to have a profound effect on the overall accessibility of all E&IT products. Some guidance does exist, such as the technical requirements associated with Section 508 and Section 255; however, the guidance is sometimes ambiguous or subject to alternative interpretations.

There is no standardized method of measuring accessibility or comparing the accessibility of two similar products. The industry partners struggled with the issue of measuring accessibility of products or comparing the accessibility of two similar products. An industry agreed-upon accessibility metric does not exist. In addition, industry has not identified a standard method of measuring accessibility. Currently, accessibility is measured only in terms of Section 508 conformance. The VPAT is currently the agreed-upon vehicle for reporting accessibility; however, it does not necessarily reflect the actual accessibility of the product it was created for, nor does the VPAT allow procurement officials to directly compare the accessibility of two similar products.

Many feel that there is no clear definition of how accessible a product has to be in order to be considered an accessible design. Many people see UD as a goal. The goal is to create a product that is usable by as many people in as many situations as possible. Given that complete accessibility is either impossible or cost prohibitive, companies are struggling with determining just how accessible their product needs to be in order to be considered accessible. The problem is compounded by the fact that companies do not have useful methodologies for measuring accessibility.

Often there is a lack of communication across departments regarding accessibility requirements. Communication between the accessibility program offices and other departments was limited by the resources of the program office. While some proactive outreach activities were observed, the accessibility program offices were generally reactionary in nature. Most of the decisions that impact accessibility take place within product design teams working on specific projects and outside the influence of the program office. Also, sales departments in two of the industry partners were not well connected with personnel making decisions about new product development. In two companies, the demand for accessible products was great, but that demand was not communicated to the group defining the requirements for the next generation products.

Many companies lack accessibility champions who are in a position to influence company decisions. Accessibility champions working within the companies participating in this study had diverse backgrounds and job responsibilities. The accessibility champion, in order to be truly effective, must be able to influence corporate decisions for the purpose of setting priorities and securing resources to further UD efforts.

Middle management often perceives accessible design to be in direct conflict with schedule and budget requirements. Project managers are responsible for making sure that a development project comes in on time and on budget. Since accessibility generally does not have a specific budget, the research required to identify accessibility requirements and integrate them into the design is perceived as being a threat to the objectives of the project manager. If accessibility features can be developed without adversely impacting budget and schedule, they have a chance of be integrated into the product; however, accessibility activities are often the first activities to be cut if budget and schedule are threatened.

Individuals with disabilities are not integrated into the design or evaluation processes. Many of the industry partners did not include people with disabilities in either the design phase or the testing and evaluation phase of product development. Tight schedules and limited resources were the most common reasons sited for lack of integration of people with disabilities into the design process. Other problems exist because of the accessibility barriers themselves. For example, it would be difficult to find a user who is blind and has extensive experience with computer-based training software if computer-based training software is generally inaccessible to users who are blind. Also, very few users with disabilities are experienced in participating in design focus groups or accessibility evaluations. Industry partners that perform user testing with people with disabilities typically perform only very limited or sporadic testing.

Barriers Specific to Product Lines

ATM Industry UD Barriers. The most important barriers to UD expressed by the industry partner representing the ATM industry were the following:

- A standard accessible design process has not been documented, tested, or verified.
- Sometimes accessibility features are poorly communicated to the consumers who require the features.
- The cost of developing and fielding new technologies associated with accessibility is often seen as prohibitive.
- Personnel responsible for making accessibility decisions often have little knowledge about accessibility or accessible design.
- Accessibility is often interpreted narrowly to include only physical access to the technology.

Barriers specific to the ATM industry identified during the industry study are discussed in detail in the following paragraphs.

A standard accessible design process has not been documented, tested, or verified. Factors beyond the immediate control of manufacturers of ATMs often affect the accessibility of ATMs. For example, while the manufacturer supplies guidelines for placement of the ATM, the purchaser of the ATM may choose to install the ATM in an inaccessible location. Furthermore, the purchaser often insists on loading custom software onto the ATM that may or may not take advantage of the built-in accessibility features of the device.

Sometimes accessibility features are poorly communicated to the consumers who require the features. Some users may not be fully aware of the accessibility features available on ATMs. UD features may not be utilized if users are unable to identify which ATMs possess the features or understand how to use them. While manufacturers often create end-user instruction materials and product brochures, the applicability of the materials is limited by the extent of software customization performed by the purchaser.

The cost of developing and fielding new technologies associated with accessibility is often seen as prohibitive. ATMs represent a substantial investment for the purchaser. Replacement of ATMs is often cost prohibitive and extremely difficult. Furthermore, the life expectancy of ATMs is such that they rarely need a full replacement. Product components are simply replaced as needed or as substantially upgraded functionality is made available. Accessibility enhancements are unlikely to justify replacement of an existing ATM or even provide justification for replacing key ATM components. However, if the accessibility enhancements are bundled with security or performance enhancements, purchasers may find the upgrade more attractive.

Personnel responsible for making accessibility decisions often have little knowledge about accessibility or accessible design. Banks may place the ATM in an inaccessible location, may design inaccessible screens, or may design the pathway to the ATM in such a way as to make it inaccessible

Accessibility is often interpreted narrowly to include only physical access to the technology. During a normal design process the total user experience is often considered; however, it may be overlooked when the design is focused on accessibility. For example, when addressing access issues for individuals in a seated position, the inability of the user to privately enter his or her PIN is overlooked. A seated person cannot conceal the key presses in the same manner as someone standing. Accessibility evaluations should address the total user experience and not just the physical access issues.

Cell Phone Industry UD Barriers. The most important barriers to UD expressed by the industry partner representing the cell phone industry were as follows:

- Marketing and technology trends sometimes run counter to accessibility requirements.
- Sometimes accessibility features are poorly communicated to the consumers who require the features.
- Companies often do not know how to market to people with disabilities.

- The cost associated with purchasing accessible products is not affordable by people with disabilities.

Barriers specific to the cell phone industry identified during the industry study are discussed in detail in the following paragraphs.

Marketing and technology trends sometimes run counter to accessibility requirements. Several marketing trends currently run counter to UD within cell phones. Miniaturization is currently driving the development of most cell phones. As the form factor of cell phones is reduced, the space available for both the display and the keypad is reduced. Users who have difficulty reading information on small displays or users who have difficulty selecting small keys have difficulty using small cell phones. In addition, there is a current trend to expand the capabilities of phones to include PDA functionality. The "smart phones" are controlled by complex menu structures that may be difficult for some users to navigate.

Sometimes accessibility features are poorly communicated to the consumers who require the features. Cell phone manufacturers build phones to the requirements specified by the carriers and often have little interaction with end-users. In general, the cellular network providers are the exclusive customers of the cell phone manufacturers. The cell phone manufacturers have little control over how their products are marketed to end-users. Therefore, accessibility features built into cell phones are often not communicated to the end-user.

Companies often do not know how to market to people with disabilities. In the cell phone industry, this issue applies to the cellular network providers rather than the manufacturers. The sales staff members of the cellular network providers are often not familiar with the accessibility features of the phones operating on their networks and are incapable of advising people with disabilities about their purchase decision.

The cost associated with purchasing accessible products is not affordable by people with disabilities. Accessibility features tend to be added to the high-end products, which are typically not subsidized by the carrier. Higher processing speeds and greater memory are often required to operate accessibility features such as voiced menu options. Phones containing adequate processing and storage resources tend to be relatively expensive. In addition, customized third-party software designed to increase the accessibility of programmable phones is expensive and therefore out of reach of most users with disabilities.

Distance Learning Software Industry UD Barriers. The most important barriers to UD expressed by the industry partner representing the distance learning software industry were the following:

- Designers lack an understanding of accessible design and what can be achieved if products are designed with accessibility in mind from the beginning.
- There is a lack of tools and resources useful for efficiently creating accessible products.
- The amount of time required to produce accessible products is prohibitive.

Barriers specific to the distance learning software industry identified during the industry study are discussed in detail in the following paragraphs.

Designers lack an understanding of accessible design and what can be achieved if products are designed with accessibility in mind from the beginning. Although developers of the core distance learning software seem to understand and design for accessibility, the developers of course content may not have the same appreciation for UD. Professors, teachers, instructors, and teaching assistants are responsible for the development of the vast majority of distance learning course content. The content may consist of videotaped lectures, audiotapes, transcripts of lectures, PowerPoint presentations, PDF documents, multimedia presentations, streamed video, and electronic texts. Each content type is associated with very specific accessibility issues. For example, streamed video should be closed captioned and, in some cases, audio described in order to be

considered accessible. Unfortunately, few content providers are able to commit the necessary resources required to develop fully accessible content.

There is a lack of tools and resources useful for efficiently creating accessible products. The tools available to content providers provide very little assistance in creating accessible content. Often, content must be recoded manually in order to be accessible. For example, the effort required to design and develop an accessible slide presentation is often many times greater than the effort required to create the presentation without the accessibility features. Presentation software such as Microsoft's PowerPoint does not natively generate accessible content. Therefore, the content provider must work outside of the presentation software to develop an accessible HTML representation of the original presentation.

The amount of time required to produce accessible products is prohibitive. The effort required to caption one hour of video can take an experienced professional as much as 14 hours to complete. Content providers simply do not have the time, resources, or the tools to create fully accessible distance learning content.

PDA Industry UD Barriers. The most important barriers to UD expressed by the industry partner representing the PDA industry were as follows:

- Marketing and technology trends sometimes run counter to accessibility requirements.
- Companies often do not know how to market to people with disabilities.
- The cost associated with purchasing accessible products is not affordable by people with disabilities.
- Designers lack an understanding of accessible design and what can be achieved if products are designed with accessibility in mind from the beginning.

Barriers specific to the PDA industry identified during the industry study are discussed in detail in the following paragraphs.

Marketing and technology trends sometimes run counter to accessibility requirements. The primary interface for most PDA devices, such as Palm OS or Pocket PC-based products, is a touch-sensitive stylus interface. The touch-sensitive interface, like the touchscreen interface, is not accessible to people who are blind. Low-vision users may find it difficult to utilize assistive technologies, such as a magnifying lens, while holding the device and using the stylus. Users with fine motor control limitations will find it extremely difficult to select items from the on-screen menus because of the precise motor control movements required to use a touch-sensitive stylus interface. Although the potential for use of a PDA by people with disabilities is great, the technology is currently inaccessible to many users.

Many of the elements needed for the development of an accessible PDA are already embedded into existing products. Technologies needed for voice recognition interfaces—such as microphones, speakers, storage, and a sufficiently fast processor to process the voice recognition algorithms—are generally built into many PDAs. However, the software required to fully implement the technology in an accessible manner has not yet been developed. As an alternative to using the stylus interface, some programs support navigation using the hardware keys found on many PDAs. Key press navigation is available for some applications, but adoption of the alternative navigation scheme is not widespread among software developers.

Companies often do not know how to market to people with disabilities. Perhaps because of the inaccessibility inherent in the touch-sensitive stylus interface, the accessibility of mainstream PDAs seems to have been overlooked. Therefore, PDAs are generally not marketed to people with disabilities, nor is the potential for PDAs to improve the lives of people with disabilities recognized.

The cost associated with purchasing accessible products is not affordable by people with disabilities. While the cost of PDAs has been reduced, they still represent a substantial investment for consumers. People with disabilities are reluctant, and rightly so, to invest in technologies with unproven track records on

accessibility. Accessible devices with PDA functionality, such as Freedom Scientific's PACMate, can cost up to 10 times the standard PDAs. Therefore, few people with disabilities are able to afford the devices without assistance.

Designers lack an understanding of accessible design and what can be achieved if products are designed with accessibility in mind from the beginning. Because of the touch-sensitive stylus interface, many see the PDA as inherently inaccessible, just as a digital camera is inherently inaccessible to a person who is blind. PDAs, particularly as storage capacities and processing power increase, are gradually becoming true handheld personnel computers. It is reasonable to assume that a capable PDA could employ some of the same mechanisms for accessibility as personal computers. For example, voice displays used in conjunction with keypad navigation could be used in a similar manner to the way screen readers are used with personnel computers. Voice recognition technologies could provide access to users who are unable to interact with the screen or keys. Screen magnifiers could be employed to assist users with low vision. Cooperation between hardware manufacturers, operating system developers, software application developers, and AT software developers will be needed in order to produce a fully accessible PDA. Currently, hardware manufacturers are reluctant to change their product unless the necessary accessibility features are built into the operating system and demand from software application developers increases.

Television Manufacturing Industry UD Barriers. The most important barriers to UD expressed by the industry partner representing the television manufacturing industry were the following:

- Personnel responsible for making accessibility decisions often have little knowledge about accessibility or accessible design.
- There is a lack of realistic standards, guidelines, and principles of accessible design.

Barriers specific to the television industry identified during the industry study are discussed in detail in the following paragraphs.

Personnel responsible for making accessibility decisions often have little knowledge about accessibility or accessible design. Accessibility of televisions depends on the cooperation of television manufacturers, content distributors, and content developers. Television manufacturers are responsible for developing hardware designs to take advantage of accessibility features, such as closed captioning and descriptive audio, added by content developers. Content distributors must be aware of the accessibility features and deliver the content so it does not interfere with accessibility features. Design decisions made by television manufacturers, content distributors, and content developers often are made for technological, financial, or creative reasons without consideration for accessibility.

There is a lack of realistic standards, guidelines, and principles of accessible design. While standards and guidelines exist for some aspects of television accessibility, such as closed captioning, very little guidance is available for the accessibility of most television components. For example, little if any guidance is available for the accessibility of remote controls or on-screen menus.

Voice Recognition Software UD Barriers. The most important barriers to UD expressed by the industry partner representing the voice recognition software industry were as follows:

- The technology required to produce accessible products is not available at a reasonable cost.
- The cost of developing and fielding new technologies associated with accessibility is often seen as prohibitive.

Barriers specific to the voice recognition software industry identified during the industry study are discussed in detail in the following paragraphs.

The technology required to produce accessible products is not available at a reasonable cost. Great advances in technology have improved both the response time and accuracy of voice recognition software. However, frequent errors and recognition delays greatly impact the overall usability of voice recognition software. There are two basic types of voice recognition software. Natural

language recognition software, such as Dragon Naturally Speaking or IBM ViaVoice, attempts to process and recognize a vast vocabulary of words. Such programs can be used to navigate computer programs as well as produce text. In general, the user is required to tune the voice recognition software to the nuances of his or her voice in order to obtain acceptable levels of voice recognition accuracy. In contrast, limited vocabulary voice recognition software, such as an automated phone attendant, improves accuracy by constraining the number of words that the system can recognize. Limited vocabulary systems are speaker independent and do not require tuning to the user's voice.

Natural language voice recognition software is still perceived as being too inaccurate and slow for use as an alternative to keyboard and mouse input. Users with disabilities who have used the technology in the past are reluctant to purchase additional software because of past disappointments. However, user perception of limited vocabulary voice recognition software is changing. Specialized voice recognition software can be embedded in common products such as digital copiers and public kiosks to provide access to a device that would otherwise be inaccessible.

The cost of developing and fielding new technologies associated with accessibility is often seen as prohibitive. Although the pathway to embedding voice recognition technology in common E&IT products is understood, implementation of the integration can be challenging. The embedded voice recognition system typically consists of a voice recognition algorithm, audio input and output circuitry, a processor to execute the voice recognition algorithms, and a software vocabulary. The audio circuitry and processor represent a nontrivial production cost. The cost to develop the voice recognition algorithms, or license existing ones, and capture needed samples of the vocabulary can also be expensive.

For additional information, please visit the online version of this report located at www.ncd.gov.

List of Acronyms and Abbreviations

3G	third generation
AAATE	Association for the Advancement of Assistive Technology in Europe
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
ANSI	American National Standards Institute
ASX	active streaming XML
AT	assistive technology
ATIS	Alliance for Telecommunications Industry Solutions
ATM	automated teller machine
B2B	business-to-business
B2C	business-to-consumer
BSNL	Bharat Sanchar Nigam Limited
BWA	broadband wireless access
CAGR	compounded annual growth rate
CC	closed captioning
CCG	country commercial guide
CCID	China Center of Information Industry Development
C-DoT	Center for Development of Telematics
DEL	direct exchange line
DWDM	dense wavelength division multiplexing
DOC	Department of Commerce
DTV	digital television
DVD	digital videodisc

DVS	descriptive video service
E&IT	electronic and information technology
EU	European Union
FCC	Federal Communications Commission
FDI	foreign direct investment
GDP	gross domestic product
GPS	global positioning system
GSM	Global System for Mobile Communications
GTRI	Georgia Tech Research Institute
HAC	Hearing Aid Compatibility Act
HDTV	high definition television
HREOC	Human Rights and Equal Opportunity Commission
HTML	hypertext markup language
Hz	Hertz
IC	integrated circuitry
IDEA	Individuals with Disabilities Education Act
IEP	individualized education program
IMMA	Instructional Material Accessibility Act
ISDN	integrated services digital network
ISP	Internet service provider
IT	information technology
iTV	interactive television
IT&T	information technology and telecommunications
ITTATC	Information Technology Technical Assistance and Training Center

IVR	interactive voice response
MAIT	Manufacturers Association of Information Technology
MFN	most-favored nation
MII	Ministry of Information Industry
MNC	multinational company
MTNL	Mahanagar Telephone Niagam Limited
NAFTA	North American Free Trade Agreement
NALS	National Adult Literacy Survey
NCAM	National Center for Accessible Media
NCD	National Council on Disability
NCI	National Captioning Institute
NDA	nondisclosure agreement
NOIE	National Office for the Information Economy
OEM	original equipment manufacturer
PC	personal computer
PDA	personal digital assistant
PIN	personal identification number
PROSEC	program of sectoral promotion
PSAP	public service answering point
ROI	return on investment
SDH	synchronous digital hierarchy
SME	small- and medium-sized enterprise
SMS	short messaging service
SOHO	small office home office

SRT	speech recognition technology
TIDE	Telematics Applications for the Integration of Disabled People and the Elderly
TTY	teletype
UD	universal design
VDRA	Video Description Restoration Act
VoIP	voice over Internet protocol
VPAT	voluntary product accessibility template
VPN	virtual private network
VPT	village public telephone
VRT	voice recognition technology
VXML	VoiceXML
W3C	World Wide Web Consortium
WTO	World Trade Organization
xDSL	all types of digital subscriber lines
XML	extensible markup language

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