

# Survey of wireless computing 18595 essay



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Survey of Wireless Computing Wireless technology can provide many benefits to computing including faster response to queries, reduced time spent on paperwork, increased online time for users, just-in-time and real time control, tighter communications between clients and hosts. Wireless Computing is governed by two general forces: Technology, which provides a set of basic building blocks and User Applications, which determine a set of operations that must be carried out efficiently on demand. This paper summarizes technological changes that are underway and describes their impact on wireless computing development and implementation. It also describes the applications that influence the development and implementation of wireless computing and shows what current systems offer. Wireless computing is the topic of much conversation today. The concept has been around for sometime now but has been mainly utilizing communication protocols that exist for voice based communication. It is not intended to replace wired data communication but instead to be utilized in areas that it would be otherwise impossible to communicate using wires. Only recently has the industry been taking steps to formulate a standard that is more suitable to data transmission. Some of the problems to be overcome are: (1) Data Integrity - relatively error free transmission, (2) Speed - as close as possible to the speed of current wired networks, (3) Protection - making sure that the data now airborne is encoded and cannot be tapped by unwelcome receivers, (4) Compatibility - ensuring that the many protocols that are sure to be created subscribe to a standard to allow inter-operability, (5) Environmentally safe - strengths of electromagnetic radiation must be kept within normal levels. In our study of the theories and implementation concerns of wireless computing, we found that it is being treated in an object

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oriented fashion. Scientists and development crews, including the IEEE, are doing their best to implement wireless connectivity without changing the existing computer hardware. As a result, a lot of focus is on using existing computer hardware and software to convert data to a format compatible with the new hardware which will be added to the computer using ports or PCMCIA connections that already exist. This means that wireless communication will be transparent to the user and when wireless computing is utilized on a wide scale. Wireless computing applications covers three broad areas of computing today. Replacement of normal wired LAN's need to retain the speed and reliability found in wired LAN's. Creation of semipermanent LAN's for quick and easy setup without the need for running wires. This would be necessary for events such as earthquakes. The last category is that of mobile computing. With advent of PCMCIA cards, notebook computers are being substituted for regular desktop machines with complete connectivity of the desktop machine. However, you lose the connectivity when out of the office unless you have a wireless means of communicating. On the compatibility issue, the ability to mix wireless brands on a single network is not likely to come soon. The IEEE Standards Committee is working on a wireless LAN standard — 802. 11, which is an extension of the Ethernet protocol. Because the field of wireless communication is so broad, the IEEE was not able to set a standard by the time private researchers were ready to test their theories hoping to set the standard for others to follow. 2

Methods There are a few methods of wireless communication being theorized and tested. (1) Radio: This is the method that makes use of standard radio waves in the 902 MHz to 928 MHz frequency range. Although these frequencies are well used, methods have been developed to ensure data

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integrity. Spread spectrum transmission of data is a method where the transmitter will send information simultaneously out over many frequencies in the range increasing the chance that all data will eventually reach the receiver. Frequency hopping is an additional measure that also enables data security. The 26 MHz range of frequencies is further divided into channels. The transmitter then sends out data hopping from one channel to the next in a certain pattern known to the receiver. Within each channel, spread spectrum transmission can be used to maintain interference avoidance. Some of this transmission manipulation can be avoided by transmitting at a frequency that is less used. Some developers have tried transmitting in the gigahertz range. The disadvantages here are: 1) Higher frequencies mean shorter wavelengths and shorter wavelengths do not penetrate solid objects like walls and floors; 2) The same transmission strength employed by lower wavelength transmitters yields a shorter range at higher frequencies. This means that transmission strength will need to be boosted something hard to accomplish using portable tools and potentially dangerous to humans; 3) Transmission frequencies of 3 GHz and higher are licensed by the Federal Communications Commission. Developers in the range have the additional hassle of obtaining a license every time an installation is done. (2) Laser: Laser-based communication is the fastest way to communicate without wires. Information travels at the speed of light. The drawbacks however far outweigh the speed advantage and prevent this method from becoming the standard. The major drawback is that communication is restricted to line of sight. Also, very thick fog or blizzard conditions will diffuse the laser beam and causing interference and reducing data integrity. (3) Infrared: This method is similar to Laser. High speed communications are easy to achieve

using this method. However, it suffers from the same problems that plague laser communications. It requires line of sight transmission and can be disrupted by strong ambient light. Infrared wireless computing exists more commonly in the form of peripheral connections in a small area. (4) Cellular connections although expensive to use now is the area of much development by private companies. Cellular computing can be likened to the current wire-based internet network. Data is packaged in to units, size of the unit is dependent on the actual hardware, and is sent to the nearest participating cell. That cell then forwards the packet to the next cell and so forth until the packet reaches its destination.(5) Microwave: This method of communication has been utilized for quite some time now. However this method has makes little provision for data aware transmission. It used extensively in Europe where wired transmission of any type including voice is poor. For data transmission, a lot of technology is utilized in packaging the data into a form that is compatible to voice communication. On the receiving end, the process is reversed. The advantage of this method however is that communication can be accomplished using existing satellite connections making worldwide connectivity possible. 3 StandardsThe IEEE 802. 11 committee has voted to create a minimum requirement for wireless computingconnections. In their consideration:(1) Use the frequencies 2. 4 to 2. 5 GHz. This is in the low end of the high frequency spectrum and is currently not licensed by the FCC. (2) Use spread spectrum technology. Compared to the current bandwidth 26 MHz, 902 MHz to 928 MHz, the range 2. 4 to 2. 5 GHz yields a bandwidth of 100 MHZ. Spread spectrum transmission now gives 385% percent increase in data reliability. (3) Many more sub-channels can be formed in a bandwidth of 100 MHZ. This increases

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the capability of frequency hopping which in turn yields greater data security. (4) Utilize Gaussian Frequency Shift-Keying. Frequency shift-keying is a form of frequency modulation in which binary signaling is accomplished by using two frequencies separated by some  $D_f$  Hz. The frequency duration is small compared with the carrier frequency,  $f_c$ . A signal received at frequency  $f_c$ , would represent a digital low and signals received at frequency  $f_c + D_f$ , would represent a digital high. Note that this does not interfere with spread spectrum or frequency hopping capabilities since those function on frequencies separated by 1 MHz or more. As part of setting a wireless standard some modifications of the standard set by the IEEE 802.

3committee have been adopted. The most significant of these is the modification to the carrier sense multiple access / collision detection, or CSMA/CD, protocol used in wired networks today. This is a method whereby any machine at any time, wishing to send a message on the net, will first send a token out to ensure that a carrier exists (network ready). After establishing this, the message will be sent. Because any machine may send at any time, collisions of information will occur. If any machine detects a collision, it will send out a jamming signal to all the others. All machines will then wait on a random interval timer after which they will try to send again. For wireless networks however, since a machine is not in constant communication with the rest of the LAN, detecting a collision and notifying all other machines on the net is impossible. A modification in the way of the collision handling had to be made. A method known as collision avoidance is employed to create the CSMA/CA standard. In a collision avoidance strategy, the net estimates the average time of collisions and send a jamming signal at that time. A wireless transceiver will not only sense a carrier but will also listen

out for the jamming signal. When all is clear it then send its message. This collision avoidance method has two drawbacks: 1) It cannot completely filter all collisions since it operates on estimated times of collisions; 2) and if it did, it slows the network significantly by sending jamming signals whether or not a collision actually occurs.

#### 4 Physical Layer

Much of the focus of wireless computing development is centered on the physical and media access control layers of a system. It is on this level of the LAN protocol of which wireless products like modems and transceivers. On the physical layer issue, the 802.11 is focusing on the one proposed by Apple Computer Corporation. The Apple physical-layer protocol appears the most robust of any considered to date in 802.11. Apple's system is a full-duplex, slow frequency-hopping protocol. By using a frequency-hop spread-spectrum radio, the system fits with the spread-spectrum methods of virtually all 802.11 specifications. Apple splits the data-transport protocol into two layers:- The RF Adoption Layer is similar in some respects to cell-based data protocols, such as Asynchronous Transfer Mode and IEEE 802.6 Switched Multimegabit Data Services; like ATM and 802.6, the RF Adoption Layer includes segmentation/reassembly functions and Protocol Data Unit generation functions, and it also includes Forward Error Correction (FEC) generation and verification functions which substantially increase packet integrity in wireless environments but adds FEC overhead. - The RF Hopping Protocol Physical Layer consists of a transmission convergence sublayer including header generation, RF framing, and RF hopping protocol functions and the physical-medium-dependent sublayer, in which the actual characteristics of the RF channel are handled. In the RF Adoption Layer, a Protocol Data Unit is split into three segments, and two error-correcting data units are added. The RF

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Hopping segments, and two error-correcting data units are added. The RF Hopping Physical Layer builds special Burst Protocol Data Units out of the data and FEC units and uses carrier-sense methods borrowed from Ethernet to determine whether an RF Hop Group is clear for transmission. Each hop group consists of five separate radio channels. The controller scans hop groups via state-machine operation with four states: scan, receive, carrier-sense, and transmit. In early tests at Apple, the hop system showed 80-microsecond hop times, 57-microsecond clock recovery, and a 5-microsecond lapse between the time an empty channel is sensed and transmission begins. Since each cluster of wireless LANs can use different hop groups, multiple LANs could operate in the same area without interference. One concern is whether the overhead for error correction for each packet, which can be as much as 50% is too high to give the proposal a chance. The safety of those operating new equipment now plays a larger role in determining the direction of technological growth now more than ever. Factors under consideration are the effect of infrared and strong electromagnetic radiation that would pervade the workplace on the workers. This limits the strength of and communication device that would be used in accomplishing transmission. For the Personal Computer. The adapters have a small attached antenna through which they send and receive network traffic as radio signals. Some wireless products are small boxes that attach to your PC's parallel port. In either case, the signals may travel from PC to PC, forming a wireless peer-to-peer network, or they may travel to a network server equipped with both wireless and standard Ethernet adapters, providing notebook users a portable connection to the corporate network. In either case, wireless LANs can either replace or extend wired networks. Standards



are lacking. Wireless networking is still a technology looking for a standard, which is why very few wireless products can work with one another. Each vendor uses a different protocol, radiofrequency, or signaling technology. If wired networks still operated like wireless, you would have to use the same brand of network interface card throughout your network. Right now you are, for the most part, tied to whichever brand of wireless LAN you pick. Most of the products in this comparison listed their wireless protocol as Ethernet carrier sense multiple access/collision avoidance (CSMA/CA), a variation of standard Ethernet. Unfortunately, each vendor has put its own spin on CSMA/CA, which means even their protocols are incompatible.

### 5 Wireless services

As technology progresses toward smaller, lighter, faster, lower power hardware components, more computers will become more and more mobile. For space concerns this paper will exclude any further discussion of the hardware developments toward mobility except for devices directly related to wireless connectivity such as modems. A wireless computer is not connected via a wireline and thus has mobility and convenience. A wireless LAN provides the convenience of eliminating the wires, yet is not necessarily mobile. (What is mobility?) Mobility is a characteristic where the wireless computer may connect, lose the physical communication (possibly due to interference) and reconnect (possibly to another sub-network) and retain its virtual connections and continue to operate its applications. The network protocols will be discussed later. (Then, what is portable?) Portable is defined that the wireless computer may connect, lose the connection and then re-connect, as well. However, the mobile unit will have to restart if it is reconnected to another sub-network, requiring that running processes be shut-down and windows closed. Mobility may be limited by the wireless

service subscribed. Four basic service zones are described: Global/National service zone: Ubiquitous radio coverage throughout a region, country or the entire globe, low user densities, and minimal bandwidth requirements.

Typically satellite systems. Mobile service zone: Radio coverage in urban, suburban and populated rural areas, medium to high user densities, low to medium bandwidth requirements (tens of Kbps), and high vehicular speed.

Cellular (AMPS) system is a good example. Local/micro service zone: Radio coverage in densely populated urban areas, shopping malls, and transportation centers. High enduser densities,

medium bandwidth requirements, hand-held portable terminals, low-speed mobility. Indoor/pica service zone: in-building radio coverage, low to high

user densities, medium to high bandwidth requirements (Mbps), very low mobility. Prior to the cellular phone network, base station radio covering a

single cell geographic area with a fixed number of channels was the only

service available. The cellular phone service divides the service area into

cells and assigns a subset of the available channels to any given cell. This way the channels can be reused and interference from neighboring cells is

reduced. The system tracks the active mobile unit, delivers calls, and

maintains connections as units move between cells (Hand-off: a realtime

transfer of a call between radio channels in different cells). This system is

called Advanced Mobile Phone Service (AMPS). Current cellular systems use

analog FM technology. However, implementation of digital radio technology is

being deployed now. These systems utilize Time Division Multiple Access

(TDMA) or Code Division Multiple Access (CDMA) to increase throughput up to

ten times the previous analog system. Additionally, end users will access a

wider range of telecommunications as the implementation of integrated services digital network (ISDN) principles are utilized. Personal Communication Services, similar to the current cellular system, will soon be available from the larger telecommunication services, but with reduced price and wider availability. Wireless Advantages Limitations Traditional Cellular no restrictions on length or type of data transmission national coverage bill by minute potential line interruptions, congestions in urban areas limited throughput CDPD enhanced technology for data over cellular bill by message size integrated voice and data packet switching error correction techniques lack of applications development not fully developed Dedicated packet switched mobile networks integrated applications and communications no call setup time inherent reliability and security of packet switching coverage not full nationwide limited packet size require specialized modems data only Specialized mobile radio voice and data vehicle based limited coverage Satellite-enabled networks geographic reach expensive equipment and service costs The application of the wireless computing system determines the type of wireless medium system to be employed. Circuit switched or packet switched, both are available through wireless technology and provide connectivity. Circuit switched systems provide a continuous connection established to the destination by the switching system. The most popular examples are the wireline public switched telephone network (PSTN) and cellular telephones systems. This method of communication can be relatively expensive. If the phone systems offers voice grade bandwidth, then a standard modem can provide speed of 14.4 Kbps (at the time of this writing). However, if a digital line is provided then higher communication rates can be achieved with more specialized equipment. Packet switched

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systems provide a delivery system of information packets. The packet contains the data and an address to the destination. Packet switching is far less expensive than circuit switching. Examples would be RAM, ARDIS, and Internet networks. Packet radio networks have been the target of many studies since the military has a vested interest in the communication medium. Concerns such as reliability, throughput optimization and re-routing of packets have been recent topics.

Packet Switched Systems ARDIS RAM Mobile Data Circuit Cellular CDPD Network Capacity 1, 300 base stations in approx. 325 metro service area (MSA) 840 base stations in 210 MSAs 8, 000 cell sites in 734 metro areas potentially entire cellular network Coverage (cities and towns) 10, 7006, 300 NANA Transmission speed 4. 8Kbps. 19. 2Kbps upgrade in major metro areas 8Kbps 38. 4Kbps to 56Kbps 19. 2Kbps Message capacity 256 bytes 512 bytes NA 114 bytes National roaming completed by mid Sept 94 yes no yes In-building coverage yes top 20 MSAs by June 1993 limited limited Cellular Digital Packet Data technology (CDPD) utilizes the space between the voice segments on cellular (AMPS) network channels and inserts a data packet. The user pays only for the packets sent as opposed to a cellular circuit switched connection. CDPD cellular communication systems such as the Ubiquity 1000 from PCSI, offer packet burst rate of 19. 2 Kbps with full duplex. This CDPD modem offers the option to use circuit switched cellular, wireline PSTN and voice support. However, in a large urban area with thousands of stations using any packet switching service at current speeds, delay may be unacceptable. Satellite can be used as long distance links within wireless networks. Three major projects have been proposed. The Teledesic system, composed of 840 low orbit satellites, was proposed by

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Bill Gates (Microsoft) and Craig McCaw (McCaw Cellular). Second, the Pentagon, solicited a system, using 1,000 smaller satellites, from TRW and Martin Marietta. Both the Teledesic and the Pentagon systems cost around \$9 billion. The third system, called Iridium, from Motorola, will use 66 satellites to offer mobile phone service all over the globe. This project will begin this year and be in place by 1996.

6 Software concerns in a wireless computing environment can be broken into two areas, system and application.

7 System Software Network operating systems must be able to handle the uniqueness of a wireless computer. Advanced operating systems utilizing distributed technology must be adapted to the specific communication media. The advancement of technology has provided that even mobile computer systems the size of notebooks are capable of internetworking as a host in global networks. Mobile host protocols compatible with TCP/IP have been developed to allow continuous network connectivity wherever the host may be. Due to the unpredictable nature of wireless connections, even operating systems may have to be written to provide support services for mobile network. The WIN\*OS, a micro kernel for a wireless-compatible operating system, was developed to “support concurrent and composable objects and coordinated communication among groups of objects through a process of agreements.”

8 Application Software Application software concerns in the wireless computing environment vary depending on the type of application and wireless medium used. For example, E-mail software must know how to communicate with the packet switched network as compared to the traditional cellular network. Software developer kits (SDK) and application programmers interfaces (API) are usually available by the service provider. Remote access software allows

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the remote user to connect to a host workstation to view the screen and control the keyboard as if the user was there. The data does not have to be communicated to the remote user and thus allows processing locally. Carbon copy and PC anywhere are among the programs which provide remote access for microcomputers. High baud rate is needed especially when a graphical user interface (GUI) is used.

### 9 Wireless Local Area Networks (WLAN)

WLAN offers the same features as a wireline LAN but without the wires. Coverage can range from a room to a building to a "campus" (wide-spread, multi-building). Both stationary desktop systems and mobile notebook computers can connect using specialized wireless LAN adapter cards. Another configuration allows wireless additions to current networks. Wireless Hubs have been developed which bridge the wireless units into the wireline network. As mentioned before, during the recent natural disasters in California, the Federal Emergency Management Agency (FEMA) set up field offices with WLAN very quickly. Here is a great example of how WLAN can be used: An ETHERNET connection over a radio link provided data from a low-power PC in a buoy to a PC on a ship. The system provided a megabyte/sec data rate for four days while guaranteeing error-free delivery of data. Even more incredible is the MBARI acoustic LAN. Since under water, radio waves travel only a few feet but sound waves can travel for miles, the acoustic LAN uses the better carrier of wireless data signals. The acoustic LAN has two 5Kbps data channels and two slow-speed command channels. The LAN is used to communicate with tilt meters and buoys. Personal Data Assistants (PDA) are the new handheld computers which also have wireless options. Using a pen-based GUI operating system, the applications are accessed from local storage. Fax, data and voice can be transferred to and

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from the PDA via cellular phone system. The AT&T EO can run a program called Gnosis which when also loaded on a remote server host will allow the user to search for documents and have them downloaded in minutes including graphics. Even though all these nifty devices such as radiomodems and PDAs are developed and marketed, a recent study of mobile professionals shows that currently relatively few spend time far from their desks. In fact, only 13 percent of mobile users spend time outside their metro area and just 1 percent outside the country. As the technology becomes more common place, more users will find themselves moving further out of their wired areas and into the wireless field. 10

Security becomes essential in wireless computing. Especially since the data is broadcast to the receiving unit. International Standards Organization (ISO) has published security services which provide for secure data and computer systems on standard wireline networks. However, these must be modified to meet the needs of mobile users and systems. Data encryption and Two possible solutions include exchanging security information between a small number of entities, or even more complex involving an information center. Infrared offers the least problem of security due fact that stations must be in the line-of-sight and the limited area of coverage, usually one room. Spread spectrum RF transmissions spread the data over a range of frequencies making interception extremely difficult. Also, low power limits the coverage area, although the signal will penetrate walls. Cellular phone networks offer no security of their own. Even though listening to these transmissions has been made unlawful, the signals can be overheard by a radio scanner. Data encryption is left up to the connecting unit. Packet radio offers inherent data security by scrambling the data

packets. Clipper chip will replace the digital encryption standard (DES). The Clipper chip boasts to be 16million times stronger with 80-bits as compared to the old DES, which has a 56-bit binary key. This chip will be used in many communication products, especially wireless. The Department of Justice and AT&T will be installing them in their telephone products. The controversy about these chips stems from the fact that they are programmed with a back door. The government can, with a court order, access the chip and monitor the communication.

### 11 Conclusion

In the relatively short time of the Information Revolution, the world has seen several technologies, first introduced as "convenient", become "essential" the basic structure of the modern lifestyle. The automobile, telephone, and the refrigerator are easy examples to cite. The wireless revolution will transform another "convenience" to a necessity. "Emerging wireless systems will provide the technology to allow people and machines to communicate anytime, anywhere, using voice, [video,] data and messaging services through telecommunications." The wireless revolution began with the introduction of the cellular phone networks. This coupled along with the reduction in size of the microcomputer and an increase in the applicable technologies. After surveying the many aspects of wireless computing, several areas stand-out and apparently require further research and development. Among those are mobile networking protocols, which would allow a mobile host to connect to any part of the network. Mobile "aware" operating systems would further allow more features catering to mobile users. Features such as built-in APIs in the OS kernel available for specific applications which would provide services pertaining to suspend/resume and store and forward operations. Standardized mobile networking protocol will allow interoperability



between open wireless systems. Advanced signal processing and speech coding techniques will allow more efficient use of bandwidth and data transfer speed. Security research at all levels will continue to remain an issue and must stay one step ahead of the criminal elements. All of these areas will help to bring about the wireless computing revolution. 12

About the authors Christopher xxxxx Christopher xxxxx is a first year Computer Science graduate student of Florida International University. He is also an operations systems analyst for xxxxxxxx xxxxxxxx xxxxxxxxxxxxxx xxxxx of Florida where he participates in the implementation of a DB2/Client-Server operating system. He graduated with a Bachelors in Computer Science from FIU in 1992. His current interests in research include mobile computing and visual object oriented programming. David R. xxxxxxxxx David R. xxxxxxxxx is currently a Master's degree candidate at Florida International University where he originally graduated with a Bachelors degree in Computer Science in 1986. He also designed curriculum and taught lower and upper division computer classes for the School of Computer Science at FIU. For six years he has been employed at xxx xxxx xxxxx as Accounting/Information systems manager. He is an avid user of mobile computers and advanced technology.

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