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Comparative Study on IEEE Standard of Wireless LAN/ Wi-Fi 802.11 a/b/g/n

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***Abstract*— Wireless Communication is an application of science and technology that has come to be vital for modern existence. From the early radio and telephone to current devices such as mobile phones and laptops, accessing the global network has become the most essential and indispensable part of our lifestyle. Wireless Local Area Network is a data transmission system considered to provide location independent network access between computing devices by using radio waves rather than a cable infrastructure. In the business venture, wireless LANs are frequently employed as the final link between the existing wired network and a group of client computers, giving these users wireless access to the full resources and services of the corporate network across a building or campus setting. The 802.11 is a family of specifications developed by the IEEE for WLANs. The IEEE 802.11 standard supports radio transmission within the 2.4 GHz band. In this paper, we concern on different WLAN standards and their comparative study on standard 802.11 a/b/g/n which will help to WLAN user's , student and researcher's for selection of better type of WLAN standard.**

***Index Terms*— WLAN, IEEE 802.11, 802.11a/b/g/n**

I. Introduction

WLAN technologies were first available in late 1990, when vendors initiated introducing products that operated within the 900 MHz frequency band. These solutions, which used non-standard, proprietary designs, provided data transfer rates of approximately 1Mbps. It was considerably slower than the 10 Mbps speed provided by most wired LANs at that time. In 1992, sellers began selling WLAN products that used the 2.4GHz band. Even if these products provided higher data transfer rates than 900 MHz band products they were expensive provided comparatively low data rates, were prone to radio interference and were often designed to use proprietary radio frequency technologies. The Institute of Electrical and Electronic Engineers started the IEEE 802.11 project in 1990 with the objective to develop a MAC and PHY layer specification for wireless connectivity for fixed, portable and moving stations within an area.

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II. IEEE 802.11 WLAN/Wi-Fi

Wireless LAN (WLAN, also known as Wi-Fi) is a set of low tier, terrestrial, network technologies for data communication. The WLAN standard operates on the 2.4 GHz and 5 GHz Industrial, Science and Medical (ISM) frequency bands. It is specified by the IEEE 802.11 standard and it comes in many different variations like IEEE 802.11a/b/g/n. The application of WLAN has been most visible in the consumer market where most portable computers support at least one of the variations. In the present study, we overview on different standard in table-1 and four WLAN standards were preferred for comparison that are IEEE 802.11a, IEEE 802.11b, IEEE 802.11g and IEEE 802.11n because these standards are very much popular among the users. It is noted that all 802.11 standards used Ethernet protocol and Carrier Sense Multiple Access / Collision Avoidance (CSMA/CA) for path sharing. [1][12][9]

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.

III. Overview on IEEE802.11 WLAN Standard

Table-1: List of Concurrent and Future IEEE Standard of WLAN/ Wi-Fi.[2][6][7][9][10]

Sr. No.	IEEE 802.11 Standard	Year of Release	Comments
1	IEEE 802.11a	1999	Speed 54 Mbits and 5 GHz band
2	IEEE 802.11b	1999	Enhancements to 802.11 to support 5.5 and 11 Mbits speed
3	IEEE 802.11c	2001	Bridge operation procedures; included in the IEEE 802.11D standard
4	IEEE 802.11d	2001	International (country-to-country) roaming extensions
5	IEEE 802.11e	2005	Enhancements: QoS, including packet bursting
6	IEEE 802.11F	2003	Inter-Access Point Protocol, Withdrawn February 2006
7	IEEE 802.11g	2003	54 Mbits, 2.4 GHz standard (backwards compatible with b)
8	IEEE 802.11h	2004	Spectrum Managed 802.11a (5 GHz) for European compatibility
9	IEEE 802.11i	2004	Enhanced security
10	IEEE 802.11j	2004	Extensions for Japan
11	IEEE 802.11k	2008	Radio resource measurement enhancements
12	IEEE 802.11n	2009	Higher throughput improvements using Multiple In Multiple Out
13	IEEE 802.11p	2010	WAVE-Wireless Access for the Vehicular Environment
15	IEEE 802.11r	2008	Fast BSS transition (FT) (
16	IEEE 802.11s	July 2011	Mesh Networking, Extended Service Set (ESS)
17	IEEE 802.11u	February 2011	Improvements related to Hot Spots and 3rd party authorization of clients, e.g. cellular network offload
18	IEEE 802.11v	February 2011	Wireless network management
19	IEEE 802.11w	September 2009	Protected Management Frames
20	IEEE 802.11x	-	Extensible authentication network .for enhancement of security
21	IEEE 802.11y	2008	3650–3700 MHz Operation in the U.S.
22	IEEE 802.11z	September 2010	Extensions to Direct Link Setup (DLS) (September 2010)
23	IEEE 802.11aa:	June 2012	Robust streaming of Audio Video Transport Streams
24	IEEE 802.11ad	December 2012	Very High Throughput 60 GHz
25	IEEE 802.11ae	March 2012	Prioritization of Management Frames
In process			
26	IEEE 802.11ac:	February 2014	Very High Throughput <6 GHz, potential improvements over 802.11n: better modulation scheme (expected ~10% throughput increase), wider channels (estimate in future time 80 to 160 MHz), multi user MIMO
27	IEEE 802.11af:	June 2014	TV Whitespace ()
28	IEEE 802.11ah:	January 2016	Sub 1 GHz sensor network, smart metering.
29	IEEE 802.11ai:	February 2015	Fast Initial Link Setup
30	IEEE 802.11mc:	March 2015	Maintenance of the standard
31	IEEE 802.11aj:	October 2016	China Millimeter Wave :
32	IEEE 802.11aq	May 2015	Pre-association Discovery
33	IEEE 802.11ak	-	General Link

IV. EEE 802.11A

Ratification of 802.11a took place in 1999. The 802.11a standard uses the 5 GHz spectrum and has a maximum theoretical 54 Mbps data rate. Like in 802.11g, 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. The 5 GHz spectrum has higher attenuation (more signal loss) than lower frequencies, such as 2.4 GHz used in 802.11b/g standards. Penetrating walls provides poorer performance than with 2.4 GHz. Products with 802.11a are typically found in larger corporate networks or with wireless Internet service providers in outdoor backbone networks [9][12].

V.IEEE 802.11B

In 1995, the Federal Communications Commission had 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 and is now obsolete. Then in July 1999 the 802.11b standard was ratified. The 802.11 standard provides a maximum theoretical 11 Megabits per second (Mbps) data rate in the 2.4 GHz Industrial, Scientific and Medical (ISM) band [9][12].

VI. IEEE 802.11G

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. 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. 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. To illustrate 54 Mbps, if you have DSL or cable modem service, the data rate offered typically falls from 768 Kbps (less than 1 Mbps) to 6 Mbps. Thus 802.11g offers an attractive data rate for the majority of users. The 802.11g standard is backwards compatible with the 802.11b standard. Today 802.11g is still the most commonly deployed standard [9][12].

VII. IEEE 802.11N

In January, 2004 the IEEE 802.11 task group initiated work. There have been numerous draft specifications, delays and lack of agreement among committee members. Yes, even in the process of standards development, politics are involved. The Proposed amendment has now been pushed back to early 2010. It should be noted it has been delayed many times already. Thus 802.11n is only in draft status. Therefore, it is possible that changes could be made to the specifications prior to final ratification. The goal of 802.11n is to significantly increase the data throughput rate. While there are a number of technical changes, one important change is the addition of multiple-input multiple-output (MIMO) and spatial multiplexing. Multiple antennas are used in MIMO, which use multiple radios and thus more electrical power. 802.11n will operate on both 2.4 GHz (802.11b/b) and 5 GHz (802.11a) bands. This will require significant site planning when installing 802.11n devices. The 802.11n specifications provide both 20 MHz and 40 MHz channel options versus 20 MHz channels in 802.11a and 802.11b/g standards. By bonding two adjacent 20 MHz channels, 802.11n can provide double the data rate in utilization of 40 MHz channels. However, 40 MHz in the 2.4 GHz band will result in interference and is not recommended nor likely which inhibits data throughput in the 2.4 GHz band. It is recommended to use 20 MHz channels in the 2.4 GHz spectrum like 802.11b/g utilizes. For best results of 802.11n, the 5 GHz spectrum will be the best option. Deployment of 802.11n will take some planning effort in frequency and channel selection. Some 5 GHz channels must have dynamic frequency selection (DFS) technology implemented in order to utilize those particular channels [12][8][9].

VIII.COMPARATIVE OVERVIEW ON 802.11 A/ B/ G/ N

In this paper, we have compared of IEE **802.11 a/b/g/n** standard of WLAN/ WiFi we use some basic characteristics like Operating frequency, Modulation technique, Data rate (Mbps), Slot time (µs), Preamble, Throughput, Speed,

Indoor Range, Outdoor Range, Multiple Access, Channel Bandwidth, Half/ Full duplex, Number of spatial streams, Mode of operation Ad-hoc, Infrastructure, VANET, FEC Rate, License /Unlicensed.

IX. CONCLUSION

Wireless Communication is an application of science and technology that has come to be vital for modern existence. From the early radio and telephone to current devices such as mobile phones and laptops, accessing the global network has become the most essential and indispensable part of our lifestyle. Wireless communication is an ever-developing field, and the future holds many possibilities in this area. Deployment of Wireless LAN increases well around the globe, it is increasingly important for us to understand different technologies and select the most appropriate one. Research in this area suggests that a dominant means of supporting such communication capabilities will be through the use of Wireless LANs. The future in this field is that, the devices can be developed to support communication with higher data rates and more security. In this paper we concentrate on most famous standard IEEE 802.11a/ b/ g/ n and compared on basis of basic characteristic of it. This comparative study help to beginner like student, researchers and different user to know about the Different standards of Wi-Fi understand their purpose and comparison to select standard best standard. Future work of this paper is Comparative study on different IEEE standard of Wi-Fi on performance basis in simulators.

Table-2: Comparison overview of WLAN /Wi-Fi IEEE Standard 802.11 a/ b/ g /n [1][3][4][5][9][11]

	IEEE 802.11a	**IEEE 802.11b**	**IEEE 802.11g**	**IEEE 802.11n**
Operating frequency	5 GHz UNII/ISM bands	2.4 GHz ISM band	2.4 GHz ISM band	2.4 - 5 GHz
Modulation technique	BPSK, QPSK, 16-, 64-QAM , OFDM	QPSK , DBPSK, DQPSK, CCK, DSSS	BPSK, QPSK, 16-, 64-QAM , OFDM	64-QAM, Alamouti, OFDM,CCK, DSSS
Data rate (Mbps)	6,9,12,18,24,36,48,54	1, 2, 5.5, 11	1, 2, 5.5, 11, 6,9,12,18,24,36, 48,54	7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65, 72.2, 15, 30, 45, 60, 90, 120, 135, 150
Slot time (µs)	9	20	20,(9 optional)	Less than 9
Preamble	OFDM	Long / short (optional)	Long/ Short/ OFDM	HT PHY for 2.4 and 5 GHz,
Throughput	23 Mbits	4.3 Mbits	19 Mbits	74 Mbits
Speed	54 Mbits	11 Mbits	54 Mbits	248 Mbits
Indoor Range	35 Mtrs	38 Mtrs	38 Mtrs	70 Mrs.
Outdoor Range	120 Mrs.	140 Mrs.	140 Mrs.	250 Mrs.
Multiple Access	CSMA/CA	CSMA/CA	CSMA/CA	CSMA/CA
Channel Bandwidth	20 MHz	20, 25 MHz	20 MHz	20 or 40 MHz
Half/ Full duplex	Half	Half	Half	Full duplex
Number of spatial streams	1	1	1	1,2,3or 4
Ad-hoc(mode of operation)	Yes	Yes	Yes	Yes
Infrastructure	Yes	Yes	Yes	Yes
VANET	Yes	Yes	Yes	Yes
FEC Rate	1/2,2/3,3/4	NA	1/2,2/3,3/4	3/4, 2/3 and 5/6
License/Unlicensed	Unlicensed	Unlicensed	Unlicensed	Unlicensed

REFERENCES

[1] Anil Kumar Singh, Bharat Mishra, "COMPARATIVE STUDY ON WIRELESS LOCAL AREA NETWORK STANDARDS", International Journal of Applied Engineering and Technology ISSN: 2277-212X , 2012 Vol. 2 (3) July-September
[2] Sourangsu Banerji, Rahul Singha Chowdhury , "Wi-Fi & WiMAX: A Comparative Study"
[3] Jan Magne Tjensvold, "Comparison of the IEEE 802.11, 802.15.1, 802.15.4 and 802.15.6 wireless standards", September 18, 2007
[4] Raju Sharma, Dr. Gurpal Singh, Rahul Agnihotri "Comparison of performance analysis of 802.11a, 802.11b and 802.11g standard", (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 06, 2010
[5] Amit R. Welekar, Prashant Borkar, S. S. Dorle, "Comparative Study of IEEE 802.11, 802.15,802.16, 802.20 Standards for Distributed VANET" International Journal of Electrical and Electronics Engineering(IJEEE) Vol-1,Iss-3,2012
[6] Vijay Chandramouli, "A Detailed Study on Wireless LAN Technologies"
[7] http://en.wikipedia.org/wiki/IEEE_802.11
[8]http://eetimes.com/design/microwave-rf-design/4012676/Tutorial-on-802-11n-PHY-layer--Part-3[fec of n]
[9] Carlo de Morais Cordeiro, Dharma Prakash Agrawal, "ADHOC &SENSOR NETWORKS Theory and Application", World Sientific Publishing Co.Pvt.Ltd, 2010
[10] D. P. Agrawal, Q A Zeng, "Introduction to Wireless and Mobile System", Cengage, 2/e
[11] Upen Dalal, "Wireless Communication ", Oxford
[12] IEEE 802.11 a/b/g/n Wi-Fi Standards and Facts