Guest Editorial

Mobile wireless technologies for rehabilitation and independence

Mobile wireless technologies are changing how we communicate, conduct business, and interact with our family, friends, and community. The technology is freeing us from the constraints of fixed-site communications, physical transactions (e.g., handling money, opening doors), and manual controls (e.g., adjusting thermostats, pressing elevator buttons). Wireless technologies, combined with advances in computing, are enabling many exciting new applications that can simplify daily activities, increase independence, and improve quality of life. People with all types of disabilities will be prime beneficiaries of this wireless revolution, which goes far beyond mere cellular telephones (cell phones) and pagers.

As we move forward with enthusiasm for these positive developments, we must also be aware of important concerns about accessibility, privacy, and interoperability. While it is interesting to contemplate how new wireless applications may change society, there are already many examples of wireless adoption in business, education, transportation, healthcare, and entertainment.

Today, cell phones are only the most widely used example of mobile wireless technology. Cell phone adoption has spread more rapidly than that of any other global consumer product, and mobile computing is rapidly overtaking desktop computing. By mid-2004, the Cellular Telecommunications & Internet Association estimated that the United States had more than 169 million wireless subscribers, while the International Telecommunication Union estimated worldwide wireless subscribers at more than 1.4 billion. There are now more cell phones in the world than computers and televisions combined.

The progression of cell phone technology is often described in terms of generations. The first-generation cell phones began with analog technology in the 1960s. The market developed gradually in the 1970s as car telephones slowly became popular and then exploded during the 1980s as costs and handset sizes shrank. During the 1990s, the second-generation cell phones emerged with digital technology that enabled better security, more efficient network management, and new data applications. Today, we are at the leading edge of third-generation technology enabling higher-speed data communications, multimedia messaging, and mobile computing applications.

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Wireless data networks now compete with cell phone networks. Low-speed wireless data networks have been around for many years for pagers, and in recent years, the Blackberry two-way pager has become a top choice among the deaf community for

independent mobile communications. For high-speed wireless Internet access, wireless fidelity (Wi-Fi) technology based on Institute of Electrical and Electronics Engineers (IEEE) standard 802.11 has spread rapidly into homes, businesses, campuses, and community facilities because it provides high-speed network access (up to 11 Mb/s) for very low cost. This technology is also attractive because it operates in a radio-frequency band that does not require a license fee. The main limitations are that Wi-Fi networks usually cover, at most, a few hundred feet and security and bandwidth become concerns when sharing public networks.

An emerging Worldwide Interoperability for Microwave Access (WiMAX) wireless technology may solve the range and bandwidth limitations of Wi-Fi. WiMAX, based upon the IEEE 802.16 standard, is designed to provide broadband (potentially up to 134 Mb/s) connectivity for long ranges (potentially up to 50 km). Wide-area broadband networking with WiMAX may provide a wireless solution to the "last mile" connectivity problem, eliminating the need for expensive and time-consuming wired installation procedures to establish high-speed Internet access in the home. Because of competing wireless networks in the foreseeable future, mobile wireless devices will support capabilities for transmitting and receiving signals on different frequencies, and sophisticated software radio algorithms will detect and tune to the optimal communication mode for the best currently available wireless network.

Radio Frequency Identification (RFID) tags, another interesting wireless technology, could significantly change the way we interact with products, places, equipment, and objects during our daily activities. RFID tags emit a wireless signal that can be read without physical or visual contact with the tag. Some are very small, are low cost (less than 25 cents), and require no power. Retailers are integrating these into their inventory control systems, and drug manufacturers use them for product tracking that is more accurate and efficient than bar coding. RFIDs could also be built into structures to mark navigation landmarks such as doorways, street signs, bus stops, etc. The full potential is intriguing. The blind could use this technology to scan their surroundings and identify objects close by. The elderly could be reminded where they left their pill boxes and how many times to take the pills inside. We are not there yet. RFID readers have size, cost, and range limitations. However, manufacturers and retailers are pushing for RFID to become a standard inventory tool, so it is likely to become a big part of our future.

Wireless position-tracking technologies are also rapidly changing the world by enabling navigation systems and context-aware applications that simplify the user interfaces on our mobile devices. The satellite-based Global Positioning System (GPS), developed originally for the U.S. military, is now available to everyone and can provide latitude and longitude coordinates accurate to within a few meters in outdoor settings. Cell phones currently have some position-tracking capability, and more precise emergency-locating services are being added. We also expect to see implementation of RFID tags for marking locations around the home and community. As mobile devices add position-tracking capabilities, location-aware applications such as OnStar can automatically provide information about stores and services close to any user's current location.

Combining location with date, time, and personalized preference profiles, sophisticated context-aware network applications will simplify independent navigation and daily activities. For example, a context-aware mobile device could anticipate that during lunch hour in a restaurant district, the user would be interested in accessible places to eat. Previously defined preferences for wheelchair access and types of cuisine would allow such a "mobile information system" to suggest nearby restaurants with easy access or to warn of closed wheelchair ramps or broken elevators. Wireless networks will deliver dynamic updates to maps, directions, and preferred paths and allow people to receive or send consumer recommendations about the accessibility of community resources.

The world is moving toward an environment of pervasive computing in which information is collected, processed, and disseminated everywhere. As tiny low-cost wireless devices are incorporated into

more of our everyday products, we will be freed from performing many routine physical tasks and will be able to control our environment more efficiently. Our mobile phones are becoming portable computers that provide continuous access to these communications and information networks. Today, multifunction devices can support voice and email communications and function as calendars, address books, cameras, and Internet terminals. Tomorrow, our cell phones will be complemented by a wider collection of associated sensors and devices that communicate with each other over local- and wide-area networks. Mobile communications will allow family and caregivers to stay in touch at all times. Those in need will be able to initiate emergency calls for help anywhere in the community—far beyond the reach of pull-cord alert systems on retirement home walls. Sensors monitoring temperature, humidity, movement, smoke, intrusion, and air quality will quietly stand guard. Intelligent information-filtering algorithms will send wireless warnings if those sensors detect dangerous changes in the home, school, or business environment. Through automatic wireless connections and invisible data communications, your watch will access your online calendar, your cell phone will link to your car's computer, your identification card will open the office door and turn on the lights as you approach, and your child's picture on your desk will tell you whether he or she arrived safely at school.

The interaction with and control of machines, devices, and automated buildings will be another important application area. A powerful and exciting new standard called V2 is being developed for a wireless universal remote console (URC) by the V2 subcommittee of the InterNational Committee for Information Technology Standards (see the V2 URC Standards Whitepaper at www.myurc.com/). The basic idea is that everyone will carry his or her own personal controller that can control any V2-compliant device. V2-compliant products will use wireless technology to automatically make their controllable functions available on the personal controller. Imagine if your television remote control could automatically reprogram itself to work with your new videocassette recorder and entertainment system.

Manufacturers of consumer electronic products are excited about V2 as an intelligent one-device URC solution, but the standard will have additional value for people with disabilities because it will allow them to use an alternate interface for any off-the-shelf product that adheres to the V2 standard. The key is that consumers will purchase a personal controller that is most comfortable for them. Someone who is visually impaired may prefer an audio-based personal controller, while someone who is deaf may prefer a graphical touch-screen controller. Middle-aged consumers (like me) who need reading glasses may prefer a controller with larger buttons and lettering. V2 personal controllers will come in many types and sizes, but they will all be able to interact with and control any off-the-shelf V2-compliant consumer products. Such universal compatibility will be a tremendous advantage for people with disabilities because it will reduce or eliminate the need to buy special-purpose assistive technology products, which cost more, support fewer features, and become outdated more quickly than mainstream products.

Mobile wireless technologies will become a more important part of our future, and they can provide greater freedom and independence for people with disabilities. However, there are challenges in making wireless products universally accessible. Today's cell phones often have displays that are difficult to read, buttons that are too small to press, audio that is difficult to hear, and features that are too complicated to understand. Accessibility problems are aggravated by the compact nature of many mobile wireless devices, in which integrated functions limit or prevent alternative input/output capabilities. The National Institute on Disability and Rehabilitation Research established the Rehabilitation and Engineering Research Center (RERC) on Mobile Wireless Technologies for Persons with Disabilities to promote universal wireless access and to explore innovative wireless applications for people with disabilities. A variety of research, development, training, and dissemination activities are part of the center's mission. For more information, please go to the Wireless RERC Web site at www.wirelessrerc.org

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