NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Computer Engineering

WIRLESS NETWORK

Graduation Project
COM- 400

Student: Belal Abu Salim (20001182)

Supervisor: Prof. Dr Fakhraddin Mamedov

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Abstract

When the wireless communications is coming to the offices and the homes, there are some new wireless LANs issues to be taken care of. Today we have continuously growing markets for the wireless LANs, There is also some discussion about the threats and vulnerabilities in wireless networks compared to wired networks. And last but not least the protocols and mechanisms needed in the wireless LAN are described.

This thesis will be presented in 6 sections; each or which will contain many subsections dealing with various relevant issues which need to be considered when designing a WAP application.

Chapter 1- we will define wireless networks and its connections.

Chapter 2- This paper addresses the Wireless Local Area Network (WLAN). The wireless system for Local Area Network (LAN) is an important landmark in the history of the Internet and electronic applications. It opens up existing systems, databases and intranets to mobile equipment such as telephones and hand-held terminals through a graphical customer interface. The most important benefit of WLAN is that it is independent of different mobile technologies that are used in different parts of the world.

CHAPTER 3– will provide a general introduction both to WAP and the application, which has been designed. This will include definitions, the benefits of WAP, and a literary review (wap forum, wapnet .com, phone.com)

CHAPTER 4– will discuss the practicalities and the actual architecture of the wireless application protocol.

CHAPTER 5 – will address the physical implementation of the author's application. This will include a subsection on W.M.L (wireless mark-up language) as well as the presentation of the actual cards of programming language.

CHAPTER 6– will seek to evaluate the possibilities for WAP and, how successful the author's application has been. It will also provide an in-depth analysis into the author's study.

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INTRODUCTION

Increased use of laptop computers within the enterprise, and increase in worker mobility has fuelled the demand for wireless networks. Up until recently, wireless technology was a patchwork of incompatible systems from a variety of vendors. The technology was slow, expensive and reserved for mobile situations or hostile environments where cabling was impractical or impossible. With the maturing of industry standards and the deployment of lightweight wireless networking hardware across a broad market section, wireless technology has come of age. The information offered here should apply to most wireless networking devices. I n this Knowledge Share document addresses the main types of wireless networking today based on the IEEE 802.11 standard.

Over the last five years desktop computers have changed from stand-alone workstations into networked clients which rely on connectivity. E-mail, remote storage and the Web are just a few of the uses that are common place in most institutions, both educational and commercial? In addition, computing is becoming more mobile, handheld and notebook computer sales are growing each year. A report from Dataquest I have shown that notebook sales have increased by 20% each year for the last three years and show no Sign of slowing.

This move towards mobile use and a reliance on the network has caused increasing problems for computing departments in all areas of industry and education. To address these problems Radio and Infrared technology are being used to connect mobile users to the network and provide a network infrastructure in buildings that previously would have been impossible. What was once a fledgling technology is being transformed by improved systems into a viable and cost-effective solution?

Wireless networks can be divided into two areas in much the same way that traditional wired networks are: Local Area Networks (LANs) and Wide Area Networks (WANs). As With wired networks, wireless LANs have a higher data rate and are confined to small areas such as a building or campus. Wireless WANs can cover anything from a city to a continent. This work concentrates on Local Area Networks and much of the content of this paper is dedicated to wireless LANs, however, a brief description of wireless WANs is included.

Wireless media has been undergoing a rapid innovation process in search for a reliable, simple and business-viable solution to consumer demands for fast, easy, and inexpensive information access. Over the last five years, a number of wireless protocols have been developed and a variety of application vendors have begun to ship wireless products to the market. In fact, the word "wireless" has become a staple buzzword synonymous to "cutting edge" in the software and content sales vocabulary. Among the hype and publicity over the new technology generated by vendors and media lie protocol specifications, containing the clear description of today's wireless media capabilities. This paper attempts to analyze and compare the specifications of various wireless protocols, including WAP, J2ME, I-mode, LEAP, EZWeb, and J-Sky Web, in order to evaluate protocol viability in both technical and commercial spheres.

The analysis of wireless protocols and their interaction with existing Internet infrastructures presented in this document concentrates on three specific areas: protocol efficiency and Internet-wireless communication security (including authentication, access control and authorization functions), as these two disciplines often play decisive role in protocol viability. The analysis focuses mostly on WAP, IMode, and LEAP specifications due to fact that J2ME, EZWeb, and J-Sky Web documentation has limited availability in English at the time this paper is written.

1. INTRODUCTION

In this chapter we will write about wireless networks ,we will define its contents ,how it works using lan networks

1.1 What Is Wireless Networking?

The term wireless networking refers to technology that enables two or more computers to communicate using standard network protocols, but without network cabling. Strictly speaking, any technology that does this could be called wireless networking. The current buzzword however generally refers to wireless LANs. This technology, fuelled by the emergence of cross-vendor industry standards such as IEEE 802.11, has produced a number of affordable wireless solutions that are growing in popularity with business and schools as well as sophisticated applications where network wiring is impossible, such as in warehousing or point-of-sale handheld equipment.

1.2What Is a Wireless Network Made Up Of?

There are two kinds of wireless networks: An ad-hoc, or peer-to-peer wireless network consists of a number of computers each equipped with a wireless networking interface card. Each computer can communicate directly with all of the other wireless enabled computers. They can share files and printers this way, but may not be able to access wired LAN resources, unless one of the computers acts as a bridge to the wired LAN using special software. (This is called "bridging")

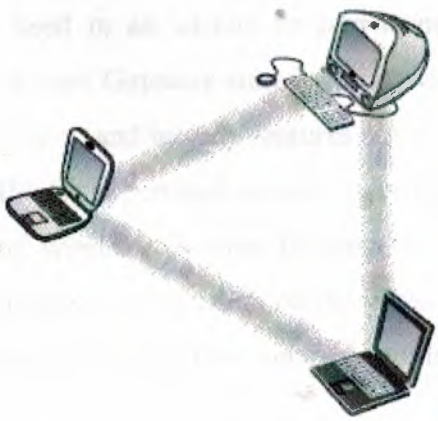

Figure 1.1 Ad-Hoc orPeer-toPeer Networking .

Each computer with a wireless interface can communicate directly with all of the others. b.A wireless network can also use an access point, or base station. In this type of network the access point acts like a hub, providing connectivity for the wireless computers. It can connect (or "bridge") the wireless LAN to a wired LAN, allowing wireless computer access to LAN resources, such as file servers or existing Internet Connectivity.

There are two types of access points:

Dedicated hardware access points (HAP) such as Lucent's WaveLAN, Apple's Airport Base Station or WebGear's AviatorPRO. (See Figure 2). Hardware access points offer comprehensive support of most wireless features, but check your requirements carefully.

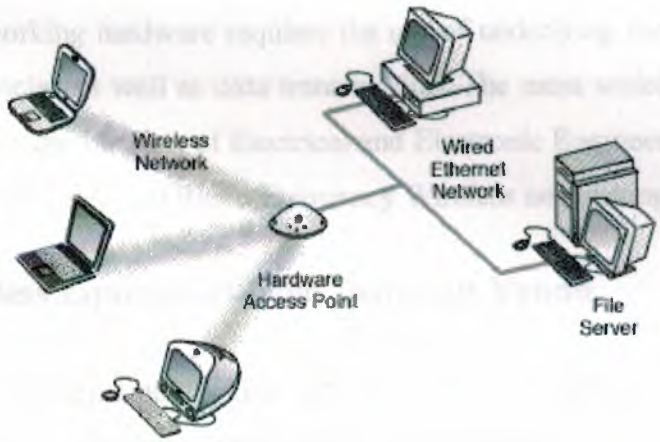

Figure 1.2 HardwareAccessPoint .

Software Access Points which run on a computer equipped with a wireless network interface card as used in an ad-hoc or peer-to-peer wireless network. (See Figure 3) The Vicomsoft Internet Gateway suites are software routers that can be used as a basic Software Access Point, and include features not commonly found in hardware solutions, such as Direct PPPoE support and extensive configuration flexibility, but may not offer the full range of wireless features defined in the 802.11 standard. With appropriate networking software support, users on the wireless LAN can share files and printers located on the wired LAN and vice versa. Vicomsoft's solutions support file sharing using TCP/IP.

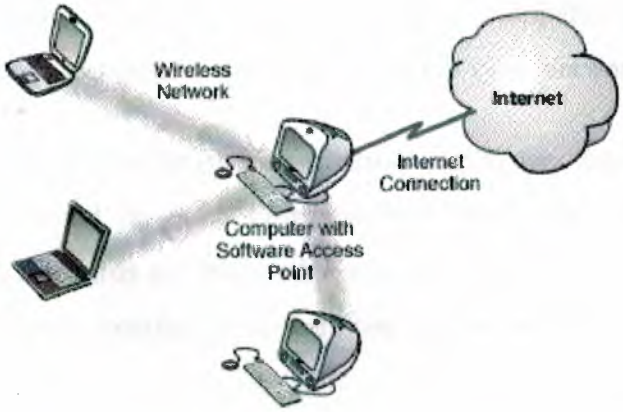

Figure 1.3 SoftwareAccessPoint .

1.3 IEEE802.11

Wireless networking hardware requires the use of underlying technology that deals with radio frequencies as well as data transmission. The most widely used standard is 802.11 produced by the Institute of Electrical and Electronic Engineers (IEEE). This is a standard defining all aspects of Radio Frequency Wireless networking.

1.4 Mix Wireless Equipment from Different Vendo

Because most wireless networking hardware vendors support the 802.11 standard they can inter operate. However, we recommend verification as the standard is a fairly recent one, and does specify two different methods for wireless communications; Frequency Hopping (FH) and Direct Sequence Spread Spectrum (DSSS or DS), which are not interoperable.

When purchasing wireless networking hardware from separate vendors be sure to obtain guarantees from the vendors that the hardware will interoperate and follows the standards.

Within a short time we expect all new wireless cards, like ethernet cards, to become inexpensive, ubiquitous and totally interoperable. Also of note is that the latest version of the standard defines 11mbps and 5.5mbps networking, with support for the older

standard 1mbps and 2mbps speeds. This provides some compatibility with different or older equipment. Note that this new standard covers DS-type Networks, not FH types.

Software access points such as the Internet Gateway which uses the wireless interface of the host computer should have no compatibility issues with third party wireless hardware, as long as standards are followed. Typically wireless hardware is identified to the software as a network interface, and therefore can be used in the same way as any other network card.

1.5 Connect a Wireless LAN with Computers on a Wired LAN

To do this you will need some sort of bridge between the wireless and wired network. This can be accomplished either with a hardware access point or a software access point. Hardware access points are available with various types of network interfaces, such as Ethernet or Token Ring, but typically require extra hardware to be purchased if your networking requirements change.

If networking requirements go beyond just interconnecting a wired network network to a small wireless network, a software access point may be the best solution. A software access point does not limit the type or number of network interfaces you use. It may also allow considerable flexibility in providing access to different network types, such as different types of Ethernet, Wireless and Token Ring networks. Such connections are only limited by the number of slots or interfaces in the computer used for this task.

Further to this the software access point may include significant additional features such as shared Internet access, web caching or content filtering, providing significant benefits to users and administrators.

1.6 The Range of a Wireless Network

Each access point has a finite range within which a wireless connection can be maintained between the client computer and the access point. The actual distance varies depending upon the environment; manufacturers typically state both indoor and outdoor ranges to give a reasonable indication of reliable performance. Also it should be noted that when operating at the limits of range the performance may drop, as the quality of connection deteriorates and the system compensates.

Typical indoor ranges are 150-300 feet, but can be shorter if the building construction interferes with radio transmissions. Longer ranges are possible, but performance will degrade with distance. Outdoor ranges are quoted up to 1000 feet, but again this depends upon the environment. There are ways to extend the basic operating range of Wireless communications, by using more than a single access point or using a wireless relay /extension point. for further information.

1.7 Wireless Networked Computers Using a Single Access Point

This depends upon the manufacturer. Some hardware access points have a recommended limit of 10, with other more expensive access points supporting up to 100 wireless connections. Using more computers than recommended will cause performance and reliability to suffer.

Software access points may also impose user limitations, but this depends upon the specific software, and the host computer's ability to process the required information.

1.8 Use More than One Access Point

Yes, multiple access points can be connected to a wired LAN, or sometimes even to a second wireless LAN if the access point supports this.

In most cases, separate access points are interconnected via a wired LAN, providing wireless connectivity in specific areas such as offices or classrooms, but connected to a main wired LAN for access to network resources, such as file servers. a single area is too large to be covered by a single access point, then multiple access points or extension points can be used. -- Note that an "extension point" is not defined in the wireless standard, but have been developed by some manufacturers. When using multiple access points, each access point wireless area should overlap its neighbors. This provides a seamless area for users to move around in using a feature called "roaming. " (See the next an explanation of Roaming) .

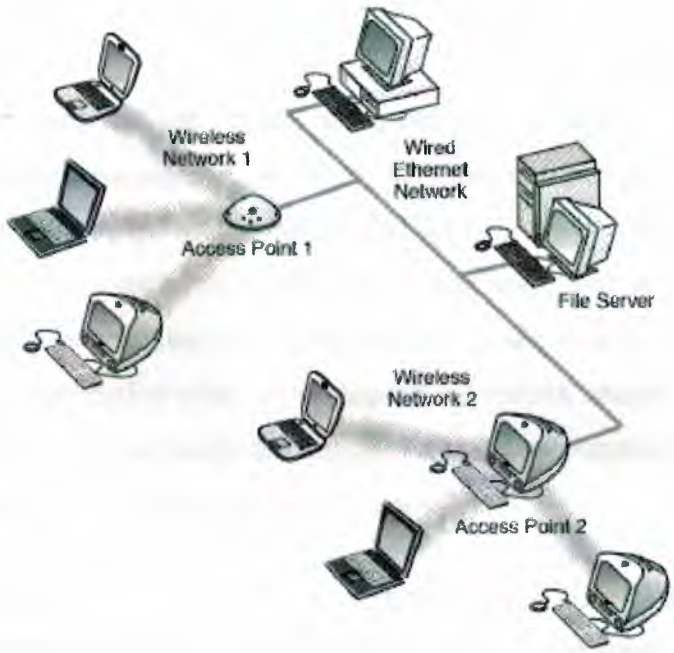

Figure 1.4 MultipleAccessPoints .

Some manufacturers produce extension points, which act as wireless relays, extending the range of a single access point. Multiple extension points can be strung together to provide wireless access to far away locations from the central access point.

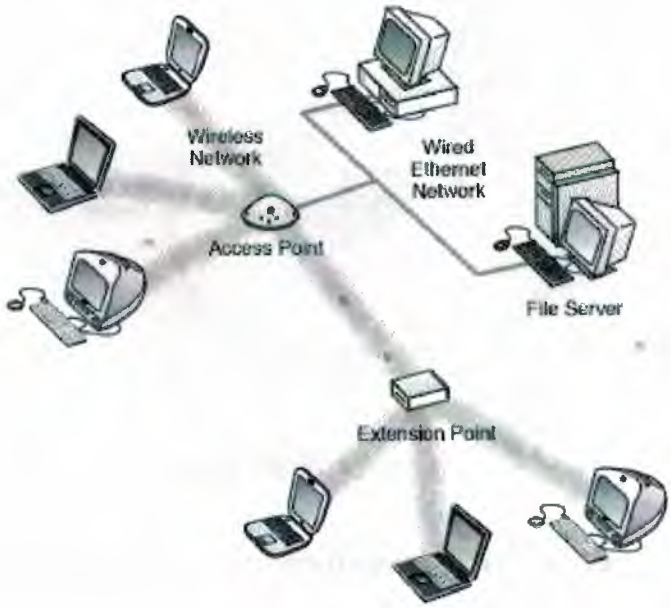

Figure 1.5 Access Point with an Extension Point .

1.9 Roaming

A wireless computer can "roam" from one access point to another, with the software and hardware maintaining a steady network connection by monitoring the signal strength from in-range access points and locking on to the one with the best quality. Usually this is completely transparent to the user; they are not aware that a different access point is being used from area to area. Some access point configurations require security authentication when swapping access points, usually in the form of a password dialog box. Access points are required to have overlapping wireless areas to achieve this as can be seen in the following diagram:

A user can move from Area 1 to Area 2 transparently. The Wireless networking hardware automatically swaps to the Access Point with the best signal.

Not all access points are capable of being configured to support roaming. Also of note is that any access points for a single vendor should be used when implementing roaming, as there is no official standard for this feature.

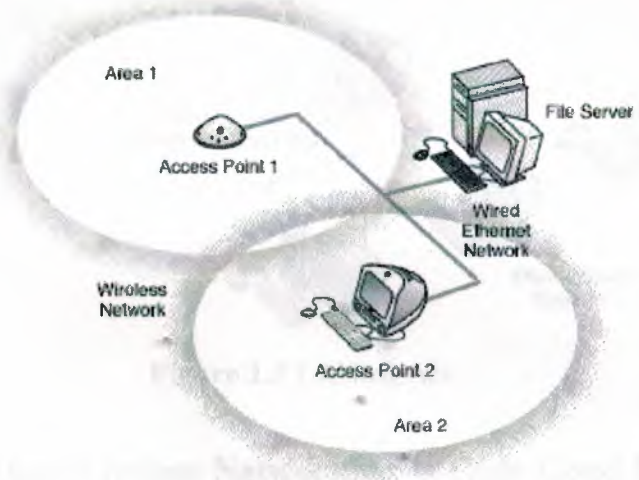

Figure 1.6 Roaming .

1.10 Use a Wireless Network to Interconnect Two LANs

Yes. Wireless networking offers a cost-effective solution to users with difficult physical installations such as campuses, hospitals or businesses with more than one location in immediate proximity but separated by public thoroughfare. This type of

installation requires two access points. Each access point acts as a bridge or router connecting its own LAN to the wireless connection. The wireless connection allows the two access points to communicate with each other, and therefore interconnect the two LAN's.

A Hardware Access Point providing wireless connectivity to local computers and a software access point. The software access point provides Wired Ethernet network 2 computers access to Wired Network 1. Note that not all hardware access points have the ability to directly interconnect to another hardware access point, and that the subject of interconnecting LAN's over wireless connections is a large and complex one, Wireless Communications .

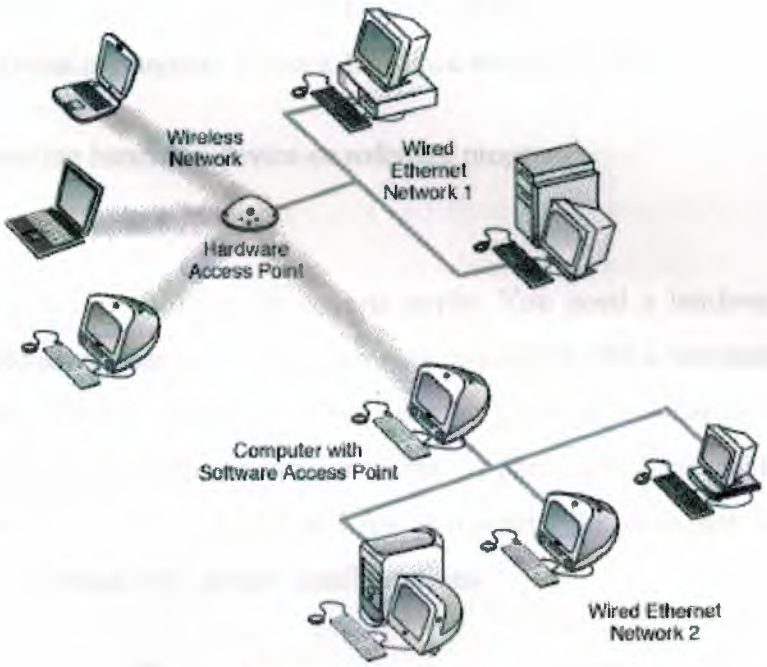

Figure 1.7 LANtoLAN .

1.11 It Is True That Wireless Networking Is Only Good For Laptop Computers?

Although wireless networking offers obvious benefits to users of laptops who move from location to location throughout the day, there are benefits for users of fixed position computers as well:

Many schools and businesses have unsuitable building layouts or walls that cannot be wired for various reasons making it difficult or impossible to build a wired network. Wireless networking in these environments is a very cost effective alternative also providing future flexibility. In cases where a small number of computers are separated from a main network a wireless link may be more cost effective than network cabling although the latter is perfectly feasible. Temporary wireless LANs can easily be created for exhibitions, school or business projects, all without any trailing cabling.

1.12Wireless Networking and the Internet

1.12.1 Use A Wireless Network to Share An Internet Connection

Once you realise that wireless cards are analogous to ethernet cards and that empty space is analogous to ethernet cabling, the answer to this question becomes clear. To share an Internet connection across a LAN you need two things:

1.an Internet sharing hardware device or software program

2.a LAN

If your LAN is wireless, the same criteria apply. You need a hardware or software access point and a wireless LAN. Any computer equipped with a wireless network card running suitable Internet sharing software can be used as a software access point.a number of vendors offer hardware access points. A hardware access point may provide Internet Sharing capabilities to Wired LAN computers, but does not usually provide much flexibility beyond very simple configurations.

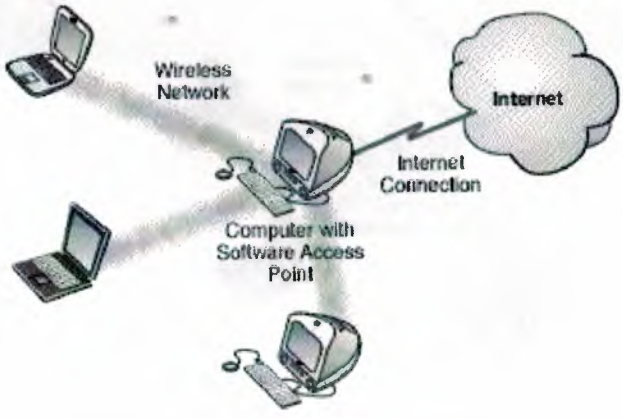

Figure 1.8 SoftwareAccessPoint .

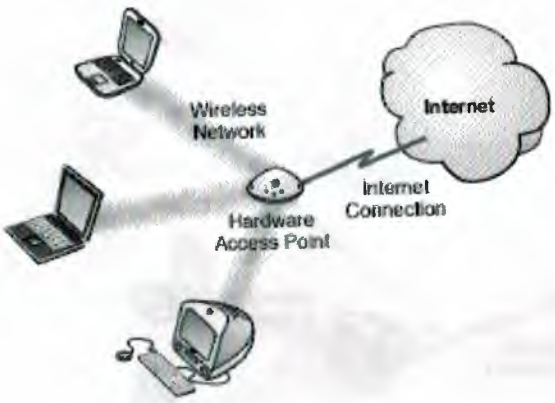

Figure 1.9 HardwareAccessPoint .

1.12.2 Share A Single Internet Connection More Than One Hardware Access Point

If an existing wired LAN already has an Internet connection, then the hardware access points simply connect to your LAN and allow wireless computers to access the existing Internet connection in the same way as wired LAN computers.

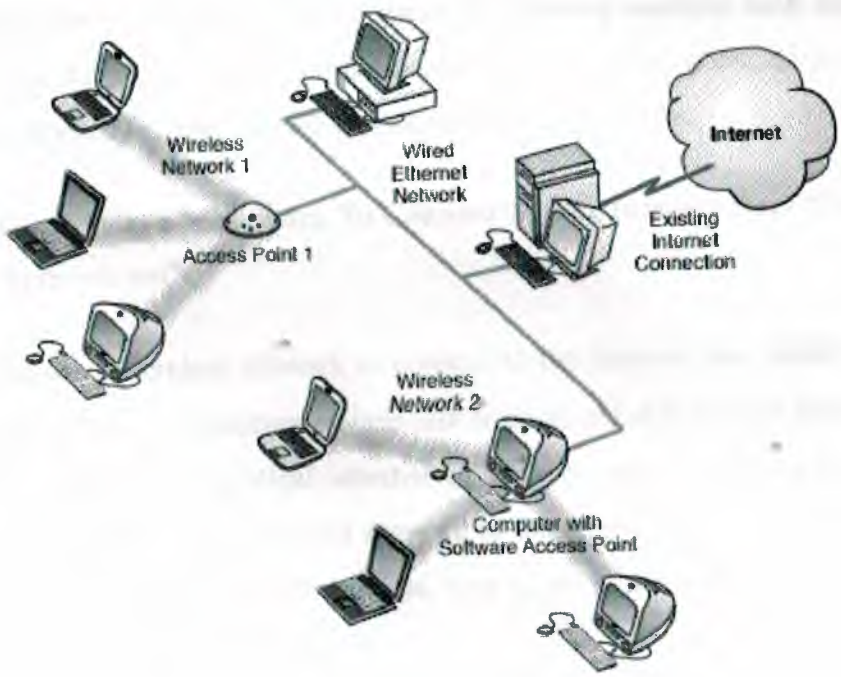

Figure 1.10 MultipleAccessPoints .

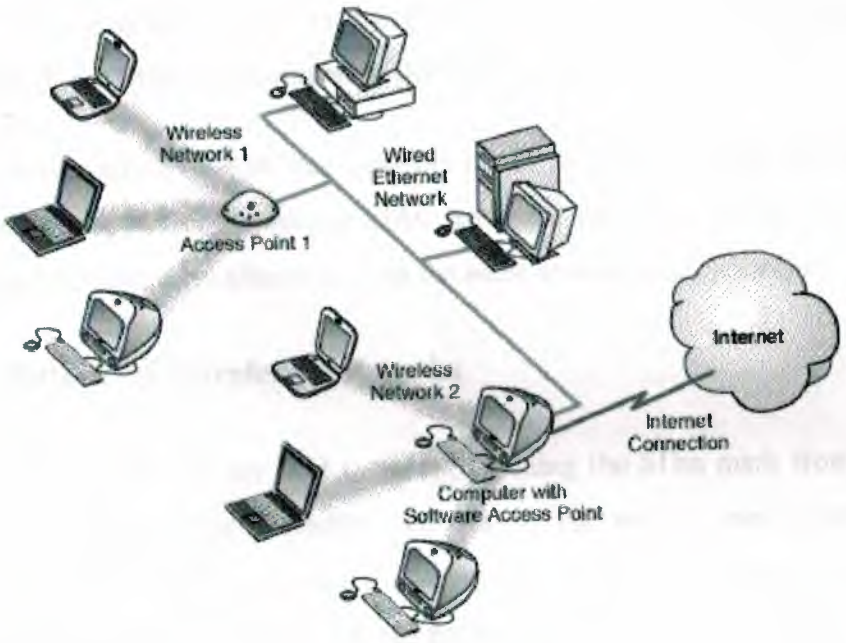

Figure 1.11 Multiple Access Points .

If there is no existing Internet connection, then this depends on the access point: Wireless connected computers using Multiple Access Points. All wired and wireless computers access the Internet through a single software access point. If an access point provides some form of Internet sharing itself, then having multiple such access points connected to a wired LAN may require some special configuration, or possibly may require an additional Internet sharing device or software program.

1.12.3 If I Use A Wireless Network To Connect To The Internet Does My Isp Need A wireless network too?

If you use a wireless network to connect to the Internet, the wireless part only concerns your LAN. The communications link from your LAN to your Internet service provider (ISP) would be identical whether or not you had a wireless network. For example, if you connected an ethernet network to the Internet via a 56K modem, when you upgraded your network to use wireless, you would still use the same 56K modem to connect to the Internet.

1.12.4 Can Networking Software İdentify A Wireless Computer İn The Same Way İt Can İdentify An Ethernet Computer On The Network?

Wireless cards look just like ethernet cards to your network drivers. In fact, wireless networking cards have unique MAC hardware addresses that are formatted like ethernet hardware addresses allocated from the same standards organization.

1.13 The Future of Wireless Networks

Wireless LAN sales are said to be approaching the $1bn mark from a level of only $157m in 1995. This incredible growth in the market has prompted those networking manufacturers not currently offering systems to begin developing their own wireless products. More importantly, it has prompted those already established to begin research and development into new and improved wireless technologies. Research is being conducted by large companies such as British Telecom and in Universities throughout the world. Improved speeds and reliability along with new systems will help wireless technology maintain a footing in the ever increasing and competitive networking market. Some of the projects and advancements are discussed below.

The IEEE 802.11 Working Group has set up a study group to develop the standard in order to take advantage of some the advancements being made in research and development. Current projects under review include methods of achieving higher speeds in the current 2.4 GHz band and new systems which operate in the higher 5 GHz band which hope to yield improved performance. In addition to these, products are becoming available which use Quadrant Phase Shift Keying (QPSK) and Quadrant Amplitude Modulation (QAM). These methods, already used in modem technology, allow a greater number of binary combinations to be represented by a single signal increasing system performance. Speeds of 3.2Mbits/s are capable, compared to 2Mbits/s with conventional techniques.

The University of San Diego's Centre for Wireless Communication is currently working on a number of important projects regarding wireless LANs and WANs. Energy Constrained Wireless Communication is a project designed to investigate Battery Conservation in the mobile environment. The research revolves around how the

wireless link can be used most efficiently with close examination of error detection and recovery to prevent packet retransmission.

Asynchronous Transfer Mode (ATM) networks are rapidly becoming an important area of network technology and many papers have been written on wireless ATM. The major ATM standards bodies have yet to define any standards for wireless ATM. Despite this, several projects have been undertaken by Industry and Education. Two such projects are WAND (Wireless ATM Network Demonstrator) which aims to develop a 20Mbit/s ATM air interface in the 17 GHz frequency and MEDIAN (Wireless Broadband CPN/LAN for Professional and Residential Multimedia Applications) which operates at 155Mbit/s in the 60 GHz band.

British Telecom is a large investor in research and development and has done considerable work in wireless communication. A recent publication has demonstrated how BT is committed to wireless LANs in the office and home. They have developed a new type of access point which they have named the 'passive Pico cell'. The Pico cell emits radio waves which can be used to communicate data over a network; the Pico cell is connected back to a central network server using fiber optic cables which carry the radio waves on a carrier pulse of light. This feat is achieved using an alloy based on indium phosphate which translates radio waves into light and vice versa. The unit has several advantages, namely that no power is required and the units are small, inexpensive and maintenance free. The units could cost as little as £35 each and the technology should be commercially available by 2005.

2. WİRELESS LAN NETWORKİNG

Wireless LAN is a networking technology that allows the connection of computers without any wires and cables, mostly using radio and infrared frequency (RF) technology. It's called LAN because the range targets within an office, a building, a store, a small campus, or just a house.

2.1 Mobility

The most important benefits of WLAN are flexibility, mobility and portability, but no industry standard currently addresses the tracking or management of mobile equipment in its Management Information Base (MIB). This omission would reject customers from roaming between WLAN AP s that cover a common work area, such as a complete floor of a building.

The manufacture has engineered this problem, offering its own solutions of flexibility algorithms that facilitate roaming within an IP domain such as a floor with an eye towards optimizing roaming across IP domains.

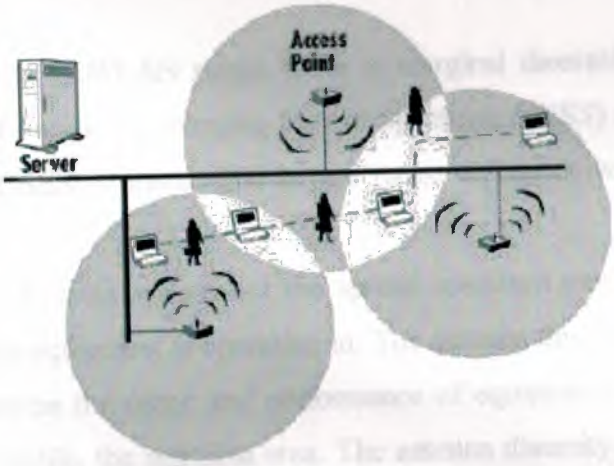

Figure 2.1 Handing off the WLAN Connection Between Aps .

The WLAN equipment can provide customers with connectivity to real-time information anywhere in their work areas. This flexibility supports productivity and service opportunities not possible with traditional wired networks. Installation of WLAN equipment can be fast, easy and can eliminate the need to pull cable through walls and ceilings.

This new equipment enables technology, through a gateway infrastructure deployed in mobile operator's network; this will bridge the gap between the mobile world and the intranet, bringing sophisticated solutions to WLAN customers, independent of the

bearer and network. When a customer sends data using WLAN equipment, it sends low energy radio waves to a local antenna site, which connects the customer with the landline or wireless location from where the customer is dialing. That same antenna also sends signals back to the customer wireless equipment. The WLAN equipment has the ability to move from one area to another within an adequate range. This technology allows services to derive the function and added value of the WLAN network. There is a key set of general functions and basis services that must be supported to have a viable service offering. This key set of functions and services includes the ability for the customer's computer to register, transmit which is to send, receive, and maintain data via one or more different media types. These features can be provided to the customer within a reasonable time if a tactical mission is on the horizon. The RF result is low power, and works with an AP that sends the radio waves to several customers. High expand antennas and multiple APs are required to send the signals over thousands of feet, see figure 2. Handing off the WLAN Connection between APs.

2.2 Range

In the analysis of WLAN range, there is marginal theoretical difference in the range capabilities of Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS) systems. The largest range difference will be caused by two sources; the type
and location of the antenna system not the spread spectrum modulation used and the environment that the equipment is operating in. The antenna diversity is one of the most important influences on the range and performance of equipment, particularly near the edge of the range profile, the marginal area. The antenna diversity is the use of multiple antennas that are physically separated. This is done because the radio waves will reflect off all objects, walls, buildings, bridges, cars, hills, trees, etc and cause nulls and peaks arbitrarily distributed in the air (OCBN, 2001).

It is significant for a good path to have a high height for the antenna. Basically, a better antenna elevation means better connectivity range, with all other things being equal. An appropriate antenna height would be required to "shoot over" path obstructions like hills or trees and also to reach suitable "Fresnel" zone permission, see figure 5 on WLAN frequency & range. This is much the same as the peaks and troughs

that are seen on the surface of water when separate waves encounter each other and are called "Multipath" in the radio environment. With two antennas separated by a quarter of a wavelength, a few inches for 2.4 GHz band, it is statistically very unlikely that both antennas will be in a null or wave trough at the same time, whereas a single antenna will be realistically possible to be in a null in a highly reflective environment, such as an office building (Proxim, 1998).

Figure 2.2 WLAN Range Between Client And AP .

For a better performance, large antennas placed high above the ground will always provide better range than small antennas that extend marginally from a Personal Computer (PC) card and are low down on the side of a notebook computer. The range of the different equipment components is therefore different. Single PC cards have the shortest range, 100-500 feet depending on the environment, see figure 3. An AP with elevated, efficient antennas will achieve up to 3000 feet. Fortunately in most communication equipment the client card will communicate with an AP and the overall link will benefit from the better antenna on the AP, though it will still have a shorter range than two APs communicating with each other.

The environment that the equipment is used in has a very significant influence on the rangeland performance. This should be of a little surprise to everyone that has used a cordless phone, as they suffer from similar range and performance problems as WLAN. When the environments outside, in line of sight (LOS), with little to reflect off and cause multi-path, the range is at its best. When the environment is in a solid walled building, such as an old stone house or in the building basement, the range is greatly reduced. This is the same for WLAN; however the multipath problem can significantly

degrade megabit communications where it will not significantly affect connectivity quality.

Every WLAN configuration is different, when engineering an in-building solution, varying facility sizes, construction materials, and interior divisions raise a host of transmission and multipath considerations. When implementing a building-to-building solution, range, physical obstructions between facilities, and number of transmission points involved must be accounted for. Several factors come into evaluation when measuring radio transmission range like, transmitter power, receiver sensitivity, antenna gain, antenna height, RF cable attenuation (RF connection from transmitter to antenna), and terrain. Since WLAN equipment operates in the 2.4 GHz band they need a LOS transmission path. The link range will be severely degraded if trees, hills, walls, heavy fog, or other obstructions are in the radio transmission path. It is very difficult to predict link range achievement for non-LOS paths.
Most office environments are constructed of materials that are relatively "translucent" to radio waves at 2.4 GHz so the range will not be greatly limited, however they do tend to present very reflective and refractive environments and the ultimate limitation will probably be caused by severe multi-path problems. Range up to 80 meters was achieved in point to multipoint tent configurations. Indoor range is considerably less and depends on the physical layout. Equipment based on the "Bluetooth" WLAN technology interferes with IEEE 802.11b WLAN. For most cases, Germany and European cities in general, support 2.4 Gbps transmissions to 100 mw:

100mw = 1mw transmitter * 20 dbi Dish Antenna
100mw = 5mw transmitter * 14 or 15dbi Yagi Antenna
100mw = 50mw transmitter * 2dbi monopole antenna

The standard IEEE 802.11b data is encoded using DSSS technology. The DSSS works by taking a data stream of zeros and ones and modulating it with a second pattern, the chipping sequence. The standard IEEE 802.11, that sequence is known as the Barker code, which is an 11-bit sequence (10110111000) that has certain mathematical properties making it ideal for modulating radio waves. The basic data stream is exclusive OR'd with the Barker code to generate a series of data objects called

chips. Each bit is "encoded" by the 11-bit Barker code, and each group of 11 chips encodes one bit of data (Conover, 2000).

Communication network managers often find that WLAN fall short of expected range. Even though a vendor's specifications may say that the equipment has a range of 300 feet, obstacles such as walls, desks and filing cabinets can significantly reduce the range in some directions.

This results in an irregular propagation pattern of the radio signal. To provide adequate radio coverage throughout work areas, communication network manager needs to perform a RF site survey that determines the number and location of APs, as well as uncover potential RF interference .

2.3 Frequency

The FHSS uses a slim band carrier that changes frequency in a pattern known to both transmitter and receiver. Properly synchronized, the net effect is to maintain a single logical channel. To an unintended receiver, FHSS appears to be short duration impulse noise (NDC Communications, 1999).

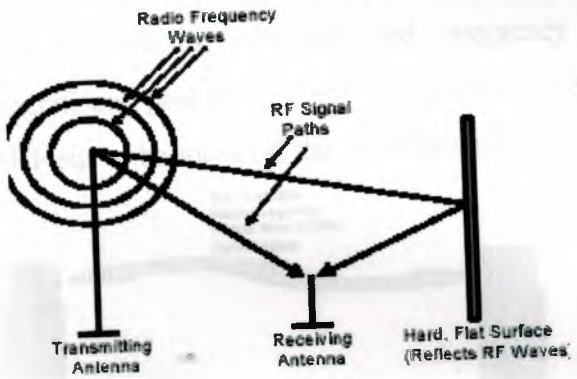

Figure 2.3 WLAN RF .

There are two main technologies that are used for WLAN communications today, RF and infra red (IR). In general they are good for different applications and have been designed into products that optimize the particular features of advantage. The RF is very capable of being used for applications where communications are not LOS and over longer range. The RF signals will travel through walls and communicate where there is no direct path between the equipment. In order to operate in the license free

portion of the spectrum called the industrial, Scientific and Medical (ISM) band, the radio system must use a modulation technique called Spread Spectrum (SS). In this mode a radio is required to distribute the signal across the entire spectrum and cannot remain stable on a single frequency. This is done so that no single customer can dominate the band and collectively all users look like noise (NDC Comm., 1999).

The SS communications were developed during World War II by the military for secure communications links. The fact that such signals appear to be noise in the band means that they are difficult to find and to jam. This technique lends itself well to the expected conditions of operation of a real WLAN application in this band and is by its very nature difficult to intercept, thus increasing security against unauthorized listeners, see figure 5 for WLAN frequency and range.

The WLAN uses RF or IR instead of copper or fiber optic cable to connect customers together into a LAN. The WLAN is appealing because it allows customer mobility, flexibility can easily be reconfigured, and requires no cable infrastructure. The WLAN is particularly useful when mobile access to data is necessary, such as in health care environments and warehouses. It is also appropriate in situations where a temporary LAN is needed but no communication infrastructure is available, such as when hosting conferences at hotels or community clubs, or when providing computer based training in ad-hoc classrooms, exercises, and emergency missions. Frequency hopping addresses a significant problem with RF "transmission-Multipath" distortion, which occurs when an RF signal bounces off the stationary objects.

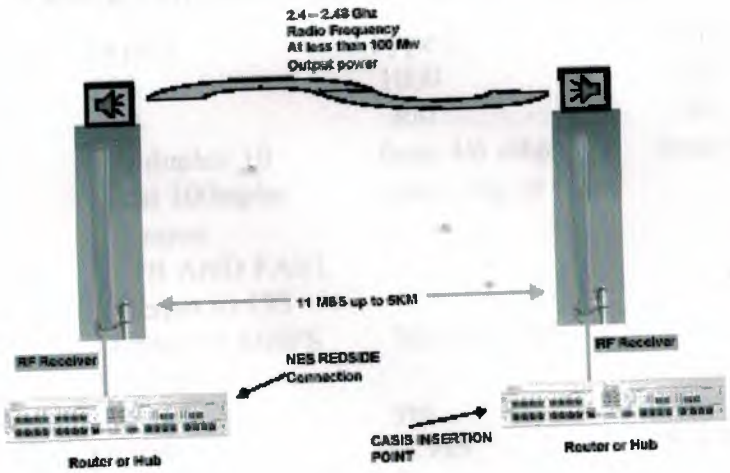

Figure 2.4 WLAN Frequency and Range .

A receiving antenna can receive multiple copies of the same signal at slightly different times, figure 4, WLAN RF, which blurs or smears the signal content causing bit detection errors. The problem is especially severe in-door where there are numerous hard, flat surfaces to "bounce" RF signals (Burd, 1998).

2.4 Equipment Cost

An analysis reveals savings can be measured in terms of equipment cost for WLAN compared to what customarily is in used for wired LAN connection. In order for two customer's to communicate over the wired network, the following are required for installation, network cable installation with, data drop ($500), PC LAN card ($50), a hub ($100), small router ($2,500), a network T1 modem ($1,300), and cable conduit between customer buildings, bringing the total to $9,000. For the WLAN, connecting two customers to a LAN, the total cost is not more than $7,000 that to include the bridge 100Mw output ($1,400), ceiling antenna ($82.00), 11Mbps DSSS AP ($990) and cable ($120). The big savings is that there is no need to open a trench to bury network cable beneath the ground, quick installation, and can easily to be removed, see table 1 on equipment cost, range and performance for three types of WLAN equipment. The relatively high cost of transmission equipment and licenses makes short wave radio a rare method for a signal user or company; instead, companies are formed to purchase and maintain the required licenses and infrastructure (Burd, 1998).

Table 2.1 Equipment Cost ,Range And Performance .

Feature	**Type 1**	**Type 2**	**Type 3**
Distance (feet):	500	1000	1000
Meters :	150	300	300
Speed/protocol:	full duplex 10 T3 to 100mpbs Ethernet FDDI AND FAST Ethernet to 155 Duplex 10 MBPS Ethernet	from 4/6 mbps token ring to full MBPS ATM	from 45mpbs
Remote management:	no	yes	yes
List price $us	$6.995	$8.995	$16.995

For usual wired LAN connectivity, the immediate cost is high, the installation site requires extra money compared to the WLAN connectivity, this is not to include the wired cable is a lease line, and switched line rates, the actual rates for dedicated leased

lines may vary from one country to another. In the U.S. the rates are based on range, see table 2 for leased line rates and table 3 for switched line rates in the U.S .

Table 2.2 Leased Line Rates İn Germany

Range	Rate
First 100 miles	$2.52 per mile
Next 900 mike (101-1000)	$0.94 per mile
Each mile over 1000	$0.58 per mile

TABLE 2 LEASED LINE RATES IN U.S.

Type of Charge	Rate
First minute of connect time	$0.60
Each additional minute	$0.40

Table 3 switched line rates

Line Type	Rate (Year)	One Time Cost
E1 speed	$87.732	$5.000
T1 speed	$84.264	$5.000
Fiber 2 strands	$252.000	
Distance 40km		

Factor in the price of a mobile device plus application software, wireless service, maintenance and support, each user's tally can reach $3000 annually (Bednarz, 2001). Table 5 shows the immediate and recurring requirements comparison for two LANs, the traditional wired LAN and WLAN. The difference between these two LANs is small.

A WLAN implementation includes both infrastructure costs for the Wireless APs and user costs for the wireless LAN adapters. Infrastructure costs depend mainly on the number of APs deployed, APs range in price from $800.00 to $2,000.00. The number of APs typically depends on the required coverage region and/or the number and types of customers to be supported. The supported area is proportional to the square of th product range

Table 2.3 Two Types Of Lans Comparison

Immediate Requirements	**Wired LAN**	**W LAN**
Equipment upgrades:	x	x
Documentation:	x	x
Site preparation (AC.raised floor.Etc...)	x	---
Hardware installation:	x	x
Installation applications:	x	x
Testing:	x	x
Training	x	x
Installation of cabling:	x	---
Equipment software installation	x	x
Creating user environments:	x	x
Space required for new equipment:	x	---
Supplies and spares:	x	x
Backup:	x	x
Recurring requirements:		
LAN management:	x	x
Consumable supplies:	x	x
Hardware and software maintenance:	x	x
Training	x	x

2.5 Equipment Bandwidth and Performance

The WLAN protocol is engineered to reduce the demanded bandwidth and maximize the number of wireless network types that can deliver. Multiple WLAN networks within an area can be achieved, with the additional aim of multiple networks. In other words, an IP-networked world will enable the multimedia evolution to optimize the bandwidth required to support the multimedia applications demanded by the marketplace. This will reduce the cost to own or lease a dedicated LAN circuit. The WLAN equipment can go point-to-point (PPP), speed up to 100MB at range of 3000 meters. The WLAN equipment speed is adequate among customers to send and receive e-mail messages, upload and download documents (PowerPoint briefing slides, spreadsheet, etc.) and small data files, see table 1 equipment cost, range and performance for WLAN performance.

The ISM spread spectrum bands do not offer a great deal of bandwidth, keeping data rates lower than desired for some applications. The IEEE 802.11 working group, however, dealt with methods to compress transmission data, making the best use of available bandwidth. Efforts are also underway to increase the data rate of 802.11 to accommodate the growing need for exchanging larger and larger bandwidths .

The standard for WLAN networks is IEEE 802.11b. The 802.11b standard specifies the use of DSSS in the 2.4 GHz band. Most European countries have a maximum of 100mw power output. The data communications rate for this standard is at 1 and 2 Mbps. The 802.11b high-rate (HR) Wi-Fi version of the standard increases the throughput to 11 Mbps but the same power maximum applies in Europe. The WLAN equipment can theoretically support up to 200 customers. Table 7 compares the conventional wired LAN and WLAN. The evaluation performance rates criteria on a scale of 1 to 5, with 1 being best.

Table 2.4 Types Of Media .

Type of Media	**Maximum BPS (Kilobits per Sec)**
Twisted pair-unshielded/shielded	2m-100m (million)
Coaxial cable-base band/broadband	264m-550m (million)
Satellite/terrestrial microwave	100m (million)
Wireless LAN	3.3m (million)
Infrared LAN	4m (million)
Fiber optic cable	40G (billion)

Figure 2.5 WLAN Performance

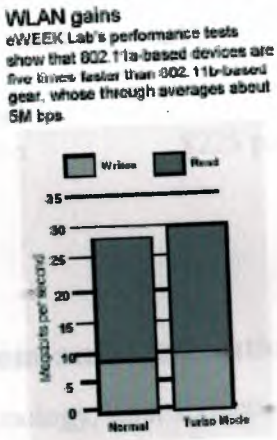

Table 2.5 LANs Comparison

CRITERIA	**WIRED LAN**	**W LAN**
Number of workstations:	1	4
Initial cost:	4	2
Personnel costs:	5	1
Operations/maintenance costs:	5	2

The "Multipath" Fading problem is caused by a signal bouncing off the walls and other surfaces, as the signal arrives at the receiver, a reflection of the signal will arrive shortly afterwards. This causes interference as old signals arrive at the same time as the new data. Frequency hopping equipment is protected from this problem since a reflected signal arrives after the receiver has hopped to a new frequency and any signal on the old frequency is ignored. Direct sequence systems do not have this advantage, however a technique identified as antenna diversity allows them to show some improvement. Antenna diversity involves having two antennas built into the hardware. Two antennas allow the equipment to determine which signal is stronger (Canterbury Campus, 2001). Table 8 displays the IEEE series topologies and protocols:

Table 2.6 IEEE Series Comparison

CRITERIA	**IEEE 802.3**	**IEEE802.5**	**IEEE802.11**
Speed:	10.100.1000mpbs	4.16.100 Mpbs	vary
Medium:	twisted –pair wires Coaxial cable, fiber optic	twisted –pair wires	wireless
Range:	500m for thick table Up to 1000m 185m for thin-net cable Up to 2500m W/repeaters	366m for the main ring 750w/repeaters 4000m fiber optic	
Number Of stations	802.3-100 per thick	260	200
Cost for Nic and Connectors Only:	$30 per thin-net $50 per station	$225 per station	N/A

2.6 Equipment Procurement and Installation

In view of wireless technology, cost reductions of network components will be possible compared to alternative technologies like traditional wired LAN. Cards that plug into PC or laptop are promptly available, and operate either Peer-to-Peer or Peer-to-AP Mode. The WLAN equipment can be configured in a matter of hours while customarily used equipment (hard wire) can take a week to a month if cable between customers is not available. For scalability, WLAN can be installed and configured in a variety of topologies to meet the needs of specific applications and installations, see figure 7 on vendor equipment.

Table 2.7 WLAN vendors

Vendor	Product	Type	Data Rate	Power	Max Indoor Range (Indoor/Outdoor)		Configuration	Work Station?	Price ($US)	Miscellaneous
Aironet	PC4500	FH	Up to 2 Mbps	100 mW	130 m	300 m	PCMCIA Type II	U	-	IEEE 802.11
Aironet	PC4500	DS	1 or 2 Mbps	50/100 mW	75 m (2 Mbps) 100 m (1 Mbps)	400 m (2 Mbps) 500 m (1 Mbps)	PCMCIA Type II	U	-	IEEE 802.11 compliant
Lucent	WaveLAN PC-AT Wireless Adapter	DS	2 Mbps	32 mW	240 m	-	ISA card	U	545	-
Lucent	WaveLAN PCMCIA Wireless Adapter	DS	2 Mbps	32 mW	240 m	-	PCMCIA Type II	U	495	-
Proxim	RangeLAN2 7100 ISA	FH	1.6 Mbps	100 mW	150 m	300 m	ISA card	U	595	15 channels. OEM version available.
Proxim	RangeLAN2 7401/02 PC Card	FH	1.6 Mbps	100 mW	150 m	300 m	PCMCIA Type II	U	695	15 channels. Several antennas

The WLAN configurations are easily changed and range from peer-to-peer networks suitable for a small number of customers to full infrastructure networks of thousands of customers that enable roaming over a broad area, as used in several U.S airports and hospitals. Micro cells (the physical areas covered by each of the LAN AP) are established to provide coverage to all customers, figure 8 shows a notional WLAN configuration.

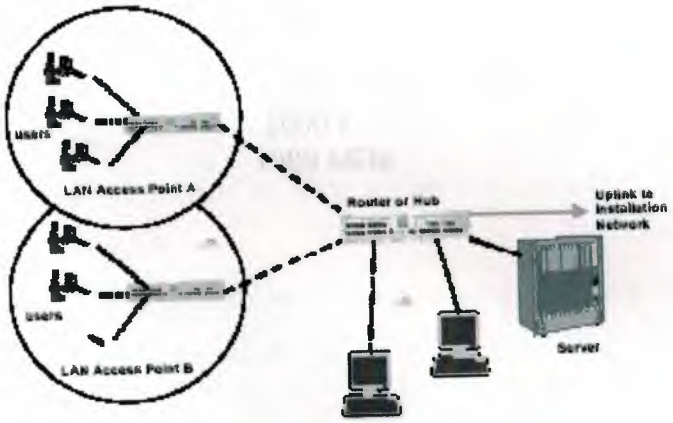

Figure 2.6 WLAN Configuration .

The range a WLAN can be from a LAN AP depends on many factors including the types and numbers of obstructions (such as walls, hills, trees, etc.), the data rate, and the equipment used.

The LAN AP serves as the LAN hub for the WLAN customers and as connection points into normal building LANs. Each LAN AP typically supports large number of customers, depending upon their network use.

A variety of factors must be considered when selecting type equipment for LAN connectivity. The company should decide whether a wired LAN is required or an alternative like WLAN will be sufficient. Factors, which must be considered, include cost- effectiveness, hardware, application software, security, training, etc. The weight associated with each selection criterion may differ among companies. In making the right selection, company management and IT analysts need to evaluate the alternatives from the perspective of their companies' immediate short-term and long-term communication objectives, see evaluation criteria below.

Table 2.8 Criteria Selection .

CRITERIA	WLAN	OTHERS
Cost:	$8.995	$6.548
Number of concurrent users:	8	6
Medium:	yes	no
Expandability:	yes	yes
Software and hardware:	yes	no
Number of work stations:	10	5
Type of use:		
Mobility and flexibility:	yes	yes
Speed:	to much	very much
Vendor on site:	yes	no
Applications:	---	---
Security:	yes	no
Range:	1000 z	2000 Hz
Frequency:	1000 MHz	2000MHz

2.7 Security

The WLAN service cannot be perfectly secured, but the wireless industry has made significant investments to prevent intruders and hackers. The WLAN equipment can support session layer protocols that establish the connection between applications, enforces rules for carrying on the dialogue, and tries to re-establish the connection if a failure occurs. The WLAN manufacturing companies claim that the current IEEE

802.11b standard contains an optional 40- bit encryption algorithm to ensure data sent over the air is scrambled and remains private.

A small research group at the University of California at Berkeley in recent times put out a statement stating that they found flaws in the. IEEE 802.11 standard (and IEEE 802.11b standard). Their statement says that they were able to intercept transmissions over the wireless network. These transmissions were encrypted, but the encryption was broken (Dunne, 2001).

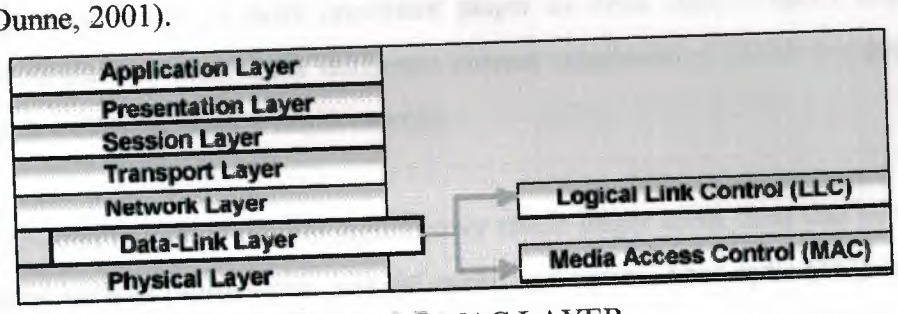

Figure 2.7 MAC LAYER

A company may implement WLAN for the customer's specific requirement; however, WLAN security is the most serious issue that a customer must consider. Most WLAN circuits enter European controlled areas; non-secure encryption device is a requirement. Throughput is the next most critical WLAN issue. WLAN should not be used for critical data transfer without a study on the maximum throughput requirement. The WLAN technology is considered an emerging technology, and therefore should be approached with caution. The technology is largely untested for the secure environment, and it introduces a potential for operational data-loss and yet-unknown security risks.

As with wired networks, the first line of security defense is the customer IDs and passwords in the operating system of client computers and servers. Additional security varies from one AP to another.

Many AP manufacturers allow network administrators to limit AP connections by creating a table of wireless client hardware media access control (MAC) addresses, see figure 9 above on MAC layer. There is no WLAN solution exists for sensitive data processing. Also, before any wireless equipment is procured or operated in Europe, the customer must verify that the specific wireless equipment used has host-nation approval to be used in the country where the LAN is to be set up. Although WLAN is a part of the Information Systems Architecture (ISA), there are numerous procedural guidelines processes that must be completed before they can be implemented; host-nation approval

is required for any wireless application. Host-nation vendor equipment that is used out-of-the-box by anyone must be approved before use for company applications.
The WLAN is still considered an emerging technology. Several technologies (Fast Ethernet-Gig E, Cell Telecommunications) are in competition with this new technology and it is not determined that this technology wins out in any particular situation. It has promise and with faster data rates and longer reliable operating distance. This new technology may become a more important player as these characteristics improve. All new implementations must meet minimum current standards of 3DES for security and 100mw at 2.4 GHz frequency requirements.

The WLAN can't send or receive signals over much larger areas than that of traditional wired media such as twisted-pair, coaxial cable, and optical fiber optic (FO). In terms of privacy, therefore, the WLAN have a much larger area to protect. To utilize security, the IEEE 802.11group has to organize their work with the IEEE 802.10 standards committee accountable for developing security mechanisms for all IEEE 802 LAN series . Security mechanisms in IEEE 802.11b networks should be equivalent to existing mechanisms in wire-based networks. Traditional wired network jacks are located in buildings already protected from unauthorized access through the use of keys, badge access, facial recognition, finger printing and so forth. A customer must gain physical access to the network building in order to plug a client computer into a network jack. In contrast, a WLAN AP that is configured incorrectly may be accessed from off the grounds (for instance, from a parking lot next to the building). Properly designed WLAN secure access to the APs and isolate the APs from the internal private network prior to user authentication into the company network domain .
Empowering Empowering the customer with the ability to access a large quantity of information and services from WLAN equipment will create a new battleground. The WLAN industry will fight to provide their customers with sophisticated and value added services. As WLAN technology becomes a more secure and trusted channel by which customers may conduct their financial affairs, the market for WLAN will become even more lucrative.

2.8 Wireless LAN Applications

Below are given a few examples of how Wireless LANs can be very useful and important in various fields. These examples illustrate the many uses of Wireless LANs in health care, education and research.

2.8.1Health Care

When disaster strikes, the American Red Cross Disaster Service operates like a huge mobile warehouse, setting up, on a moment's notice, locations for receiving and storing thousands of pallets of food, supplies and equipment, and efficiently distributing those supplies to disaster victims. These operations often take place under extreme conditions: heavy storms, power and telephone outages, continuing floods and other logistical difficulties posed by the preceding destruction. Field houses for relief operations must be swiftly set up and often moved during the course of the operation.

When relief needs have been met, they must be shut down quickly and the equipment made ready for immediate deployment to a new disaster site. Voice and data communications are critical to the Red Cross operations and wireless solutions are a natural choice.

Prior to adopting a wireless application, the American Red Cross used paper-based inventory systems. Richard Hoffman, senior systems programmer with the American Red Cross National Headquarters, said recent disasters demonstrated the need for a high capacity, automated system the primary requirements for the new system were mobility, reliability, ease-of-use by staff and volunteer workers, and the ability to provide six to eight hours of continuous battery operation in the event of a power failure. Secondary requirements included tight tracking of accounting and traceability records of materials and donated goods used during the operation, in order to meet IRS tracking requirements. The system tracks everything from perishables and water to equipment such as fax machines, cellular phones and tables and chairs. The system also maintains warehouse data and transmits that data to a central logistics database at the local disaster operational headquarters. (The Red Cross central logistics database enables it to provide a current inventory of all relief material on hand for the entire operation.).

2.8.2 Education and Research

Wireless Andrew is a 2Mbit/s wireless local area network connected through access points to the wired Andrew network, a high-speed Ethernet backbone linking

buildings across the Carnegie Mellon campus. The combination of networks gives high-speed access to any user with a portable computer and a wireless LAN card from any building covered by access points. In addition, a low-bandwidth wide area network that covers the greater Pittsburgh area provides researchers and others with off-campus wireless access to campus networks. Campus network services include e-mail and file transfer, access to audio and image data, access to the library and other databases, and full Internet access.

The Institute's wireless initiative not only serves the campus community by increasing high-speed access to campus networks, it also provides an infrastructure for research in wireless communication. As the university's Dr. Ben Bennington points out, "What makes us different from other wireless technology customers is that we're not implementing an application; we're implementing infrastructure, a kind of 'honey pot' to attract people to mobility research".

In the area of infrastructure, Carnegie Mellon has anticipated the need for the next generation of systems to integrate wired and wireless networks by giving researchers a platform for developing and testing "middleware" - software that allows seamless access to the various wired and wireless networks which a roaming computer encounters. As for mobility research, the system will provide a major test bed for Carnegie Mellon and its sponsors, giving researchers in many fields, inside and outside the university, a way to explore the uses of mobile computing. Programs include systems research, development of computer platforms for mobile use, compression research, and research on the human factors of mobile computing. The Institute's ongoing development is resulting in numerous innovative uses of wireless LANs, including emergency response, health care, and vehicle maintenance. One project involves communication with trains to download diagnostic data. Another involves "wearable computers" - a project for developing innovative maintenance systems that free technicians' hands while still giving them access to engineering drawings and other information. Benefits: Increased Access to Campus Networks and Creation of Leading Research Platform.

2.9Analysis

2.9.1Advantages

• The WLAN Internet connectivity is great for any company whose site is not conducive to LAN wiring because of building or budget limitations, such as older buildings, leased space, or temporary sites.

• While the initial investment required for WLAN hardware can be higher than the cost of traditional wired LAN hardware, overall installation expenses and life-cycle costs can be significantly lower. Long-term cost benefits are greatest in dynamic environments requiring frequent moves and changes.

• The WLAN concept ensures the Internet customer, web-served mobile communication and field service productivity, the benefits of wireless communications sooner, and hard dollar savings quicker than from any other commercial equipment available today. WLAN can provide network hardware for in-building and building-to-building data networks, as well as mobile communication equipment for information capture and display.

• WLAN mobility, i.e., a student attending class on a campus accesses the Internet, accesses information, information exchanges, and learning.

• Senior executive officers, managers can present their briefings using WLAN without carrying the data files, charts, and any storage equipment.

• Trade show and branch office workers minimize setup requirements with central database thereby increasing productivity.

• Most WLAN equipment is plug-and-play. This will help to reduce the total cost to include vendor technical installation, equipment maintenance and to eliminate equipment redundancy in case of system crash.

• WLAN technology allows the network to go where regular wire cannot go.

• The WLAN was clearly better then wired in setup/teardown time and effort.

2.9.2 Disadvantages

• Due to the limited bandwidth, the WLAN technology cannot support Video teleconference (VTC). However, experts believe that WLAN will support VTC within the next five years.

• Due to the security reason, using the WLAN equipment as a contingency model s not recommended.

• The WLAN operated within typical wired LAN parameters provides less downtime and n increased invisibility to the customer.

• The WLAN technology also have obvious potentials in customer mobility and configuration changes significantly worse then wired in the risk of jamming, in the Potential or interference and in the detection of customer location.

• The WLAN is not capable to download and upload large data files.

• The WLAN is significantly worse then wired in the risk of jamming, potential for inference, and in the detection of RF signal.

• Products from different WLAN manufacturers are often incompatible with each other.

• Interference from friendly network will likely effect WLAN operation as the popularity of this industry increases.

• The WLAN equipment is not capable of sending and receiving data successfully during Field exercises in case of heavy fog or dust storm.

• The WLAN equipment has difficulties at time in sending and receiving data when a Flying object passes over a WLAN field exercise.

• If too many people or businesses in the same area have WLAN, then the band of air that they transmit signals on can become overloaded. Problems with signal interference are Already happening and there are no doubts that the airwaves will become overloaded (Dunne, 2001).

• Most office environment and modern homes are constructed of materials that are relatively "translucent" to radio waves at 2.4 GHz so the range will not be greatly limited, however they do tend to present very reflective and refractive environments and the ultimate limitations will probably be caused by severe "multipath" problems.

• The problem has been the lack of interoperability among WLAN products from different manufacturers. The classic Ethernet 802.11 standard was ignored in developing current WLAN products (Seymour 2000).

• The WLAN weakness is susceptibility to many forms of external interface and the cost of transmitting stations. In addition, United States, international authorities and treaties strictly regulate most of the bands that can support high-speed communication. Use of these bands requires an expensive license (Burd, 1998).

Conclusion

2.10 Future of WLAN

Wireless data networks have been with us, in one shape or another for over ten years. Only in the last four years however, have they become noticed in the wider market place and as a result of this, become more common. They are beginning to move from the specialized vertical markets to the broader and more profitable mass markets of local area networks. One case, which would support this trend, is the recent acquisition of Net wave by Bay Nortel. Bay Nortel, a large and well-established network equipment manufacturer has realized the growth potential in the wireless network market. Perhaps the biggest contributing factors to this trend have been the ratification of wireless network standards and the availability of the ISM band.

3. WIRELESS APPLICATION PROTOCOL

In this chapter we will discuss of the wireless network useful application, it is wireless application protocol we will study one of its useful application.

3.1 What Is WAP?

The WAP (Wireless Application protocol) is a specification for a set of communications protocols to standardise the way that wireless devices, such as cellular telephones and radio transceivers, can be used for Internet access, including the e-mail, the World Wide Web, newsgroups, and Internet relay chat. While Internet access has been possible in the past, different manufactures have used different technologies. In the future, devices and service systems that use WAP will be able to interoperate."

WAP is a technology designed to provide users of mobile terminals with rapid and efficient access to the Internet. WAP is a protocol optimised, not only for the use on the narrow band radio channels used by second generation digital wireless systems but also for the limited display capabilities and functionality of the display systems used by today's mobile terminals. WAP integrates telephony services with micro browsing and enables easy-to-use interactive Internet access from a wireless device. Common WAP applications, which are already available to users today, include many forms of on-line banking, various information points and messaging.

Wireless devices such as mobile phones have become very popular in recent years. To coin a phase "mobile phones are no longer just phones"; they are communication devices capable of running applications and communicating with other devices and applications over a wireless network. WAP is developed to be the standard means of information transportation and Internet service gateway for mobile communication services. WAP is unique in that its hardware; software platform and network are independent. It uses a lightweight browser, a client server that can be designed to have minimal footprint and hardware requirements to fit in with a wide range of different devices.

3.2 A Wireless Application – Student Service

The author of this thesis recognised that people not only value the power and usefulness of the web but also wanted to have it available while away from home or work. The hegemony or dominant ideology behind this study is simple: someone with a cell phone, pager, or PDA should be able to do limited web surfing, for example to make reservations, to purchase tickets, or to access bank accounts. But how can a small

device with a small display render web pages that contain large amounts of text? And who wants to wait for long periods of time for a huge image to be sent over a slow wireless link? And how can a user follow links without a mouse? The answer to all these questions is answered throughout this thesis and the actual physical working of these problems and the fundamental technologies of WAP are evident in the application, which has been designed by the author.

For the purpose of this study the author has implemented an in-depth student service. The theory behind this application means that it can be customised to bring any type of information to specific users. Those interested in sport will be able to read the latest results and those interested in finding out what is happening around the globe will be able to catch up on world news. With the potential that WAP offers, it is not beyond the realms of possibilities that mobile devices will be essential for us to conduct our everyday lives. If this scenario does pan out, then all types of people will use applications such as this for various purposes. The author's application will allow students with WAP compatible devices to gain access to university news. By a simple click of a button on a mobile device, students will be able to gain information and relevant news regarding events taking place in the university within the immediate future.

Much thought went into the type of application that was to be designed. However due to the fact that the final product would be displayed on a simulator it became apparent that in order to design such an application it would be necessary to incorporate all of the primary teachings of WAP.

- The actual setting up of a site.
- The workings of the Wireless Mark-up Language.
- The architecture of the WAP environment.
- And how to travel from page to page, or card to card as it's called within the field of WAP.

After endless research and providing the necessary background on this topic the author had to construct a "water tight" methodology. The main tool necessary for creating a WAP application is a Software Development Kit (SDK). There are many of these availabl to new developers from various sites such as http://www.wapnet.com/demo/democont.aspand,http://www.forum.nokia.com. However for the purpose of this study the author decided upon version 4.0 for WML

available from the phone.com web-site1[1]. The primary reason for this decision was because the majority of others required Windows NT in order to download the necessary software and this package was not available to the author. A more detailed description of the methodology will be discussed in chapter 3.

Chapter 6 will evaluate both the successfulness of the student service as an application and the successfulness of the author's study within the realms of WAP.

3.3 Literary Review

Due to the fact that WAP is in its stage of infancy, there is very little documented information and so a great deal of background knowledge was obtained from relevant web sites and companies who are involved in developing WAP applications. As a result this literary review will include the practices and teachings of the main forerunners within the field of wireless devices, this will include companies such as Nokia [1]and phone.com[2], and more importantly a group known as WAP forum[3].

It is safe to say, that the WAP forum is driving the development of WAP, and that it is in fact the engine behind this relatively new application. . The forum was initially founded by Motorola, Nokia, Ericsson and phone.com (previously unwired planet). Since it's inception the WAP forum has grown dramatically and now comprises of over 170 full members drawn from the world's leading telecommunications and software companies. The underlying belief of the forum is that WAP is a technology, designed to provide users of mobile terminals with rapid and efficient access to the Internet. WAP is a protocol optimised, not only for the use on the narrow band radio channels used in second generation digital wireless systems but also for the limited display systems used by today's mobile terminals. WAP integrates telephony services with micro browsing and enables easy-to-use interactive Internet access from the mobile handset. The forum believes that WAP will enable operators to develop innovative services to provide differentiation in competitive market environments.

The WAP forum represents "the de facto world-wide standard for providing Internet communications and advanced telephony services on digital mobile phones, pagers, personal digital assistants and other wireless terminals".

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[1] http://www.phone.com
[1] http://www.nokia.com
[2] http://www.phone.com
[3] http://www.wapforum.com

In order to place the significance of the forum in relation to this thesis, one must realise that the forum members represent over 90% of the global handset market, carriers with more than 100 million subscribers, leading infrastructure providers, software developers and other organisations providing solutions to the wireless industry. The author fully appreciated that it would be both detrimental and naïve, to even begin an individual study, without first gaining an insight into the beliefs and teachings of the WAP forum.

3.4 The Goals Of WAP Forum

- To become independent of wireless network standard.
- To provide access to all.
- To submit specifications for adoption by appropriate industry and standards Bodies.
- Applications scale across transport options. To create a global wireless protocol specification to work across differing wireless network technologies.
- To enable applications to scale across a variety of transport options and device types.
- Extensible over time too new networks and transports.

3.5 Benefits Of WAP

There are various benefits for using WAP, in the same way that there are various groups that will benefit from using WAP, from operators to users and from manufacturers to developers.

For wireless network operators WAP will cut costs and increase revenues by both improving existing services such as interfaces to voice mail and prepaid systems, and facilitating new value-added services such as account management and billing inquires.

End users of WAP will benefit from easy, secure access to relevant Internet information and services such as messaging, banking and entertainment through their mobile device. On a smaller scale Intranet information such as corporate databases can also be accessed via WAP technology.

For manufacturers the global open standard provides endless scope for new product and marketing opportunities. And for developers, the simple fact that there are well over 100 million compatible devices worldwide makes it clearly obvious the significant revenue that is available to developers.

These goals and benefits represent the dominant ideology behind WAP applications and the formation of the WAP forum. Considering that the forum has over 95% of the wireless industry supporting it, it became obviously apparent that concentrating this literary review on the WAP forum was a necessity, in order to gain an insight into the technology and strategies required to develop, deploy and support wireless application.

4. THE ARCHITECTURE AND WORKINGS OF WAP.

Before one could possibly consider discussing how to design a WAP application, it is vitally necessary to first provide a detailed analysis of the practicalities and actual architecture of WAP. Due to the fact that this type of architecture is something that many people are not familiar with, and can therefore prove to be extremely complicated, the author decided not only to document this section but also to depict simple diagrams in order to provide a working knowledge of the WAP environment. The author deems that only once a working knowledge of this environment is established, would it be suitable to continue and discuss the design and implementation of his own application.

Despite the explosive growth of wireless networks, the wireless Internet, has not yet taken off. There are many reasons for this, both technical and non-technical. However from a technical perspective, the adoption of the wireless Internet has been limited by two primary characteristics; the capabilities of hand held devices and wireless networks. When hand held devices enter the Internet space, the gap between Internet client capabilities widens. This makes it difficult for servers to provide a level of service that is appropriate for every client. Most web servers fail to recognise that computers are no longer all wired and connected to high-speed networks.

WAP specifies two essential elements of wireless communication: an end-to-end application protocol and an application environment based on a browser. The application protocol is a layer communication protocol that is embedded in each WAP – enabled device. The network side includes a server component implementing the other end of the protocol that is capable of communicating with any WAP user agents.

4.1 Background

Due to the fact that mobile phones were unheard off 20 years ago, it is understandable that the technology developed for the Internet was designed for desktop and larger computers. These computers had generally medium to high bandwidth and reliable data networks. Whereas wireless devices present a more constrained computing environment. His key limitations of wireless devices include:

- less powerful CPUs,
- Less memory,
- Restricted power consumption,

- Smaller displays,
- Different input devices.

Further more due to the limitations with power on wireless devices, data networks also presents a more constrained communication environment. These limitations include less bandwidth, more latency, and less connection stability.

4.2 Network Operators

As the number of wireless devices and the demand for them increases, operators must be looking to provide more advanced and usable services. The operators must look to achieve this by addressing these following areas:

- Interoperable – terminals for different manufacturers communicate with different services in the mobile network.
- Scaleable – mobile network operators are able to scale services to customer needs.
- Efficient – provides quality of service suited to the behaviour and characteristics of the mobile network.
- Reliable – provides a consistent and predictable platform for deploying services.
- Secure – enables services to be extended over potentially.

A more technical and in-depth analysis of the actual workings and architecture of the Wireless Application Protocol are now offered by the author, so as one can understand not only how to develop an application, but also to understand exactly how a WAP application works.

4.3 Components Of WAP Architecture And It's Basic Workings

Just like an engine has vital parts, and the body has vital organs, WAP has vital components, which are a necessity in order to function properly. The first of these is the WAP gateway. The gateway is a telecommunications software infrastructure that provides an interface between telecommunications protocols within the mobile operator's network and Internet protocols.

The second major component is the origin server; this is a computer, which stores WAP content. The origin server communicates with the WAP gateway over the

HTTP protocol so it can be on a local network or anywhere on the Internet. Current web servers are capable of storing WML, WML Script and Wireless Bitmaps.

The third component is the wireless telephony application server. This provides an interface between the WAP gateway and other infrastructure elements of the mobile operator's network. The WTA server can also be used to provide a WAP front end to existing applications such as prepaid billing.

And finally we have the terminal device. This can vary from a pocket pager to a palm top computer. As long as the device comes complete with a WAP micro-browser and connection to a WAP gateway. The author has decided to concentrate on one of these devices, the mobile phone.

4.3.1 How A Wap Application Runs Between Client And Server.

As this is a relatively new concept for many, the author has decided to explain this somewhat complicated process, with the aid of a diagram in order to provide a more simplistic overview.

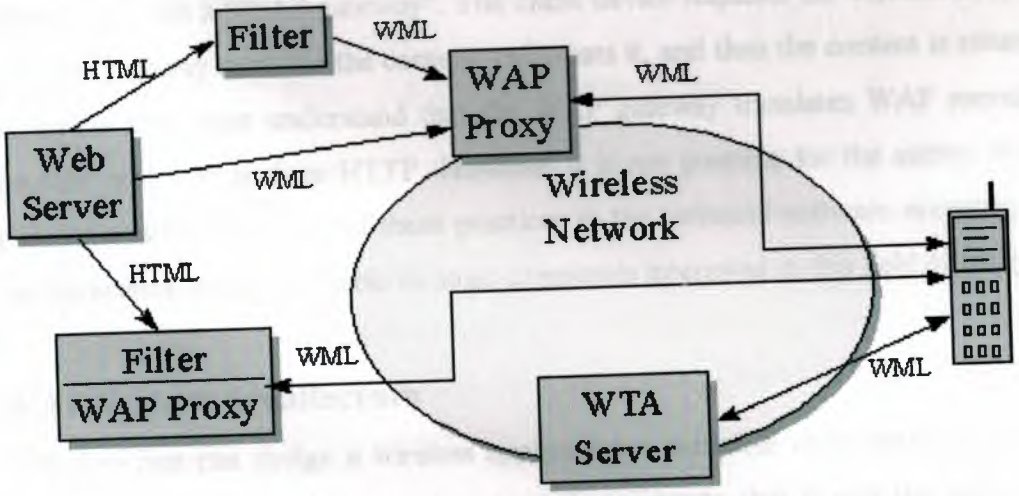

Figure 4.1 Wap Model

Applications are written in the wireless mark-up language (WML), and stored on either a normal web server or directly on the WAP gateway. The content stored on the web server will be accessible from the client device via the cellular network and a WAP gateway or proxy, (the WAP proxy acts as the gateway between the cellular network and the Inter/Intranet). This is when the WAP technology kicks in, any application written in HTML will have to be converted to WML before they are sent to the client device, this is carried out by the HTML filter which can form either part of the web server or the WAP gateway. The data sent by the origin server and the handset is binary encoded to optimise transmission over the narrow bandwidth of the cellular network.

4.3.2 So How Do These Components Work Together?

Surprisingly we all know more about the workings of WAP than we actually think; this is because it works on the same fundamentals as that of the Web. In as much to say that, a user makes a request for information using a URL. This URL is presented in the form of a hyperlink, then the information is retrieved and presented to the user. This means that at either end of the WAP system is a user and content. To apply this theory to the author's application, a person uses a mobile phone to make a request and to view the content.

However there are two ways of retrieving the content for the user. Firstly the information can be retrieved direct from a WAP server, the user simply requests content from the server, the server retrieves the content, and the content is then returned to the device. The second method is slightly more intricate in that the client device is in communication with a "WAP gateway". The client device requests the content from the gateway, the gateway retrieves the content, reformats it, and then the content is returned to the device. One must understand that the WAP gateway translates WAP messages into another protocol, such as HTTP. However it is not possible for the author of this study to demonstrate the latter of these practices as the technical software necessary for such an application is only available to large companies interested in this field of study.

4.4 WAP System Architecture

Before one can design a wireless application a complete understanding of both the internal and external architecture is extremely necessary, that is why the author has decided to allocate an entire chapter to this topic.

Many people understandably assume that WAP is a single protocol, but in actual fact it consists of a stack of protocols that provide different layers that are necessary to design an application.

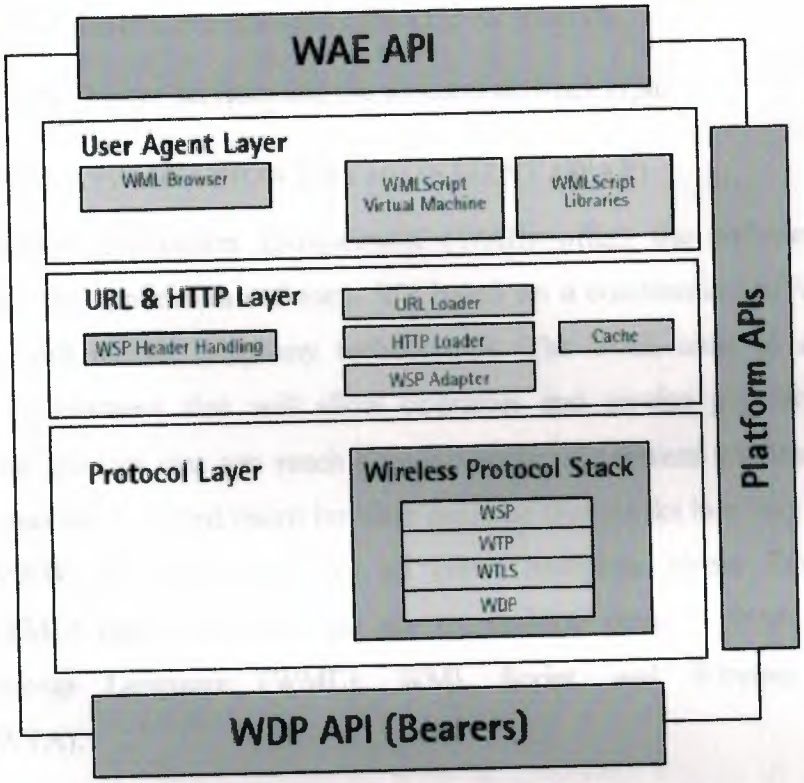

Figure 4.2 The Wap Protocol Stack.

The light weight WAP protocol stack is designed to minimise that required bandwidth and maximise the number of wireless network types that can deliver WAP content – GSM, SMS, USSD, CSD, GRPS, and CDMA. Since WAP is based on a scalable, layered architecture, each layer can develop independently of the others. This makes it possible to switch onto new bearers, to use new transport protocols, without major changes in the other layers.

The WAP layered architecture enables other services and applications to utilise the features of the WAP stack through various interfaces. External applications may access the session, transaction, security and transport layers directly. In order to analyse the WAP stack, the author has decided to discuss each layer individually.

Wireless Application Environment: a lightweight application environment based on browser technology with mark-up and script capabilities and telephony awareness.

Session Layer: provides communication session services for the application environment.

Transaction Layer: a lightweight reliability layer suited to request/response applications.

Security Layer: authentication and data encryption function.

Transport Layer: basic communications data mover function.

Network Layer: bearer services and the physical network type.

4.4.1 WIRELESS APPLICATION ENVIRONMENT (WAE)

The Wireless Application Environment (WAE) offers the software platform environment for the application software. It's based on a combination of World Wide Web (WWW) and mobile telephony technologies. The WAE aims to establish an interoperable environment that will allow operators and service providers to build applications and services that can reach a wide variety of different wireless platforms. WAE is built into the so-called micro browser program that works in a very similar way to normal WWW browsers which we all know interprets Hyper Text Mark-up Language (HTML) and JavaScript, for use on desktop devices. WAE consists of Wireless Mark-up Language (WML), WML Script, and Wireless Telephony Application (WTA).

- WML is a lightweight mark-up language, similar to HTML, but designed for use on hand held mobile devices.
- WML Script is a lightweight scripting language, similar to JavaScript
- WTA includes telephony services and programming interfaces.

A more detailed description of WML and WML Script is provided by the author, and is located in its own subsection at the end of this chapter.

4.4.2 Wireless Session Layer (WSP)

The session layer of the WAP architecture consists of the Wireless Session Protocol (WSP) and Wireless Transport Layer Security (WTLS). They provide connection-based services to the application layer, WAE and WTA. Basically a session is started, content is exchanged, and the session is later closed. Also the session can be suspended and resumed. WSP is the WAP equivalent of HTTP. Within HTTP and WSP is the concept of request and reply, each consisting of a header and a body. The header is data about the data and consists of information about the particular request or response; the body consists of WML, WML Script or images. WSP also defines a server "push" transaction where the server sends unrequited info to a client device. This service can include services such as up to the moment sports results, and can be tailored for each individual.

4.4.3 Wireless Transaction Layer (WTP)

The Wireless Transaction protocol (WTP) works between the WSP and the security layer (WTLS). What the WTP actually does is reducing data packets into lower level datagram's and transforms them in useful data. WTP also keeps track of received and sent packages and does acknowledgement sending when needed.

4.4.4 Security Layer (WTLS)

Wireless Transport Layer Security Protocol (WTLS) is made up off all the cryptography orientated features of WAP. This includes crypting , decrypting, user authentications and data integrity checking. WTLS is the WAP equivalent of the HTTP SSL or TLS.

4.4.5 Transport Layer (WDP)

The Transport Layer Protocol in WAP is commonly known as the Wireless datagram Protocol (WDP). The WDP layer operates above the data capable bearer services supported by the various network types. As a transport service it offers a consistent service to the upper layer protocols of WAP. Furthermore due to the fact that the transport layers interface and basic features are kept consistent, it allows global interoperability to be achieved using mediating gateways.

4.4.6 Network Layer

The bearer service is the wireless data link between the client and the server. Many different service bearers are possible: CDPD in the cellular system, SMS in the GSM cellular system, and one-way and two-way paging. Each client device must obviously have at least one bearer service and some client devices may have several, for example, the GSM phones.

After reading chapter 4 of this study, it is the author's desire that the notion of WAP consisting of a single protocol be dispelled. It was hoped that the stack of protocols, be described and explained in a simple yet informative manner. This chapter was extremely necessary to discuss the many different protocols and their functions before one could actually go on to design and implement a new WAP application.

4.5 Additional Features Of WAP Architecture

When using the conventional web the user interactively requests information, which web server's supply, and this is called a synchronous model. To support notifications consistently across different network types, the UP. Link platform provides two logical delivery channels for notifications. Firstly there is the asynchronous model that is also known as the "push model". Servers that use the asynchronous model do not wait until a user requests information. Instead they use a profile to determine which information is important to the user and asynchronously send the information to the user as soon as it becomes available. Secondly there is the "pull channel", WML services use the pull channel to send notifications that contain less time-sensitive information. The UP. Link platform fully supports this model of interaction, allowing WML services to send information to UP. Link subscribers asynchronously. These messages that are also known as notifications and are already widely used on mobile devices for functions such as sports up-dates, weather reports and alerts.

4.6 How WAP Content Is Displayed.

The basic display unit of a WAP application is known as a "card". A card can be considered as a screen of information or indeed a few screens can make up a single card. In many cases it takes more than one card to make up a WAP application or service, when this is the case a group of these related cards is known as a "deck". If one was to compare these terms to their counterparts, a card would serve the same purpose as a HTML file, and a deck on a client device can be called like a URL on the Internet. Due to the fact that a client device has a limited display, and may only have a single-line display a single card may need to be stretched over several screens. This is why there are variations in the presentation of content from one device to the next, i.e., a mobile phone addresses this problem by offering a scrolling option. A card called on a mobile phone can display text, images, hyperlinks, and input fields. How to navigate through these fields and how to input data varies for each manufacturer of the client devices.

Now that the author has discussed the basic format of a WAP application, what tools or language do we use to design an application?

4.7 Wireless Mark-Up Language (WML) And WML Script.

Wireless Mark-up Language (WML), is a DTD (Document Type Definition) of XML (Extendable Mark-up Language) that is a subset of SGML (Standard Generalised Mark-up Language). The WAP forum and Phone.com provides a formal DTD for WML and can be located at their respective websites (See bibliography). DTD will be discussed in further detail in the methodology of this thesis, contained in chapter three.

WML is intended for the use in specifying content and user interface for narrowband devices, such as the mobile phone. WML is very similar to HTML. It is a mark-up language with tags and elements, used for formatting textual information; it consists of approximately thirty tags. Due to the nature of its objective i.e., for use on wireless devices, it has been designed as a *lightweight language.*

Furthermore WML Script is used to complement the Wireless Mark-up Language. WML is extremely diverse considering it is designed for narrowband devices, it can display content using text, images, lists etc, however all this content is static and there is no way to extend the language without modifying WML itself. WML Script is necessary in order to make a WAP application dynamic, it was designed to provide programmable functionality that can be used over narrowband communication links in devices with limited capabilities. WMLS is to WML as Java is to HTML. WMLS is designed to provide general scripting capabilities to the WAP architecture. WMLS is based on the core of the EMCA Script language specification that defines the basic types, variables, expressions and statements of the language. This core can be used almost identically for the WMLS specification, making WMLS as familiar as possible and thus easier to learn.

5. DEVELOPING A WAP APPLICATION

Thus far everything that has been discussed represents the theory behind the actual workings and architecture of a WAP application. Chapter three will now provide the main backbone to this entire thesis, in that it will offer a detailed methodology into this application. This chapter will progress in a systematic fashion, firstly discussing how to actually get started and what technology is necessary, and then moving on to discuss and explain with the use of diagrams, in a step by step manor exactly how the author designed and implemented his application.

In order to design a WAP application it is necessary for the developer to obtain an UP.SDK (software development kit). There are many of these available to download on the Internet, which will enable any novice to get up and started. After much deliberation the author of this application decided to use UP.SDK4.0 available to download from the phone.com [1]web site. The author decided upon this option after he became aware that many of the other kits would only run on the Windows NT platform, something that was not available to the author. In order to download the UP.SDK, you must first register on the phone.com developer web site. This not only enables you to download the UP. Simulator but also a wide range of developer support services and documentation.

5.1 Up Link Platform

The UP Link platform [1] is the environment for which all the WAP applications run, it provides a secure, wireless access to many Internet and network services using data-capable wireless devices. We are all more familiar with these workings than we actually think in that many of its concepts are very similar to those, which we've experienced using a conventional web browser. Just like a desktop computer, the user must press keys in order to navigate and request URLs; however unlike computer browsers which use HTML to display information on a screen, wireless devices use WML, a language developed to facilitate small handheld devices (see chapter 2.7).

The main body of the *UP Link platform is the UP. Link* server, it allows wireless devices to access any web site acting as a HTTP proxy. Not only does the UP. Link server translate HTML, but it also enables wireless devices to conduct

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[1] http://updev.phone.com/dev/ts.html

many of the functions that we only associate with desktop computers such as being able to send, receive and save e-mails and also carry out on-line transactions.

5.1.1 How the Up Link Platform Works

Before the author begins to document and display his application, he feels it necessary to provide a basic example of how a typical transaction takes place over a wireless network. This is a simple, theoretical transaction, which should breakdown a WML transaction into its simplest form, in order to show the basic workings of the UP Link platform.

1. Suppose someone what's to find out a football result for a game, which has just finished. The user uses his/her wireless device to request a URL,

2. The UP. Browser creates a request containing the URL and sends it to the UP Link server.
3. The UP. Link server creates a conventional HTTP request, and then sends it on to the web server.
4. Once the web server receives the request it then starts the process of retrieving the information.
5. Once the HTTP file has been located by the web server it is then sent back to UP Link server.
6. Now that the UP. Link server has received the response; the content Translated into WML, and is then sent to the clients device.

7. The client can now view the content on the wireless device.

5.2 Using the Up Simulator

Just as a web developer can load and test his/her HTML before a web application is made live on the Internet, so to can a WAP developer. This testing can be conducted using a UP. Simulator, which allows you to load, test and debug your WML code.

The UP Simulator has two different modes; firstly we have the mode that includes the UP Link. The UP Simulator interacts with the UP Link server just like a real wireless device. This mode requires access to a UP. Link server before you can use it. And secondly there is the "HTTP direct". This mode loads WML directly from

a web server, bypassing the UP Link server. For the purpose of this application the author has decided to use the "HTTP direct" mode, which requires no special set-up.

When downloading your simulator it's advisable to save it to a hard drive, as it requires a lot of space. Figure 3 is a diagram of what the UP. Simulator looks like, and what key functions are available when you download the UP.SDK 4.0, from the phone.com web site.

The author did have a choice as to what kind of display the simulator would have, by simply clicking on the configuration box located in the file on the toolbar, however after experimenting with them all; it was decided to use the generic UP. Simulator as it offered all the major key functions and displayed the content in the clearest fashion, which is displayed in Figure 3 below.

5.3 Functions on the Simulator

A. At the top of the generic simulator we are provided with a go field. It is here where one would enter URL's, and be able to make your request to access information.

B. The top left button located immediately below the display screen, is known as the ACCEPT function key. Once you have navigated through the various cards to your desired destination one must press the ACCEPT button in order to access the content.

C. The top right button located immediately below the display screen, is known as the OPTION function key. By pressing this key, one is provided with a selection of applications, which are available to the user.

The four arrow keys and the four single keys directly below, all make-up the navigation functions. By using the arrows, one can place the cursor anywhere on the display screen and navigate through the various cards.

D. Like conventional web browsers, UP. Phones also have a home mechanism. This comes in the form of a HOME function key. This enables the user to return to the home page at any point during his/her journey.

E. Furthermore, similar to the web browser again, all UP. Phones have a back mechanism and this comes in the form of a BACK function key. The UP Browser keeps a history of the cards that you have accessed, enabling you to travel back through the stack. However no such FORWARD function is available on the UP Simulator.

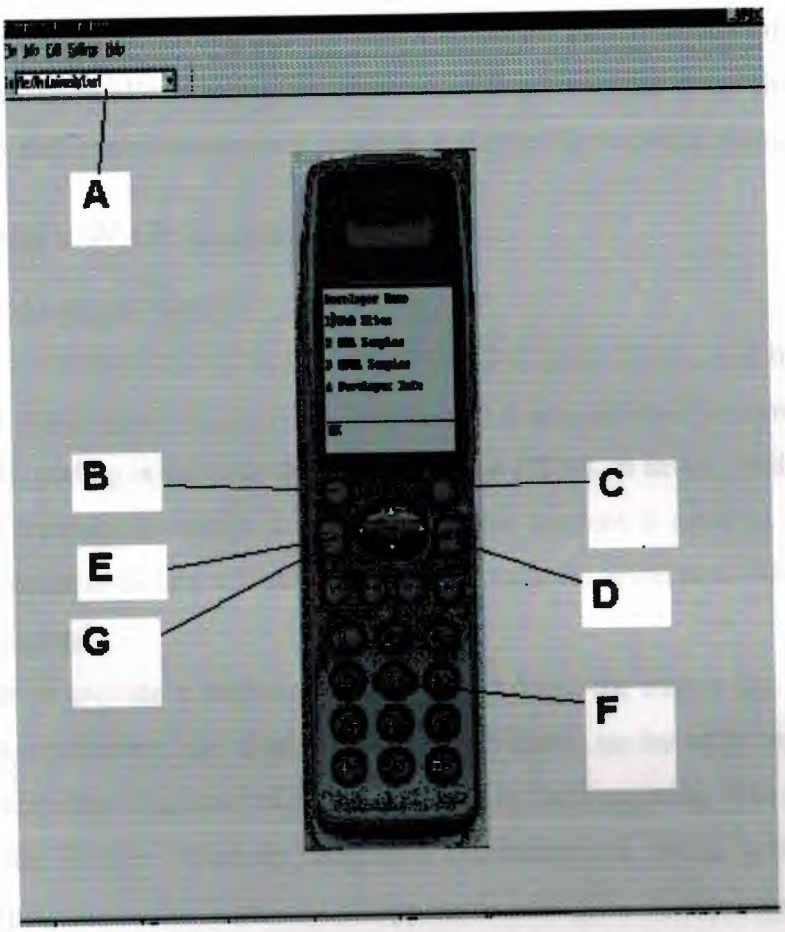

Figure 5.1 Screen Dump Bof Simulator Functions

F. Finally we have the number keys, which also double as the text entry keys. When an application has been accessed and user input is required the number keys are used to input data. To enter text on the UP. Simulator, you can either use your computer keyboard or use the mouse to click on the keypad area of the screen.

5.4 The Design of the Application

Now that the author has fully developed the practicalities and technology behind a WAP application, the foundations have been laid for the author to discuss and display his application. The aim of this study is to provide any beginner with an in-depth knowledge into the principals and workings of a WAP application. Therefore in order for this study to be a success, it became apparent that the author's application would have to incorporate as many of the aforementioned principals and functions as possible.

The theory behind this application is that the content can be changed to make the application relevant to any subject. The content could vary from local news to world sport, however to keep this application relevant to the readers and the author, it

was decided to design an application for the students at the University of Ulster. In theory this application allows people to log on to the universities news site and read up to date news that could interest and assist them for the fore coming period.

5.5 Developing a WAP Application

So how do we get started?

Once you have obtained a knowledge and feel confidant using WML, it is time to start designing your application. To begin one must open a new notepad document; this is where the WML coding is saved in the same way that HTML is saved. And just in the same way that in order to design a web page on the Internet it must be saved as a HTML file, in order to design a WAP application it must be saved as a WML file e.g. file://a:/example.wml.

In order to provide a well-structured methodology, the author has decided to breakdown the application into smaller programs. By doing so the author will be able to show the individual functions of his application as well as being able to describe the format of the Wireless Mark-up Language. Ultimately the coding will be pieced together to display the author's new WAP application.*5.6 How to Start Structuring A WML File*

Before one can get started, one must realise that WAP Forum [1] to mention the largest governs a standard for WAP.

- All WML files have to begin in a similar fashion; this is an example of how an application may begin: -

<wml version = "1.0"?>

<! DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"

http://www.wapforum.org/DTD/wml_1.1.xml>

- These lines are necessary so that the version of WML can be established and confirmed by the browsers. WML is an XML language and requires a DTD (Documentation Type Declaration). If you don't use a DTD the browser will not recognise it as all the WAP browsers look for the DTD declaration.
- As mentioned in the previous chapter, WML is very similar to HTML and is a tag-based language. Tags in WML are defined by an open tag <...> and a close tag </...>.
- A WML file then starts with the tag <wml> and ends with </wml>.

- Content within the WML file is encapsulated by the cards defined by the tags<card> and </card>. Text should also be encapsulated with in and tags.
- WML also offers various tags that allow you to specify the font, size and layout of text.
- Furthermore the designer has the capabilities to maintain whatever format he/she requires using tags such as, line break and alignment.
- And finally, there can be many cards within a WML file. This is called a "deck" of cards. Consideration must be given to the quantity of information supplied in the WML file. More content means longer download times and if the user is unlikely to use all the cards within a deck it is wasting bandwidth and time.

5.7 Creating a Static Title WML File

Now that all the key principals have been discussed, it is time to start displaying the author's application. This is a static WML file that is used by the author as a title page, and can be viewed in figure 4 below.

```
<? Xml version=! 1.0"?>
<! DOCTYPE WML PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wao.forum.org/DTD/wml_1.1.xml>
 <BR>
 <wml>
  <Card>
   <p>
    Wireless Application Protocol
   </BR>AUTHOR: DAMIEN MC MULLAN
   </p>
   </card>
    </wml>
```

[1] http://www.wapforum.com

Figure 5.2 Screen Dump of a Static Title Page

5.8.0 A Card By Card Analysis of the Author Application

The ideology behind the author's application is that any student with a wireless device can retrieve information about the university and read up to the moment news. The concept behind the application could be customised to bring the user any type of information from world news to local sport.

Once the user accesses the author's application a title page is displayed, see figure 5 below, this simply tells the user the topic of content located at this site.

Figure 5.3 Screen Dump of Student Service Application

However, in order to make this application easier for the user a timer has been put into place. The timer means that the title page is only displayed for an adequate period of time, so as the user knows what information he/she is about to read. After a couple of seconds the title page will automatically be replaced by card two, which displays a series of topics and links which are available for the user to access.

```
<Card id="main" on timer="#c1">
<Timer value="40"/>
<p><b><I>UNIVERSITY NEWS</I></b></br>
UP TO DATE UNIVERSITY OF ULSTER NEWS.
</p>
</card>
```

Figure 5.4 Screen Dump of Links

Now that the user has reached this stage in the application, he/she must know decide their desired destination and begin to use the function keys and navigate for them-selves, visual evidence of the links in provided in figure 6 above. Due to the fact that there is a limited display on the UP Simulator, not all the links are visible on the screen. The user must now scroll down using the arrow key to read all the options that are available.

A WML file is referred to as deck, made up of one or more cards of information; navigation between these cards is by hypertext links. The anchor tag specifies the url when a link is selected, and the href part of the anchor tag specifies the url to follow. The following example of coding not only shows how navigation between cards works, but also how, it is programmed so that the user must accept a link in order to view it. So if the user wants to view the content stored on card 4, he/she must scroll down the links until the arrow is aligned with that link on the simulator, this link must them be accepted by the user on the simulator.

```
<Card id="c1">
<p>
<B>THIS WEEKS UNIVERSITY NEWS</b>
<Do type="accept" label="go">
        <Go href="#c2"
        />
   </do>
</p>
        <p><a href="#c2">Kevin Curran's classes cancelled</a><br/></p>
     <p><a href="#c3">Library closes on Thursday</a><br/></p>
        <p><a href="#c4">Soccer team reaches All-Ireland finals</a><br/></p>
        <p><a href="#c5">End of term disco</a><br/></p>
     </card>
```

Figure 5.5 Screen Dump of Student Service Card Content.

The final function that is offered by the author to enable easy navigation is the back function. This allows the user to return back to card 1 where the links are

displayed. This means that the user can pick and choose which information he/she accesses and in which order. It was extremely necessary for the author to include this function as the home button on the simulator is of no use in this application, as it is set to the phone.com homepage by default.

Now that the author has discussed the systems requirements, and provided a detailed analysis into the actual workings of the application, the final-step before we conclude this study is to test and evaluate the final application. This evaluation is located in the following and penultimate chapter.

6. TESTING AND EVALUATION

As With all applications, we cannot be sure that a system is complete or error free without full testing being carried out throughout its lifecycle and also on completion of the product. Now that the application is complete, it must be tested to make sure it is free from errors. This chapter explains how the author tested the application to make sure that it achieved the requirements that are laid down at the design stage of any application including usability and performance.

For large applications there can be up to five different stages of testing including, unit testing, module testing, and sub-system is testing, system testing and acceptance testing. However when designing a WAP application, the majority of the testing can be carried out as the application is being developed. Unit testing is the most basic level of testing, which involves testing each component individually. Due to the fact that you can view your application as you develop it on the simulator, it makes it easy for the author to identify any errors at an early stage. Furthermore, just in the same way that an error in java language is displayed to the author before a program will run, the same process takes place in WML. If there is a error in the WML coding then the application will not run on the simulator and it is possible for you to view your errors in a MS-DOS window. At this stage the author can load and test each card on the simulator, this means that any errors are detected at the earliest possible stage, and by doing so causing less re-work.

During the next stage of testing the author can finally see whether or not the application works as a whole. The system is now tested in full to see if all of the features do exactly what they are meant to do. The author must make sure that the links work and take you to the correct destination, that both the timer function and the back functions are operational, and that the display and format is exactly what the author wishes. As this application is not being sent live across the network, the author is unable to complete the final stage of testing, which would involve testing the product in the market place.

6.1 Evaluation

This chapter will contain a summary of the overall application that has been developed. It will discuss how successful the product is in achieving its aims put forward in previous chapters. Furthermore it will also offer amendments, which could

be made to create a superior application. It is only after completing such a study that one can step back and see what improvements are necessary.

From the outset, this thesis was an extreme challenge taken on by the author. WAP is a new concept within the field of computers and mobile networks, and so very little work has been conducted thus far. With many other subject areas, there is an abundance of academic teachings and documentation; this was the first problem the author had to overcome. Considering the fact that the author had absolutely no experience prior to this study in this field, he had to firstly educate himself in all the technologies and practicalities within WAP not to mention trying to get a grasp of a new programming language.

When trying to develop an application for a deadline, one must adapt techniques associated with project management. Equal time and resources had to be allocated to each chapter. This was achieved by setting individual deadlines for each stage of development.

6.1.1 Possible Enhancements

Now that the application is completed the author definitely feels that there are improvements to be made, however this statement, should by no means, take away from what the author has achieved. Throughout this study a vast wealth of knowledge into wireless applications was obtained. It's in hindsight only, that the author can really fathom the possibilities that await Wireless Application Protocols. With a greater time allowance the author would be able to gather a better concept into WML Scripting, once fluent in this dynamic language, to coin a phrase "the world is your oyster".

However one must acknowledge that all the functional and non-functional requirements and objectives discussed in the earlier chapters of this study have all been successfully completed by the final application.

6.1.2 Success Of The Application

The aim of this application was to deign and implement a dynamic student service that could be accessed, by those who use WAP compatible wireless devices, such as mobile phones. Anyone who has one of these devices can obtain up-to-the moment news about the university. They can obtain useful university information at the click of a button on their mobile phone. This information can vary from library closures

to fourth-coming exam timetables. Not only does the final application achieve all its primary objectives, but it also conforms to all design guidelines, providing the users with an attractive and easy to use interface.

CONCLUSION

In conducting this project, it is my wishes to have developed a wireless network a WAP application, which could be customised to offer any content, at the click of a button, to any WAP compatible wireless device. But it is also his wish to have also developed an academic documentation that will educate any novice into the complex workings of a WAP application. By reading this study it is hoped that any would-be developer, May feel confident enough to precede and develop his/her own WAP application.

I developed this document, by breaking it into six important sections, and by placing an equal amount of time and effort on each topic: -

1. Chapter-include a definition of wireless networks and its connections

2. Chapter- The architecture provides customers with a logical migration path to IP-based networking for achieving peer-to-peer and non-hierarchical communication while maintaining interpretability with the existing infrastructure. This architecture permits the partition of customer and the LAN network, enabling network managers the flexibility for deploying end-customer services and applications independent of wireless switch manufacturers. The Wireless architecture will provide the framework for innovative technology enhancements. It's important to look at the interoperability between different wireless technologies and the interfaces with one another. Wireless manufacturers are adopting standards and conflicts could result from the use of different standards in equipment in the same area. The current use of cell phones is different from that of a WLAN; phones have higher power and lower bandwidth equipment than a WLAN. The WLAN has a limited range, but it can be used as an extension of a wired LAN. Those two can co-exist on the same network. As far as multiple standards go, there is IEEE 802.11a, which specifies 25mb/s at 5ghz and IEEE 802.11b, which specifies 11mb at 2.4ghz, and Home RF, which is at 1mb/s and could be raised to10mb/s. It is not clear which standard will be adopted in the WLAN market, but once one is developed, prices will fall as chipmakers develop specific ICs around the standards, and the FCC may open a spectrum bandwidth and faster equipment, for WLAN manufactures per cost, Today, the WLAN has redefined what it means to be connected. It has stretched the limits of the LAN. It makes an infrastructure as dynamic

as it needs to be. It's only just beginning; the IEEE standard is less than three years old, with the high speed IEEE 802.11b yet to reach its first birthday. With standard and interoperable WLAN products, LAN can reach scales unimaginable with a wired infrastructure. They can make high-speed interconnections for a fraction of the cost of traditional wide area technologies. In a WLAN world, customers should be able to roam not just within a campus but within a city, while maintaining a high speed link to extranets, intranets, and the Internet itself. The future of WLAN is imminent (OCBN 2001).

3. Chapter - included a definition of the Wireless Application Protocol. A detailed sub-section, including what the author was actually going to design, then followed this. Once this was established a literary review was offered providing the concepts of others who work in the field of wireless networks, namely the WAP forum.

4. Chapter - before one can discuss the methodology, the author felt that it was necessary to firstly provide an in-depth analysis of the WAP architecture. This included describing exactly how an application works across the network; features such as servers, clients and gateways were all discussed. This chapter then shows how WAP content is displayed and gives a brief insight into both the Wireless Mark-up and Scripting languages.

5. Chapter - contains the most important topics in this study, the methodology. Firstly, the author discusses how to develop a simple application and then continues to discuss the final product. Also in this section, are detailed instructions on how to use the UP Platform and UP Simulator? The closing stages of this chapter analysis the actual design and coding of the author's application, this is also supported using visual aides such as screen dumps.

6. Chapter - Comprises of the implementation, testing and evaluation of the final application. Testing is discussed with regards to the UP. Simulator and how the developer can check for errors as the application are being developed. The evaluation section offers possible enhancements that the author may consider, as well as discussing how successful the application was in achieving its objectives

After developing and analysing a WAP application, there are many questions that still remain in the author's mind. Without doubt, the ability to communicate with the web immediately, wherever you are, has definitely sent those interested in the mobile industry into a spin. But is this excitement premature?

Concluding this investigation, the author has come to realise that WAP has two major flaws. It can be awkward and slow to use, and at present there is little really useful information in WAP format. Even though the connection time may only be about 10 seconds, if used on a regular basis this is long enough to cause the user to become distracted. Furthermore if you don't get anything useful at the end of it all, then the whole idea may soon turn users off.

Taking these drawbacks into consideration, WAP needs to start making serious advancements otherwise it may be swallowed by the next, even better technology. The General Packet Radio System (GPRS) will bring the entire Internet to mobile computers at a great speed. The GPRS will be much faster and much cheaper than present cellular data. For many people such as Neil Bent, managing director at "one to one", they believe that WAP is doomed. "WAP is a stepping stone- GPRS has the potential to make WAP outdated very quickly. GPRS will cannibalise the market for WAP because it will make surfing the real Internet possible, in full colour and with graphics, sounds and animations we have come to expect".
(Source: Financial Times, March 15th, Alan Cane).

At first, the need to use a computer to access GPRS services will limit its appeal to users, but soon phones that look more like a palm top computer will appear. Users will be able to hold them in the palm of their hand and use an ear-piece just as many do with the ordinary mobile phone today.

However it's the author's opinion that WAP will not just fade away, even if it does not prove to be one of the major innovations of the twenty first century. There will always be a certain percentage of the population that will want the convenience of being able to obtain certain pieces of info and conduct certain tasks, from a pocket device. The greatest obstacle that WAP faces is whether or not the market accepts the concept. Will the consumer, with expectations built up for traditional web surfing, accept the limited capabilities of WAP applications? And secondly, will the advancements in technologies prove to be sufficient in order to keep the client interested. Obviously, there are unanswered questions and uncertainties with regards to WAP, however only time will answer these questions and iron out the problems. So even if WAP technologies do not dominate the market in a way that it has the potential to do, it will undoubtedly survive and continue to grow.

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APPENDIXES

APPENDIX A

DTD Document Type Definition, definition of a language built on XML or SGML.

GSM Global System for Mobile Communications.

HTML Hyper Text Mark-up Language, document definition language of WWW.

HTTP Hyper Text Transfer Protocol, transfer protocol of WWW

SGML Standardised General Mark-up Language, general mark-up languages that can be adapted to different applications like HTML.

SSL Secure Sockets Layer, security protocol now known as TLS.

TLS Transport Layer security, security protocol formerly known as SSL.

URL Uniform Resource Locator.

WAE Wireless Application Environment, execution environment for WAP applications.

WAP Wireless Application Protocol, a set of protocols and standards for wireless applications.

WDP Wireless Data gram Protocol, the transport protocol of WAP.

WSP Wireless Session Protocol, the session protocol of WAP.

WTA Wireless Telephony Application, application programmings interface for controlling telephony features of the device.

WTLS Wireless Transport Layer Security, the security protocol of WAP.

WTP Wireless Transaction Protocol, the transaction Protocol of WAP.

WWW World Wide Web.

XML Extendable Mark-up Language, a subset of SGML.

APPENDIX B

DEFINITIONS

AUTHOR - an author is a person or program that writes or generates WML, or other content.

CARD - a single WML unit of navigation and user interface.

CLIENT - a device that initiates a request for connection with a server.

CLIENT DEVICE - a device providing the user with the user agent capabilities, including the ability to request and receive information.

CONTENT - subject matter stored or generated at an origin server. Content is typically displayed or interpreted by a user agent in response to a user request.

DECK - a collection of WML cards.

DEVICE - a network entity that is capable of sending and receiving packets of information and has a unique device address. A device can act as a client or a server.

ORIGIN SERVER - the server on which a given resource resides or is to be created. Often referred to as a web server or a HTTP server.

SERVER - a device that waits for connection requests from one or more clients.

USER - a user is a person who interacts with a user agent to view, or otherwise use a resource.