

# A Review of Wireless Local Area Network Technologies

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## ABSTRACT

The Wireless Local Area Network (WLAN) is an emerging technology that is hereby reviewed. An attempt is made to explore, investigate, examine, and present those technical features that make the WLAN function as a novel technology in the arena of Local Area Networks (LANs). Its usefulness in wireless data networks, packet radios, and other future applications are also highlighted.

(Key words: LAN, WLAN, data networks, wireless, data transmission, packet radios).

## INTRODUCTION

WLAN technologies enable users to establish wireless connections within a local area (for example, within a corporate or campus building, or in a public space, such as an airport). WLANs can be used in temporary offices or other spaces where the installation of extensive cabling would be prohibitive, or to supplement an existing LAN so that users can work at different locations within a building at different times.

WLANs can operate in two different ways. In infrastructure, WLANs, wireless stations (devices with radio network cards or external modems) connect to wireless access points that function as bridges between the stations and the existing network backbone. In peer-to-peer (ad hoc) WLANs, several users within a limited area, such as a conference room, can form a temporary network without using access points, if they do not require access to network resources.

In 1997, the Institute of Electrical and Electronic Engineers (IEEE) approved the 802.11 [1] standard for WLANs, which specifies a data transfer rate of 1 to 2 megabits per second (Mbps). In 1999 two new physical layers were finalized which are today referred to as Wi-Fi,

one of which is 802.11b [2], which is emerging as the new dominant standard, data is transferred at a maximum rate of 11 Mbps over a 2.4 gigahertz (GHz) frequency band. The other one is 802.11a [3], which specifies data transfer at a maximum rate of 54 Mbps over a 5 GHz frequency band.

Another standard, 802.11g [4], was approved on June 11, 2003 and offers data speeds up to 54Mbps and operates in the 2.4GHz and 5GHz range, making it backward compatible with 802.11b. Even before the IEEE approval, it was clear the 802.11g would become the standard for Wi-Fi services and leading manufacturers started to release products in early 2003.

Bluetooth is an emerging standard and a specification for small-form factor, low cost, short-range radio links between mobile Personal Computers (PCs), mobile phones, Personal Data Assistants (PDAs), and other portable devices [5]. Today, the Bluetooth technology is the only specification targeted at new market of cable replacement.

Through this review, the authors hope to illustrate how Bluetooth and Wi-Fi technologies can be used to enhance productivity, lifestyle flexibility, and maximize profit.

## REVIEW OF TECHNOLOGIES

### *Wi-Fi Technology*

Wi-Fi, as it is generally known, is the acronym for "Wireless Fidelity", and it is used to describe products that follow the 802.11 set of standards developed by the IEEE. The most popular of these is 802.11b, which operates in the 2.4 GHz band (the same frequency band as a microwave oven and cordless telephone) and transfers data at 11 Mbps. The emerging 802.11a standard operates in the 5 GHz band and can transfer data up to 54 Mbps.

The 802.11g standard, the newest, is compatible with 802.11b and operates in the same 2.4 GHz band, but it can transfer up to 54 Mbps like 802.11a. These technologies have a range of about 300 feet. Wi-Fi uses a technique known as Direct-Sequence Spread Spectrum (DSSS) to transmit data at up to 11Mbps across 22 MHz channel.

**Table 1:** Features of Wi-Fi.

STANDARD	802.11b	802.11g	802.11a
Available RF channel	3 non-overlapping	3 non-overlapping	8 non-overlapping (4 non-overlapping in some countries)
Frequency band	2.4 GHz	2.4 GHz	5 GHz
Maximum data rate/channel	11 Mbps	54 Mbps	54 Mbps
Typical range	100 ft at 11 Mbps 300 ft at 1 Mbps	50 ft at 54 Mbps 150 ft at 11 Mbps	40 ft at 54 Mbps 300 ft at 6 Mbps

The two basic components of a Wi-Fi network are a computer device outfitted with a low-power radio and another radio-equipped gadget known as an access point, which is wired to the Internet or a local network. The two communicate with each other over a free slice of the radio spectrum reserved for consumer use and inhabited by microwave ovens and cordless phones.

Wireless Fidelity is an emerging technology that showed substantial signs of growth particularly, in 2003. The prospects for continued growth were also substantial for 2004 and 2005. Both businesses and consumers have adopted Wi-Fi for a variety of reasons including cost savings and convenience.

The freedom and mobility that Wi-Fi offers appeals to a wide range of users. At home, Web surfers can download music on the backyard patio. Businesses and universities can use the technology to avoid the high costs of wiring up offices and dormitory rooms. Police and other emergency-services providers will soon be able to link Wi-Fi with Global Positioning System (GPS) systems to track personnel.

Wi-Fi has all the necessary elements to become a desirable and successful service for providing Internet, e-mail, VPN connectivity, corporate access and entertainment.

### **Bluetooth Technology**

Bluetooth is a wireless standard that uses the radio waves located in the 2.4 GHz (2400 - 2483.5 MHz) frequency band. It was developed to provide a wireless interconnect between small mobile devices and their peripherals. Target markets were the mobile computer, the mobile phone, small personal digital assistants and peripherals. The frequency band used by this technology is part of the Industrial Scientific Medical (ISM) band, which is globally available for a variety of applications and does not require a license from the Federal Communications Commission (FCC). Unfortunately, this is an extremely overcrowded frequency band. Cordless telephones, garage door openers, baby monitors and the IEEE's 802.11b standard are among the many different devices and applications that currently use this frequency band.

Bluetooth devices use a technique called Frequency Hopping Spread Spectrum (FHSS) to minimize interference with other devices. Bluetooth devices transmit intermittently over a bandwidth of 1 MHz and they hop from one 1 MHz channel to another at a rate of 1600 hops per second, or every 625 microseconds. There are 79 individual radio frequency (RF) channels spanning the 2.4 GHz frequency band.

The Bluetooth communication channels support both data and voice configurations. The synchronous voice channels are provided using circuit switching over a synchronous connection-oriented (SCO) link at 64 Kbps. The asynchronous data channels are provided using packet switching over an asynchronous connection-less (ACL) link at a rate of 57.6 Kbps in one direction and up to 721 Kbps in the other. If the user calls for a symmetrical data link, a 432.6 Kbps link in each direction can be set-up. Packets can be up to five time slots wide and data in a packet can be up to 2745 bits in length. A Bluetooth device can use either or both of these modes.

For retail, industrial, and office applications, Bluetooth will surface in mobile computers, bar code laser scanners, cash registers, vending machines, GPS receivers, slide projectors,

printers, digital cameras, digital camcoders, test and measurement equipment, and LAN access points. For instance, a bar code scanner can scan a Vehicle Identification Number (VIN), enter mileage and fuel data, then instantly transmit a receipt to a Bluetooth-enabled portable printer.

## COMPARISON AND DISCUSSION

Over the past several years, two innovations in wireless radio technology have captured people's attention: Bluetooth and Wi-Fi. These wireless communication technologies show great promise in transforming how people work and communicate with each other [6].

The analyst and media communities continue to debate the virtues and pitfalls of both technologies, occasionally declaring one or the other 'victor' in the fight for widespread integration into electronic devices and adoption by consumers and corporate technology buyers.

Wi-Fi is also known as IEEE 802.11 (b, g, or a) wireless local area network (WLAN) standard, while Bluetooth is referred to as 802.15 wireless personal area network (WPAN) standard.

Wi-Fi is an Ethernet replacement technology for wireless network for connectivity, whereas Bluetooth is a cable replacement for device connectivity. Wi-Fi is not a completely cable-free solution, the wireless access point still must connect through a physical cable to the main network, whereas Bluetooth is used for wireless cable replacement, Wi-Fi is utilized for wireless cable extension.

Wi-Fi allows transmission of wireless data at speeds as fast as 11Mbps (802.11b) and has a theoretical range of 100-meter, while Bluetooth has a direct maximum effective range of about 10-meter between devices. Bluetooth is more flexible than Wi-Fi but Bluetooth connection speeds does not exceed 1Mbps [7].

Bluetooth experiences fewer interference problems than Wi-Fi and any other 2.4 GHz technologies. When interference occurs, Bluetooth simply changes frequencies and retransmits the data.

Bluetooth operates using FHSS technique with channels 1 MHz in width and a hop rate of 1600 hops per second. It transmits for 625usec in each channel [8]. While Wi-Fi, on the other hand, uses DHSS with a 22 MHz passband, and communicates with a throughput up to 11Mbps. It may use any of the eleven 22 MHz sub-channels from available 83.5 MHz of the 2.4 GHz frequency band.

Bluetooth has audio channel capability, but Wi-Fi does not define how voice should be transmitted and does not define any special capabilities to do it. On Wi-Fi networks, voice would commonly be sent as Voice over IP (VoIP).

Wi-Fi systems are designed to efficiently connect large groups of people over a common backbone, while the Bluetooth technology was designed to connect mobile devices over a personal and private connection. In order to achieve Ethernet-level data rates, Wi-Fi operates with higher radio power on fixed channels of greater bandwidth. The consequence is that Wi-Fi will drain a device's battery much more quickly than Bluetooth. This is a major concern for smaller devices such as mobile phones and PDAs [9].

Wi-Fi use more robust solutions like WEP (Wired Equivalent Privacy) for security, but implementing something like WEP on top of Bluetooth would once again restrict simplicity and ease of use. In the nearest future, Bluetooth chips are expected to cost less than Wi-Fi chips [10].

Bluetooth and Wi-Fi are more complementary than similar. Consequently, each technology solves a different problem and is useful in its own way [11].

### **Bluetooth and Wi-Fi Coexistence**

Coexistence means simultaneous operation of devices complying to different wireless standard in a collocated scenario with minimum degradation in performance. The coexistence of Wi-Fi and Bluetooth is of utmost importance because devices supported by these technologies have high probability of operating in same vicinity for example, a user using a PC can have his printer attached using Wi-Fi and at the same time he might be using his Bluetooth enabled mouse.

**Table 2:** Comparison of Wi-Fi and Bluetooth Features.

CHARACTERISTICS	Wi-Fi	BLUETOOTH
<i>Design Criteria</i>	Fast & Ethernet compatible	Cheap, small, low power
<i>Development start date</i>	1990	1998
<i>Specifications authority</i>	IEEE, WECA	Bluetooth SIG
<i>No of device access at the same time</i>	Multiple, sheared	Up to 8, shared
<i>Frequency</i>	2.4 GHz	2.4 GHz
<i>Maturity state</i>	Mature	Emerging
<i>Power requirements</i>	High. Too much power for a phone or handheld-sized device battery.	Low. Can work effectively off an existing phone or PDAs battery.
<i>Transceiver's size</i>	Currently, PCMCIA	1" squared
<i>Range</i>	100 meter	10 meter
<i>Cost per transceiver chips</i>	N6, 000 (About \$40)	N1, 500 (About \$10)
<i>Throughput (Data rate)</i>	11Mbps (802.11b) or 54Mbps (802.11a, 802.11g)	1Kbps
<i>Application support</i>	TCP/IP	TCP/IP, OBEX
<i>Transmission Technique</i>	Direct-Sequence Spread Spectrum (DHSS)	Frequency-Hopping Spread Spectrum (FHSS)
<i>Interoperability among brands</i>	Good	Predicted to be good
<i>Security</i>	Unsecured unless well protected. Subject to network sniffing, session hijacking & unauthorized access.	Less secure. Building link level authentication. More difficult for traffic sniffing.
<i>Primary devices</i>	Laptops, Desktops, Servers	Mobile phones, PDAs, consumer electronics office & Industrial automation devices
<i>Technical limitations</i>	High power consumption, High cost, speed & signal strength	Speed & Interference issue

Both Wi-Fi and Bluetooth technologies will coexist in corporate as well as home environments [12]. A major study suggests that almost 130 million cell phones were Bluetooth enabled by the end of 2002. And majority of these cell phones will be used in both office and home where Wi-Fi devices will also be operating. As this protocol proliferate, there is a much concern on their coexistence.

The major issue with simultaneous operation of these two protocols is interference, as this two share the same un-licensed 2.4 GHZ ISM band [13]. Although devices operating in this band must adhere to certain constraints to enable multiple devices to operate at the same time, by specifying two methods namely FHSS and DHSS to transmit. Protocols may choose anyone one of these for their transmission.

## CONCLUSION

Bluetooth and Wi-Fi are different wireless networking technologies at different stages of development and both can succeed in the market place. It can be so easy to compare Bluetooth and Wi-Fi, but in reality they do not compete, rather they complement.

Most businesses use Wi-Fi to replace costly wires or provide connectivity in hard to reach places, such as warehouses, because of its flexibility. A traveler with a mobile PC can connect to the Internet and even send e-mail through hotspots in airport lounges, railway stations and other locations. At home, users can connect devices on their desktops to synchronize data and transfer files.

Bluetooth wireless solutions will make everyday activities more convenient because of its low power consumption. Printing a fax received on a mobile phone, accessing the Internet on a notebook or a mobile phone, synchronizing a PDA, downloading music to an MP3 player, or talking through a wireless hands-free headset is all be possible through this technology.

This review has revealed that the potential users for Bluetooth and Wi-Fi technologies are significant; they will improve our ability to stay connected, informed and productive in our daily lives.

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## SUGGESTED CITATION

Ajose, S.O., I.I. Ezebuio, and B.O. Oluwo. 2005. "A Review of Wireless Local Area Network Technologies". *Pacific Journal of Science and Technology*. 6(2):111-115.