



Current and Future Applications of Mobile and Wireless Networks

Wireless and mobile networks are being used in diverse areas such as travel, education, stock trading, military, package delivery, disaster recovery, and medical emergency care.

Mobile and wireless systems cover two areas—mobility and computing. Mobile computing means continuous accessibility to the user while wireless implies communicating without wires. As indicated in [1], mobile and wireless technology has improved substantially, making wireless devices remarkably convenient and affordable.

Wireless networking is specifically appropriate for situations wherein installation of physical media is not feasible and which require on-the-spot access to information. Wireless networking makes it possible to have access to both voice and data. We attempt to highlight specific characteristics of various wireless technologies and categorize their applications. Table 1 provides an overview of different wireless technologies; Table 2 lists potential applications in numerous areas.

Applications of Cellular Systems

In the past, field employees carried several binders of documen-

tation that may not have been updated. A possible solution to this is to connect a portable computer via a wireless network to the office LAN. In a similar way, sales professionals need to stay in touch with customers about products and services, placed orders, status updates to home offices, and inventory.

Wireless technology enables a real estate agent to access a multiple-listing database. A field auditor can carry a notebook, wirelessly connected to a client information database, conduct on-site field audits useful for the IRS and other federal and state agencies, financial auditors, building permit inspectors, and so forth.

The cost of maintaining vending machines with wireless modems and microprocessors is also reduced by automatic credit card authorization capability. Mobile computing devices are used extensively by public welfare agencies such as police, fire safety, and ambulance services.

For example, as stock traders require information for closing a

sale as quickly as possible, the Chicago Mercantile Exchange has installed a PDA-based wireless pilot-project for trading.

Airline staff can gather information about ticketing, flight scheduling, and luggage using wireless devices. One example: baggage handlers are using handheld devices that scan baggage tags and wirelessly transfer information to a host computer.

Electronic bills enable consumers to receive and pay their bills using a phone by Wireless Application Protocol (WAP).

Handheld devices used by courier companies such as Federal Express, UPS, and DHL have adopted the wireless and mobile computing technology for parcel tracking, as well as emergency drop or pickups of shipments.

WLAN-based Applications

A wireless LAN (WLAN) is a flexible data communication system implemented as an extension to a wired LAN. The electromagnetic waves transmit and receive data over the air, minimizing the need for wired connections.

Retailers use wireless POS terminals and WLANs to order, sell, and keep inventories of merchandise. Warehouse staff can use the technology to manage goods, conduct inventory, and ship goods to customers. Once items are received for storage in a warehouse, a clerk scans bar-code numbers into the database via a handheld device.

In today's healthcare environment, wireless networks provide

send a message to the doctor.

With the help of WLANs, corporations and students at universities can use wireless connectivity to facilitate laptops to access necessary information.

Hospitality establishments check customers in and out and keep track of room service orders and laundry requests. Restaurants can track the names and numbers of people waiting for entry, table status, and drink and food orders.

the first GPS system that allows intelligent vehicle location and navigation. It has many military applications such as intelligence and target location, command and control, mine laying and detection, testing combat aircraft, missile guidance, and artillery pointing, to name a few. GPS can be used for surveying and can be done in almost all weather conditions. GPSs are useful in agriculture for precision farming as well as for search and rescue operations.

Automobile manufacturers have introduced GPS-based navigation in cars, with a four-inch monitor asking travelers their destination, displaying a color map of the area and scrolling down a list of preselected points of interest, such as hotels, convention centers, or a specific street address.

Another example of GPS-based applications is the use of mobile notebooks in sporting competitions, including sailboat races, where progress is recorded and communicated wirelessly to servers.

Technology	Services/Features	Coverage Area	Limitations	Example Systems
Cellular	Voice and data through handheld phones	Continuous coverage	Very low bandwidth	Cellular phones, PDAs, Palm Pilots
Wireless LAN (WLAN)	Traditional LAN with wireless interface	Only in local environment	Limited range	NCR's WaveLAN, Motorola's ALTAIR
GPS	Determines three dimensional position, and velocity	Any place on Earth	Expensive	GNSS, NAVSTAR, GLONASS
Satellite-based PCS	Mainly for paging	Almost any place on Earth	Expensive	Iridium, Teledesic
Ad hoc networks	Group of people come together for short time to share data	Similar to local area networks	Very limited range	Bluetooth
Sensor networks	Tiny sensors with wireless capabilities	Small terrain	Very limited range	Defense and civilian applications

Table 1. Wireless technologies and associated characteristics.

fast and accurate transmission of patient information and can send timely alarms to key personnel for the patients' well-being. The use of pen-based computers enables the input of electronic patient records and drug transactions, updating data from anywhere in the hospital, and increases the accuracy and speed of healthcare. Using a handheld device, a doctor can order a blood test and the lab technician can perform the necessary tests, store the results, and

State and provincial government officials can use WLANs to effectively and efficiently deal with legislature, constituent offices, and other government officials at municipal and federal levels.

GPS-based Applications

Global Positioning Systems (GPS) [4] are space-based radio positioning systems that provide 24-hour, 3D position, velocity, and time information to suitably equipped users anywhere on the surface of the Earth. The NAVSTAR system, operated by the U.S. Department of Defense, is

Satellite-based PCS

The satellite-based PCS use a constellation of low-earth orbit (LEO) satellites, orbiting around the Earth at a few hundred miles. The Iridium project, conceived and created by Motorola, is a satellite-based technology consortium for PCS. The satellites in the sky cover any point on Earth with continuous lines of sight. They provide small handheld phones with the conventional

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wireless options, and small pagers with text messaging. Teledesic is building a global, broadband Internet-in-the-sky network. The service is targeted to begin in

homes to connect multiple PCs and other computing devices by having wireless networks and one device connected to ISDN line. Another way of connecting many

WIRELESS NETWORKS ARE emerging areas with around 200 million current users and are anticipated to grow to one billion subscribers. A real challenge is to locate an addressee among millions of globally distributed terminals quickly. Other issues involve effective use of limited power for transmitting both voice and data. The future applications look promising. **C**

Wireless Features	Cellular	WLAN	GPS	Satellite-based PCS	Ad-hoc and Sensor Networks
Application Area	<ul style="list-style-type: none"> - Field Service - Sales Force - Field Audit - Vending - Public Safety - Stock Trading - Airline Activities - Bill Paying - Transportation Industry 	<ul style="list-style-type: none"> - Retail - Warehouses - Healthcare - Telediagnosics - Students - Hospitality - Office Applications - Manufacturing Industry 	<ul style="list-style-type: none"> - Surveying - Car Rental Agency - Robin Toll Collection - Sports 	<ul style="list-style-type: none"> - GPS - Multimedia - Telemetry 	<ul style="list-style-type: none"> - Battlefield Surveillance - Environmental Sensing - Machinery Prognostics - Roller Bearing Diagnostics - Roadside weather conditions - Bio-sensing - Bridge damage detection

Table 2. Potential applications of different wireless services.

2004, and the idea is to provide affordable, worldwide access to telecommunications services such as computer networking, broadband Internet access, high-quality voice, and other digital data.

Ad-Hoc Networks

An ad-hoc network is a WLAN in which mobile or portable devices are part of the network but only when they are in a relegated, close proximity. There is no fixed infrastructure, and information is forwarded in a peer-to-peer mode using multi-hop routing. Military applications for ad-hoc networks include a group of close-by soldiers who can share the information in their notebook computers using RF signals. However, numerous civilian applications are being explored. Home networking is replacing WLANs in

home devices is to employ a short-range frequency-hopping radio link of Bluetooth technology (see [2]) and connect a cellular telephone to laptops, printers, PDAs, desktops, fax machines, keyboards, joysticks, and other peripherals.

Sensor Networks

Sensor networks [3, 5–7] are the newest of wireless networks in which a large number of tiny immobile sensors are planted on an ad-hoc basis to sense and transmit some physical characteristics of the environment. The information from sensors is aggregated on a “data centric basis.” Battlefield surveillance with a large number of sensors dropped from an airplane in enemy territory is the most noted example. Other potential commercial fields include machinery prognosis, biosensing, and environmental monitoring.

REFERENCES

1. Agrawal, D.P. Future directions in mobile computing and networking systems. Workshop sponsored by the NSF, University of Cincinnati (Jun. 13–14), 1999; www.ececs.uc.edu/~dpa.
2. Bluetooth; www.bluetooth.com.
3. Estrin, D. et al. *Next Century Challenges: Scalable Coordination in Sensor Networks*. ACM Mobicom, 1999.
4. GPS applications; ares.redsword.com/gps.
5. Kahn, J.M., et al. *Next Century Challenges: Mobile Networking for Smart Dust*. ACM Mobicom, 1999.
6. Manjeshwar, A. Energy efficient routing protocols with comprehensive information retrieval for wireless sensor networks. M.S. Thesis, University of Cincinnati, OH, May 2001.
7. The Ultra Low Power Wireless Sensors project; www.mtl.mit.edu

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