From Cabling to Decabling the Libraries in Emerging WLAN Standards

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Abstract

Introduces need for WLAN due to cabling faults and costly management of cables. WLAN use Infrared and Radio Frequency technologies. Gives benefits of WLAN. Gives an account of Data Transmission in WLAN and use of 2.4 GHz for WLAN allotted for International Radio Frequency Allocation. Gives brief account of two RF technologies-Spread Spectrum and low power Narrow Band used in various RF technologies. Gives in brief an account of IrDA, Bluetooth, Wi-Fi, UWB, HomeRF, SWAP & Zigbee technologies presently in use for WLAN. Study kept an eye for various IR/RF based notebooks and computer peripherals available in India and US market provides salient features and price of these. Concludes with benefits of WLAN and library applications by undoing of what has been done in last few decades-laying cables in LAN. Provides eight references and 05 websites for further study.

Keywords : Wireless Networks, Data Transmission, Standards

0. Introduction

WLAN (wireless LAN) is a data-transmission system designed to provide location-independent network access between computing device by using infra-red & radio waves rather than a cable infrastructure. It is among the most happening technologies today, and has recently become popular in India. As far as the technology goes, it's reached a level where it can seamlessly integrate and work with the existing networks. Since some wireless LANs use RF (Radio Frequency) for communication, their signals aren't limited to the line of sight and penetrate various surfaces, like walls and doors. This makes it easy to provide network access in the most difficult of places. So whether it's the conference room in the office building or some other place where it's impossible to lay structured cabling, wireless technology can get it networked. With wireless, the hassles of planning, designing and lying the structured cabling, patch cords and patch panels aren't there.

WLANs offer variety of benefits over traditional wired networks, including productivity, convenience and cost advantages. These highly mobile, simple fast and easy-to-install networks, provide access to real time information anywhere in the building and eliminate the need to pull cable through walls. While the initial cost of installation of hardware for WLANs may be higher than wired LAN, the total cost ownership is significantly lower because WLANs eliminate the direct costsof cabling and labor associated with installing and repairing it. WLANs provide installation and configuration flexibility and the freedom inherent in network mobility.

The PC is the centre of digital universe and it ties this universe together with the tangled cables of the information age. The mess of wiring behind the computer could all be gone, the cable sticking out of the PC card Ethernet adapter could be unnecessary, the PDA cradle sitting on the desk could be counting sheep in the desk in the bottom drawer, and of course one could be working while sipping on a Coca-cola by the seaside. All this need is a couple of little upgrades to wirefree connectivity. Every single cable one on the desk has a wirelss equivalent just itching to replace it.[1]

1. Data Transmission

Wireless LANs either use Infra-red and Radio wave frequencies. The earlier wireless access points that came into the market used infrared, but today most of them use radio frequency. The advantage of RF is that radio waves can penetrate through surfaces like walls and doors. Infrared devices on the other hand are based on-line-of-sight and get blocked or reflected on such surfaces.

Data transmission over wireless using Radio frequency is similar to the techniques used in an ordinary radio, AM and FM.

The WLAN under RF technology can be operated on 2.4 GHz frequency. Industrial, Scientific and Medical (ISM) band. It is free band for ISM purpose. It starts at 2.402 & 2.480. Internationally radio frequency allocation is as follows[1].

International Radio Frequency Allocation									
10KHz	100KHz	1MHz	10MHz	100MHz			1GHz 2.45GHz	10GHz	100GHz
				TV	FM radio	TV	TV Bluetooth Wi-Fi/Home RFetc.	Satellite	

There are two RF techniques used for data transmission in wireless LANs, called Spread Spectrum and Low Power Narrow Band. Spread Spectrum is divided into two called Frequency Hopping and Direct Sequence. These are given in short.

a. Spread Spectrum

Spread Spectrum is a communication technique that spreads a signal bandwidth over a wide range of frequencies for transmission and then de-spreads it to the original data bandwidth at the receiver. The two types of SS transmission, direct sequencing spread spectrum (DSSS) and frequency hopping spread spectrum(FHSS).

a.1 Direct Sequence

In DSSS technique, every binary ‘1’ bit that’s transmitted is in the form of a sequence of ones and zeros. Every binary ‘0' transmitted uses the inverse sequence of this ‘1’ bit. This redundant pattern for every bit that’s transmitted is called a Chip. A wider chip increases the chances of data recovery by the receiver. The ratio of chips to the original bits is called the spreading ratio or gain. To unintended receivers, this appears as low-power wideband noise.

a.2 Frequency Hopping

In FHSS, there’s a narrowband carrier signal that hops from one frequency to another in a pre-defined fashion. Both the transmitter and receiver know this hopping sequence and therefore have to remain in synchronization in order to send and receive accurate data. Since the method hops over multitude frequencies, it forms a single logical channel used and maintained by the transmitter and receiver. To those who are not supposed to receive this signal, it appears to be wideband noise[2].

b. Low-Power Narrow Band

The second transmission method, called low-power narrowband uses a single frequency narrow enough to transmit the data signal. Every wireless node communicates using a different frequency, so that there's no cross talk with their nodes. This prevents one node from listening to others. So, while receiving, a node will filter out all other frequencies but for the one that's meant for it[2].

2. Various Wireless LAN Technologies

In this section we have discussed various technologies of wireless LAN both Infrared and Radio Frequency.

2.1 IrDA

IrDA (Infrared Data Association) has been around much before Wireless Personal Area Networking(WPAN). Notebooks and PDAs come with infrared ports that let them communicate with other infrared devices. So, one can fire a print from the PDA if the printer has an infrared port. Millions of devices today already have IrDA ports, something that works in this standard'' favor. Also, the cost of setting it up is the lowest vis-à-vis other standard.

Throughput varies, depending on the application and range, as the IrDA protocol suite offers different services with different data rates and ranges. IrDA 1.1, for example, offers a gross throughput of 1.15-4 Mbps over a distance of 1m. IrDA 1.1-based transceivers are quite power-efficient too, as they supply only as much current as needed to maintain as IR link. In standby mode, the device will use about 1 mA of current, while it will use about 2.5 mA when it's receiving data. Reliability and interference are non-issues, because it uses a very high frequency range, just below visible light. Since no other standard works in this frequency band, noise from other users is practically non-existent. Where security is concerned, it uses point-to-point, short-range, direct connections; so someone intercepting ones information is highly unlikely[3].

IrDA also has several limitations. It assumes both communicating devices are fixed, and in line of sight of each other. It cannot penetrate walls or floors. It cannot use it on the move. One can also have only one piconet (a short-range, small scale network) supporting a maximum of 10 devices. It does not support multiple overlaid networks. IrDA offers direct point-to-point, half-duplex connections, meaning the connection can either receive or transmit data at a time, and not both. However, specifications are coming up to handle full-duplex voice communication as well.

2.2 Bluetooth

This technology has been named after king Herald Blanted of Denmark. He ruled in 940-985 AD in united Denmark and Norway called Scandinavia. He was fond of Blue Cherries (Jamun) hence his teeth were always blue. The innovations in wireless technology stared in Scandinavia, hence this technique has been named in memory of the blue toothed kind as Blue Tooth Technology (BTT).

Bluetooth, promoted by the BSIG (Bluetooth Special Interest Group) is a short-range, full-duplex link that supports both voice and data. It transmits and receives at 1,600 hops per seconds, which is the fastest hopping rate vis-à-vis other standards. After IrDA, Bluetooth is the lowest-cost option for a Wireless Personal Area Network (WPAN). It can support upto 10 overlaid piconets, each with eight devices, making it a total of 80 devices that can communicate simultaneously. It is also excellent for mobile usage, and works on both circuit-switched and packet-switched networks. Bluetooth works in a range of 10m, which can be increased to 100m using a separate amplifier on the network. It gives a transfer rate of 1 Mbps,

and efforts are on to increase this to 2 Mbps. Bluetooth is also extremely power-conscious. In standby mode, it needs only 0.3 mA, which can go up to 30 mA when data is being transferred. Since its hopping rate is faster and packets are shorter, the interference in Bluetooth's case is less than in any other standards.

Bluetooth rules Wirefree connectivity. Bluetooth started with Ericsson who brought just handsfree handset. Bluetooth has very clearly defined some of activity, it connects personal devices[7].When two Bluetooth devices are brought within range of each other they automatically negotiate a network. More devices can be added to the network or removed at will. One of the devices becomes the Mater and regulates the transfer over the ad-hoc network. Up to eight devices can form one network, sharing communications and bandwidth in a configuration called 'piconet'- a tiny network. In any given area there can be multiple such piconets, and where they need to communicate with other piconets, they can do so across designated devices like gateways. These larger networks are called 'Scatternets'. Bluetooth also operates in the 2.4 GHz frequency band, but it uses the band in a Frequency Hopping mode. It uses 79 1 MHz bands, with each transmission lasting less than a second over any one band. The next transmission is over another abnd. Thus by rapidly jumping around, Bluetooth avoids interference problems between piconets or other devices in the same band[1].

On July 11, 2003 a new Bluetooth 1.2 specification has been released. Which includes Adaptive Frequency Hopping, using which it can automatically re-negotiated so that multiple devices using the same brand spectrum can co-exist. UK-based chip manufacturers like Cambridge Silicon Radio have already released their chips (BlueCore3) based on the 1.2 standards in anticipation. Incidentally, this specification also aims at the 2.4 GHz that 802.11b and 'g' target.

It has robust built-in security which don't need to intervene when two Bluetooth-enabled devices talk each other. The specification defines both encryption (128 –bit) and authentication. Depending on the service a particular device will be used for, the device manufacturer can configure different modes of security.

The problem with Bluetooth is that it demands a chip in every device, which balloons up the cost. As volumes ramp up, costs are expected to come down to more affordable levels in a year or two, but the prepared to pay a premium for the convenience it offers until then.

With a normal range of 10 meters and peak transfer speeds below 800 KBps bluetooth isn't designed for much more than replacing local wires. That does not stop people from trying though, and there is a wide misconception that Bluetooth will replace all your wireless networking needs.

Bluetooth is very useful in Personal Area Network with short operation area. It needs much less power as it is getting popularity in PDAs, though it has low bandwidth.

2.3 Wi-Fi

Wireless Fidelity (Wi-Fi) is an interoperability certification programme promoted by Wi-Fi Alliance, an association of wireless equipment manufacturers. 802.11b is often used interchangeably with Wi-Fi.802.11 is available in many classes-802.11a, 802.11b, 802.11g and 802.11e. IEEE 802.11b and 802.11g operate in the 2.4 GHz band but providing 11 Mbps and 54 Mbps respectively. 802.11g delivers 5 times data rate than 'b' at about 54Mbps on same 2.4 GHz. Products available in 'g' bandwidth can support 'b' bandwidth. The 802.11a works on relatively noise free 5.0 GHz band and provide bandwidth of 54Mbps but require license to operate. 802.11e is another one to be standardized, and is meant to ensure Quality of Service (QoS) support for LAN applications. At the physical layer, IEEE 802.11b follows DSSS (Direct Sequence Spread Spectrum) modulation, which works by dividing the stream of information to be transmitted in

small pieces, each of which is allocated across to a frequency channel across the spectrum. The other sub layer of Media Access Control sub layer of data link network . It uses Collision Sense Multiple Access with Collision Detection (CSMA/CD) to transmit data which happens the MAC layer.

The essential parts of Wi-Fi for wireless LAN are Access Points and Wireless cards. Three kinds of Access Points are currently available. The first is Non-bridging are those that don't communicate with other access points and do not perform any bridging functions. The second is bridging which access points that act as bridges, which are also come with different options. The third one is Mixed Media Router. It is cheaper and implemented in software on machines that are connected to all the networks. These are a) Point to point b)Point to multi-point c) Repeater [4].

Wireless Card is an essential component of wi-fi and perform same functions as Ethernet cards. These use PCMCIA[Personal Computer Memory Card International Association] to connect and thus can be used in desktop computer. PCI adopters are available to accommodate these cards to a free PCI slot in a PC. Networking can be made in two ways by the use of Access Points and Wireless Cards. Networking of Wi-Fi is done is two types namely Ad-hoc and Infrastructure according to the suitability of the system.

One of the most application of Wi-Fi is Hot-spot. A Hotspot provide wireless connectivity for free or fee on laptops or on PDA (Personal Digital Assistance) to surf the net, check e-mail, conduct business etc., using 802.11b. A Hotspot in any location be it a coffee shop, restaurant, college campus, airport, railway station etc., offers wireless access.

World wide 14712 hotspots have been reported in 2002. Which are likely to be 300000 in 2006. Australia, Hongkong, Japan, Singapore, South Korea and Taiwan are big market and hotspot are likely to raise to 38,000 in 2007 from 1625 in 2002 in these countries[5].Airports have hotspots, Changi International Airport, Singapore being first. Lufthansa has began offering Wi-Fi in overseas routes in its Boeing. British Airways is soon to follow[6].

In India luxury star hotels are leaders to opt the technology first. Some of the hotels namely Oberoi (Mumbai), Park Royal (New Delhi), Quality Inn Aruna (Chennai), GRT Grand Days(Chennai), Taj Connemmara (Chennai), Taj Coromandal (Chennai), Taj Krishna(Hyderabad), Taj Mahal (Mumbai), Taj Residency (Bangalore), Taj Residency Ummed (Ahmedabad) Taj Coromandal and Taj Connemmara (Chennai), Taj Residency (Bangalore), Taj Krishna (Hyderabad), etc are few to quote.

Café Coffee Day (Bangalore) restaurants have 133 branches in India. Indian School of Business (Hyderabad) and Pathway World School (Gurgaon) have adopted Wi-Fi in their premises[5].

2.4 Ultra Wide Band (UWB)

The research of military radar technicians of US and Soviet espionage agencies in late 1970s led to Ultra Wide Band to see through lens ground cover to locate enemy troops and equipments on the ground.

802.15.3a is Ultra wide Band was approved in SansFrancisco. UWB can handle more bandwidth intensive application because it can transmit data 10 times faster to D S L lines, cable modem or Wi-Fi, roughly from100 Mbps up to 500 Mbps, as against 11Mbps for Wi-Fi, 54 for 802.11a and 802.11g and 1 Mbps for Bluetooth, all this at low cost and lower levels of power consumption. Due to Federal Communications Commission restrictions, UWB will be used in home or in office over a short distance- say 10 meters at 100 Mbps between 3.1 to 10.6 MHz. Federal Communications Commission (FCC)has approved in February, 2002 the use of UWB after 3 years of examination and limited power spectral density so that it does not interfere with radar, satellite transmission and mobile phones. UWB signal modulators techniques limits it to 10 meters.It uses the 3.7-4.2 MHz frequency range (C band)which is also used for TV broadcast.

It has potential to transmit huge amount of data very rapidly. It can pass even through steels. It works by showering the target with rapid pulse of broad low frequency signals that punch their way through solid objects. UWB works on similar fashion. UWB blasts signals across the entire radio spectrum. A typical long radio wave is replaced by rapid fire Morse code like bursts, sending hundreds of low power (50-70 miliwatts; 110 of power of cellphone) electrical pulses each second, each lasting under nanosecond. A pulse can represent zero or one by varying the pulse timing according to a complex code. Because the signal is so low power and so broadly spread, it is both subject to, and subjects other devices to, little or no interference. Only a UWB receiver that knows the exact pulse sequence generated by the transmitted signal can make use of the information in the signal. To the rest of the world it is just more background noise.UWB energy pulses operate in the same frequency spectrum as electronic 'noise' emitted by Pentium chips, TV monitors, electric razors, automobile ignitions and fans. This is a huge swath of the spectrum, regulated only by FCC rules on how much power these devices can use.

Low power and the characteristic wide spread of the pulses means the pulses don't use up already crowded chunks of the radio spectrum, today occupied by 802.11b wireless LANs and Bluetooth devices. Hence, UWB would allow a whole new class and volume of voice and data communications that, in effect, would not take up any more 'space' in the crowded radio spectrum.

UWB transmitters and receivers are also simpler to build run and maintain. No complex radio frequency converter and modulator are required. Only a digital method to construct the pulse and modulate is required, which is done on a single chip.

Companies like Time Domain, XtreamSpectrum, Philips and General Atomic have demonstrated few of their products in DVD players and recorders, Video games, Set top boxes, TV and PCs etc. Intel also demonstrated prototype Digital cameras, phones, TV, SLCD displays and other home products can be handled with this technology at home through WLAN. Location of equipments in industries, shipping containers are amongst other applications[7].

This is new promising WLAN technology but yet to cover commercial market.

2.5 Home RF

Home RF tries to replace all cables in the home except the power lines. Based on a combination of DECT voice technology, and 802.11 networking, it aims to connect phones, entertainment devices, such as the TV and stereo systems, and your information access systems, computers and internet gateways. With such a combination, one could route connections from one phone to PC to TV set-top box. One could even use DECT cordless phone to talk to the PC as a mobile handset replacement. With appropriate software, one could use this to voice-command the PC to wirelessly control the home environment, or simply call "Grandma"[1].

HomeRF too works in the 2.4 GHz frequency range, and operates in point-point mode (Ad-Hoc) where devices within range can simply access each other over either TCP/IP or DECT(Digital Enhanced Cordless Technologies) interfaces. The key differentiator with HomeRF is QoS (quality of Service)support for prioritised traffic. Regular networks are 'dumb' in that they make no assumptions about the data they carry. They simply forward it as it comes through. When the streaming audio, or a phone conversation occurring, any delays in data transmission would be immediately noticeable. On a regular network, wireless or otherwise, traffic generated while surfing the Net would have the same priority as the voice call and would interrupt the conversation. In HomeRF the network detects the type of traffic and ensures that important data is delivered in real-time disregarding what happens with other data. HomeRF kits are a little chepaer than 802.11b, and with their additional features it may be the network one want to use at home.

2.6 SWAP

SWAP (Shared Wireless Application Protocol) from HomeRF supports both voice and data via a full-duplex connection, just like Bluetooth. It is a relatively new standard, and there are not too many products in the market that support it. It's in version 2.0 now. However, an interesting feature is that SWAP supports PSTN (Public Switched Telephone Networks). It is designed to support wireless networking at home, and supports 15 piconets with 127 devices each. SWAP transmits and receives at a relatively fast rate of 50 hops per second, and gives a gross data rate of 1 or 2 Mbps. It operates in a range of 50 m, has good power management, comparable to Bluetooth, with a 24-bit network ID, and encryption for applications considered more sensitive[3].

2.7 Zig Bee

It is low powered, short distance and low speed (250kbps)WLAN technology. It is Motorola's invention. It also uses 2.4 GHz and is suitable to men at tasks where other transceivers would quickly fizzle out[8].

3. Market Watch

Now there are many notebooks and other peripherals available with IR and RF technologies. A few have been studied for reference.

In Indian market many notebooks (laptops), a few of them have been studied here. these are Wi-Fi certified. The Toshiba TE 2000 is a 800 MHz G 4 processor with 30 GB HDD, IR Port. The cost is Rs. 1,31,993. AppiBook has 500 MHz G3 Processor, 128 MB RAM cost for Rs. 1,50,000. SAAZ (Zenith) 1.6 GHz, 256 MB RAB cost is Rs.70,000.

Besides, notebooks, market has IR and RF enabled keyboard and mouse. Targus keyboard is available with IR enabled for Rs.3950. The companies like Universal, Palm have also produced IR keyboards within the same. Mercury RF wireless internet keyboard works within 2-2.5 meter range, the mouse works 1-1.5 meter range. The product is available with Rs. 2000.

Many printers are also available. HP's 82240B is IR enabled wireless printers the is around Rs. 9000.

Other peripherals useful for WLAN are also available. Proxim Symphony Home RF based USB adapter and PC card is for Rs.5500. IBM's Smart Card kit is for Rs. 10000. Surecom's Wirelss Kit for Access point is Rs. 29,800; PCMCIA LAN card for Rs. 12,400 and PCI adapter for Rs.5000. D-Link's wireless kit PCMCIA card+adapter for Rs.16,000 and access point for Rs. 25,000 available in the market. Cisco's secure Access control server for wireless LAN infrastructure cost Rs. 300000 for version 3.1[9].

4. Benefits of Wireless LAN

1. Quick and easy to install so there is no need to lay that cabling.
2. It is highly scalable, we can configure as her requirements at any two point, scale it up as the number of users goes up.
3. Roaming is possible where users need not to worry about finding a place and plug in a network cable.
4. Provides mobility, where users can get real time information no matter where they are in the travelling.

5. Library Applications

There are various applications of Wireless technologies for library and information centres. Libraries are usually having multi floors and many rooms where all the PCs are connected with cables. With Wireless LAN there will not be any hassles of laying cables through floors and walls. The technology can be used in following applications:

1. Internet connectivity and browsing is possible from any corner of the Library.
2. E-mail sending and receiving is possible from any location within the reach of WLANs.
3. Library management with digital cameras and other apparatus having WLAN cards can be made useful for its management.
4. The multi work is possible from anywhere with access points.
5. Library OPAC is accessible through WLAN from any place.
6. Web OPAC is accessible from any corner of the campus through access points.
7. The greatest advantage is that while shifting the library building, it can be shifted without affecting the Network system, where as in LAN, this is not possible.

6. Conclusion

All technologies, though not very common in India, these are coming up slowly. Business might adopt Wireless Networking as a convenience factor, luxury for employees. In future wireless will eventually dominate its cable dependent competitions by lower price and ease of deployment Wi-Fi is already in use for data centre application but consumes much battery power. UWB is ideal for multimedia due to high data rate, low cost and low power consumption. Bluetooth is low power option for transmitting data over short distance but very slow. Bluetooth may be useful for low data rate connection between computers and their peripherals. Wi-Fi is suitable for wireless computer networks in home, offices and public places (Hotspots). Wi-Fi in contrast limited to PCs and Video displays, security devices over homes and cars, location devices, CD/DVD players, etc.

There is ongoing development in the area of wireless LANs. New standards are being developed by IEEE 802 group to improve the performance and throughput. For instance, the latest draft standard, the 802.11g, is trying to take the throughput in wireless LANs to 20+ Mbps, and that too in the 2.4 GHz band. Given such a development, wireless LANs seem to be promising technology for the future. The libraries and information centres cannot close their eyes on these developing WLAN technologies, which are very useful to them. We see that prices of these peripherals using these technologies have come down considerably, whithin the reach of a common man. The library and information centres can very well adopt WLAN technologies to provide cable free , fear free and hassles free services to clientele. What they spent on cabling in last few years, will have to be decabled in near future.

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