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A COMPARATIVE ANALYSIS OF 802.11b AND 802.11g NETWORK

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Abstract

Recent advances in wireless technology has led to the introduction of new devices utilizing the 2.4GHz industrial scientific and medical (ISM) unlicensed band traditionally used by Wireless LANS (WLAN). The increasing demand of higher data rate in WLANs has prompted the continual emergence of different 802.11 protocols with increased performance. Interoperability and coexistence between these networks become key issues and must be catered for, to guarantee satisfactory performance of both networks. 802.11 refer to a family of specifications developed by the International Institute of Electrical Electronics Engineering (IEEE) for wireless LAN technology. IEEE accepted the specification for 802.11 in 1997. Wireless Local Area Network (WLAN) has become popular in the home due to ease of installation, and the increasing popularity of laptop computers. WLAN is based on IEEE 802.11 standard and is also known as Wireless Fidelity (Wi-Fi) [1]. In this paper, the comparative analysis of IEEE 802.11b and IEEE 802.11g networks are x-rayed.

KEYWORDS: 802.11b, 802.11g, WLAN, IEEE, OFDM, LRWPANS, Wireless Fidelity, Wireless Medium Access Control, Physical Layer.

1.0 INTRODUCTION

The 802.11 standard specifies wireless LANs that provide up to 2 Mbps of transmission speed and operate in the 2.4−GHz Industrial, Scientific, and Medical (ISM) band using either frequency−hopping spread spectrum (FHSS) or direct−sequence spread spectrum (DSSS). The IEEE approved this standard in 1997. The standard defines a physical layer (PHY), a medium access control (MAC) layer, the security primitives, and the basic operation modes [2].

IEEE 802.11b is an extension to 802.11 that operates at speeds up to 11 Mbps transmission (with a fallback to 5.5, 2, and 1 Mbps) in the 2.4−GHz band and uses only DSSS. IEEE 802.11b is also known as 802.11 high rate or wireless fidelity (Wi−Fi) [3].

The 802.11g standard operates in the 2.4−GHz band and provides speeds up to 54 Mbps (with a fallback to 48, 36, 24, 18, 11, 5.5, 2, and 1 Mbps). The 802.11g differs from 802.11b because it can optionally use OFDM (802.11g draft mandates that OFDM be used for speeds above 20 Mbps).

1.1 IMPORTANTS OF STANDARDS

Standards are a set of specifications that all manufacturers must follow in order for their products to be compatible. This is important to insure interoperability between devices in the market. Standards may provide some optional requirements that individual manufacturers may or may not implement in their products.

2.0 THE PROTOCOL OVERVIEW

2.1 IEEE 802.11b

In 1995, the Federal Communications Commission allocated several bands of wireless spectrum for use without a license. The FCC stipulated that the use of spread spectrum technology would be required in any devices. In 1990, the IEEE began exploring a standard. In 1997, the 802.11 standard was ratified but is now obsolete.

The 802.11b standard has a maximum raw data rate of 11 Mbit/s and uses the same media access method defined in the original standard. 802.11b products appeared on the market in early 2000, since 802.11b is a direct extension of the modulation technique defined in the original standard. The dramatic increase in throughput of 802.11b (compared to the original standard) along with simultaneous substantial price reductions led to the rapid acceptance of 802.11b as the definitive wireless LAN technology.

Devices using 802.11b experience interference from other products operating in the 2.4 GHz band. Devices operating in the 2.4 GHz range include microwave ovens, Bluetooth devices, baby monitors, cordless telephones and some amateur radio equipment.

802.11b is a Wi-Fi standard developed by the IEEE for transmitting data over a wireless network. It operates on a 2.4 GHz band and allows for wireless data transfers up to 11 Mbps.

2.2 IEEE 802.11g

The IEEE 802.11 standard defines both the physical (PHY) and medium access control (MAC) layer protocols for WLANs [4]. The standard operates in a total of 14 channels available in the 2.4-GHz band, numbered 1 to 14, each with a bandwidth of 22MHz and a channel separation of 5MHz. This channel mapping can be seen in figure 3. WLAN output powers are typically around 20dBm and operate within a 100m range.

In 2003, the IEEE ratified the 802.11g standard with a maximum theoretical data rate of 54 megabits per second (Mbps) in the 2.4 GHz ISM band. As signal strength weakens due to increased distance, attenuation (signal loss) through obstacles or high noise in the frequency band, the data rate automatically adjusts to lower rates (54/48/36/24/12/9/6 Mbps) to maintain the connection.

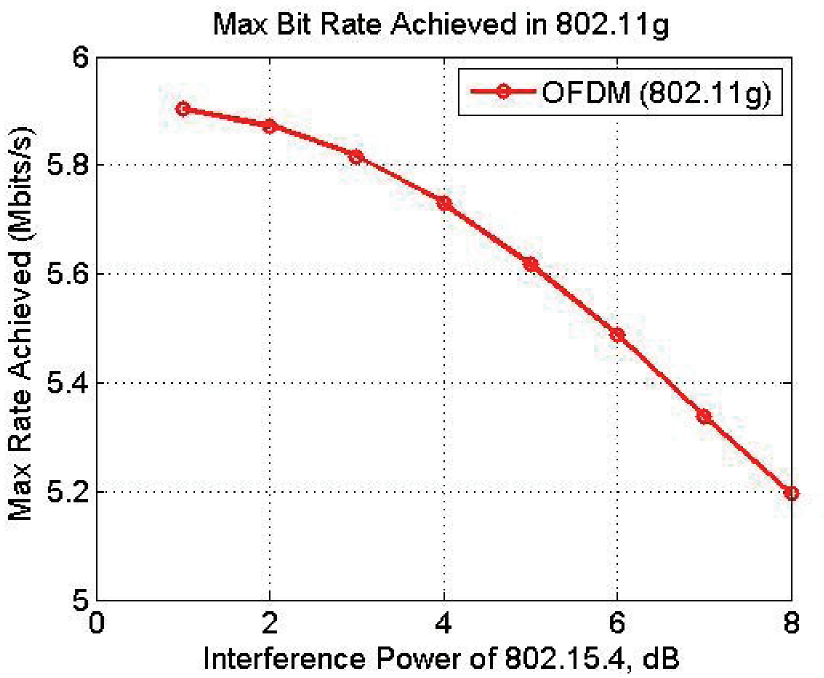

Fig.2.0: Maximum throughput for IEEE 802.11g

2.3 Spectral masks for 802.11g

Since the spectral mask only defines power output restrictions up to ±11 MHz from the center frequency to be attenuated by −50 dBr, it is often assumed that the energy of the channel extends no further than these limits. It is more correct to say that, given the separation between channels, the overlapping signal on any channel should be sufficiently attenuated to minimally interfere with a transmitter on any other channel. Due to the near-far problem a transmitter can impact a receiver on a "non-overlapping" channel, but only if it is close to the victim receiver (within a meter) or operating above allowed power levels.

Confusion often arises over the amount of channel separation required between transmitting devices. 802.11b was based on DSSS modulation and utilized a channel bandwidth of 22 MHz, resulting in three "non-overlapping" channels (1, 6, and 11). 802.11g was based on OFDM modulation and utilized a channel bandwidth of 20 MHz. This occasionally leads to the belief that four "non-overlapping" channels (1, 5, 9 and 13) exist under 802.11g, although this is not the case as per 17.4.6.3 Channel Numbering of operating channels of the IEEE Std 802.11 (2012) which states "In a multiple cell network topology, overlapping and/or adjacent cells using different channels can operate simultaneously without interference if the distance between the center frequencies is at least 25 MHz and section 18.3.9.3 and Figure 18-13.

This does not mean that the technical overlap of the channels recommends the non-use of overlapping channels. The amount of interference seen on a 1, 5, 9, and 13 channel configuration can have very small difference from a three channel configuration and in the paper entitled "Effect of adjacent-channel interference in IEEE 802.11 WLANs" by Villegas this is also demonstrated.

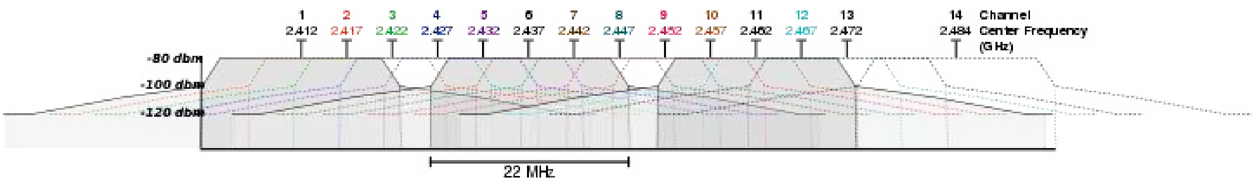

Fig. 2.1: Spectral masks for 802.11g channels 1 – 14 in the 2.4 GHz band

3.0 COMPARISON OF THE NETWORK

3.1 Differences between 802.11b and 802.11g networks

When both 802.11b and 802.11g clients are connected to an 802.11g router, the 802.11g clients will have a lower data rate but if they are connected to separate routers, the data rate of 802.11g becomes higher. Many routers provide the option of allowing mixed 802.11b/g clients or they may be set to either 802.11b or 802.11g clients only.

802.11b devices control their interference and susceptibility to interference by using direct-sequence spread spectrum (DSSS) method while 802.11g devices controls theirs using orthogonal frequency-division multiplexing (OFDM) signalling method.

Their speed of data transfer within a local network differs; 802.11g is faster and can support data transfer rates up to 54 Mbps while 802.11b can only support up to 11 Mbps.

Table 3.0: A comparison of 802.11b and g LAN Standards

Standard	**Maximum Data Rate (Mbps)**	**Typical Throughput (Mbps)**	**Operating Frequency Band**	**Maximum Non-Overlapping Channels (Americas)**
802.11b	11	6.5	2.4 GHz	3 ***1**
802.11g	54	8 (Mixed b/g) 25 (Only 802.11g)	2.4 GHz	3 ***1**

3.2 Similarities between 802.11b and 802.11g networks

Both 802.11b and 802.11g devices use the 2.4 GHz ISM band, operating in the United States under Part 15 of the U.S. Federal Communications Commission Rules and Regulations. Because of this choice of frequency band, 802.11b and g equipments may occasionally suffer interference from microwave ovens, cordless telephones and Bluetooth devices.

3.3 802.11b Limitations

802.11b is haunted by the possibility of interference in the 2.4–GHz frequency band in which it operates. However, the 2.4–GHz frequency is already crowded and will soon be more so. An even greater threat to 802.11b stability is just around the corner. Blue–tooth, the short–range wireless networking standard, which also operates in the 2.4–GHz range, is slated to coexist with wireless LANs. Bluetooth is not bothered a bit by 802.11b signals, but not vice versa. Depending on the proximity and number of devices, Bluetooth can have a negative impact on the performance of an 802.11b connection due to electromagnetic interference caused by the Bluetooth devices. Fig -1 shows the bit error rate versus Es/N0 at different data rate for 802.11b extension. The bit error rates for different data rate are shown in table-2.

3.4 802.11g Limitations

Though 802.11g devices would provide higher speed than the currently available 802.11b devices, it still suffers the interference issue with other devices operating in the same RF band; primarily the Bluetooth devices. [5]

3.5 The channel Assignments of 802.11b and 802.11g networks

The IEEE channel assignments for the two standards, i.e. 802.11b and 802.11g are shown in the table below in a detailed form.

Table 3.1 IEEE channel Assignments for 802.11b/g

Channel	Frequency Band (GHz)	Channel Center Frequency (GHz)	FCC – Americas	ETSI (Europe)
1	2.401-2.423	2.412	X	X
2	2.406-2.428	2.417	X	X
3	2.411-2.433	2.422	X	X
4	2.416-2.438	2.427	X	X
5	2.421-2.443	2.432	X	X
6	2.426-2.448	2.437	X	X
7	2.431-2.453	2.442	X	X
8	2.436-2.458	2.447	X	X
9	2.441-2.463	2.452	X	X
10	2.446-2.468	2.457	X	X
11	2.451-2.473	2.462	X	X
12	2.456-2.478	2.467	-	X
13	2.461-2.483	2.472	-	X
14	2.473-2.495	2.484	-	-

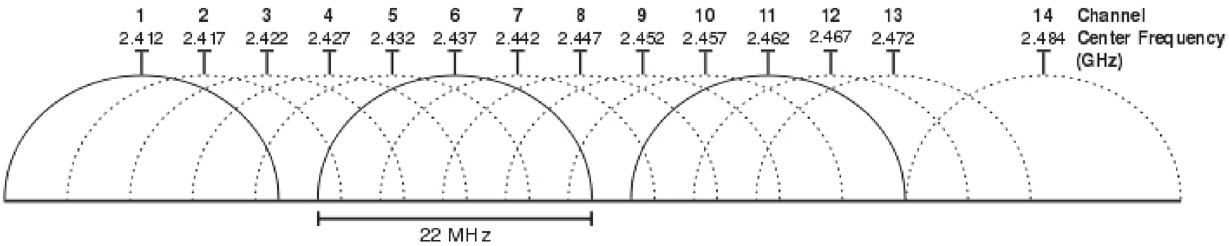

Fig 3.0: Graphical representation of Wi-Fi channels in the 2.4GHz band

4.0 Conclusion

The Institute of Electrical and Electronics Engineers (IEEE) certified a new standard, 802.11g, by merging two incompatible wireless networking standards 802.11b (goes far but not fast) and 802.11a (goes fast but not far). The new "g" standard has a 150-foot range, and the top speed is 54 Mbps

The foregoing confirms that the performance of 802.11g is better than 802.11b in the presence of interference from other sources such as Bluetooth devices and cordless telephones in the 2.4GHz ISM band.

The better performance is also because of the ability of IEEE 802.11g to improve its throughput using multiple data streams.

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