Comparative Study of Existing and Forthcoming WLAN Technologies

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Summary
In today's world as the innovation in computing application is advancing day by day which required more and more bandwidth. For example online gaming, video streaming and mega file uploading and downloading. All these application are bandwidth demanding, to full fill the requirement of these applications in communication, a medium play an important role, there are two major types of medium i.e Wired and Wireless. In wired medium fiber optic cable is the major stakeholder to fulfill the bandwidth demand but it has mobility limitation, so another medium which is called wireless that fulfill not only bandwidth demand but also provide mobility to the users. In this paper we will discuss comparison about the existing WLAN and forthcoming WLAN with respect to General, Technical parameters and Advantages and Disadvantages differences. It has been concluded which one is the best to fulfill the future communication demands.

Key Words:
Wi-Fi, Li-Fi, WLAN, Technology

1. Introduction

Wireless LAN technologies are emerged with parallel of wired LAN technologies. Wireless LAN has limitations of geographically coverage but provide enrich bandwidth for data communication. Existing available technology for wireless LAN is IEEE. 802.11(a,b,c) which is called Wifi and successfully deployed worldwide for data communication and sharing resources. With further development of wireless LAN research is in process on a new Forthcoming standard which is called Lifi this standard will provided us data communication through light instead of wave as i.e wifi. To compare these technologies first we need to understand the overview architecture and working mechanism these technologies so let's start with discussion of Exiting Wlan technology

2. Overview, architecture and working mechanism Of Existing WLAN Techonology

Overview: As discuss the existing WLAN technology which is called Wi-Fi it permits the users to connect with network via radio waves. In terms of IEEE it is called 802.11. Nowadays, many devices such as smartphones, laptops, and tablets can connect to a network environment through access points. Following are some 802.11 versions came in to being along with difference features [1]

802.11a: This standard works at 5 GHz and its maximum throughput is 54mbps. The modulation technique for this standard is OFDM, OFDM is technique that uses division of signals in to multiple sub to overcome the signal interference problem.

802.11 b: This standard is very slow and cheap. In Early days, 802.11b was the most famous standard due to its low cost. by the time being it lost its popularity as the demand for fast standard requirement increases. It works on 2.4 Ghz. With maximum throughput of11 Mbps. The modulation technique for this standard is Complimentary Code Keying (CCK).

802.11g: 802.11g works on 2.4 Ghz like 802.11b but its throughput is up to 54 Mbits . Likewise to 802.11a, 802.11g uses OFDM instead of CCK.

802.11n: This is the most advanced standard which uses MIMO technique and it is widely available in the market The improvement in this standard is with respect to range, frame aggregation to minimize the time between Tx. The improvement in this slandered is still in process in 2007 Peer-N Equipment demonstrate throughput up to 540 Mbps d. [2]

Architecture: The architecture of Wifi comprise of following parts Main Back Bone (Internet)

A. Main Back Bone
B. Access Points
C. Link Between Acces Points
D. Wireless Nodes

A. Main Back Bone: The main backbone describe as the main stream line provided by service provide in this case which ISP providing inter connection which is available via ADSL modem

B. Access Points: Access point is station which transmit and received the signal provided either by back bone , Access node or another Access point . It connects the users and server as the center point of interconnection between wired and wireless LAN

C. Link Between Access Points: It is the link that connect the two Access points it is used when we need to extend the coverage area of our network and it can be done

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wither connecting these points by wired link or wireless link.

D. Wireless Nods : Any electronic device that can transmit and receive data wirelessly is call wireless node i.e Smart Phone , Laptop, tablets smart Tv's etc.

Fig. 1 Wi-Fi Architecture

Working mechanism of Wi-Fi: As it has been studied that wifi work wirelessly and it use radio waves to transfer and receive the signals, the range of these waves are 2.4 to 5.9 Ghz. The access nodes which will connect with the wifi access point must have wireless cards and the connectivity of these access nodes depends upon the range of access point and RF planning the normal range of an access point is 32 meter. The radio signals are spread by access point through antenna and received by access node through wireless card. An access point can transmit up to 54 Mbp's and it can vary depends upon the version of wifi slandered 802.11. The speed of access node depends upon the signal strength of node as more as node will be close to the access point it will achieve maximum bandwidth the security of access point can be achieved by some parameters i.e WEP(Wired Equivalent Privacy), WPA(Wifi Protected Access) without encryption and WPA2 use encryption 25 character . Overview, architecture and working mechanism.

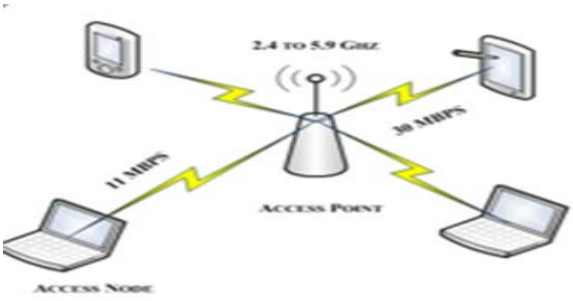

Fig. 2 Working Mechanism of Wi-Fi

3. Overview, architecture and working mechanism Of forthcomming WLAN Techonology

After detail discussion of existing WLAN technology now its turn to have another detail discussion on forthcoming WLAN technology which is known as Li-Fi.

Overview: Li-Fi will replace the wifi as it is working on light wave or we can say it is the optical version of wifi . As we know the users of triple play services are increasing day by day so in future as the bandwidth demand will increased and it will be full fill be this technology . Mr . Harald Haas presented a demon on VLC in TED talk. In his demo he transmit data through lighting device called light-emitting diodes .The procedure of his devices was very simple as he said if you ON the device means you transmit 1 and if you OFF the device means you transmit 0, further he said this mechanism can be repeated as per the bit coming from sender. In other word we can assume from his idea that the data is encoded in the light by shifting the ON and OFF states of LED

Another demo of this technology was presented in 2012 Consumer Electronics Show in Las Vegas between two smart phones to transfer data using Visible Light Communication. The distance between these devices was 10 meters.

In 2011 a group of companies were formed related to this technology for problem solving, promotion, utilization and further enhancement in the field. The expected throughput for this technology is 10Gbps tentatively which may lead to download a heavy file in more or less than 30 second.[3]

Fig. 3 Overview of Parts Connectivity of Li-Fi

Architecture: The Li-Fi architecture contains various devices such as LED bulbs, mobile devices and the photo detector which receives the binary data over light. The binary data is captured by few light receptors which are installed on all types of connecting devices such as computer tablets, phones, televisions, or appliances [4]

Modulation Techniques: Lifi Use following modulation technique

a) On-off keying (ook),
b) Variable pulse position modulation (vppm)
c) Colour shift keying (csk)

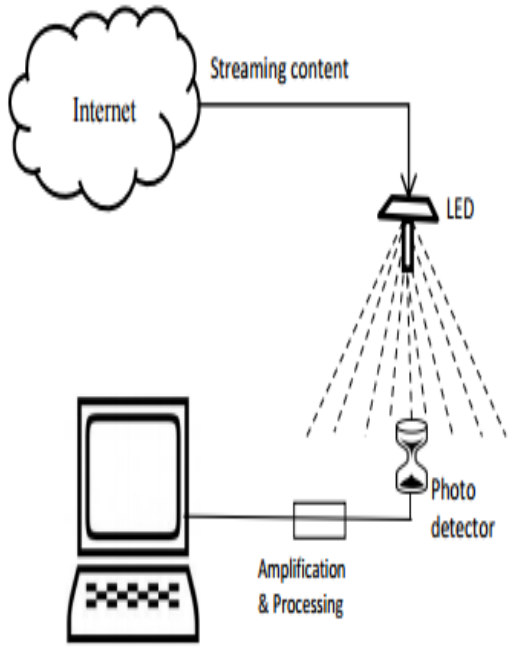

Fig. 4 Architecture of Li-Fi

Table 1: Shows General difference of Wi-Fi and Li-Fi

GENERAL DIFFERENCE	
Wi-Fi	**Li-Fi**
Wifi works on waves	Lifi works in visible light
Wifi Transmit data with use of wireless router	Li-Fi Transmit data with in Uses of LED bulb
Wifi accompanied interference issue by near access point	Lifi dos not have interference issue like radio waves transmission
Wifi is compatible with Lan 802.11(a,b,n,ac,ad)	Devices Li-Fi is compatible with IrDA Devices
Wifi signals cannot be blocked by walls, so signal need to use more secure techniques to protect data	Lifi cannot pass through wall so data is protected and more secure

Working mechanism of Li-Fi: Lifi works on visible light to transmit the data. The spectrum of this light is versatile starting from 400 THz to 800 THz. It use Led Bulb for transmission and receiving which is connected to the Transceiver and Transceiver is further connected with Ethernet cable which server as back hull. To transmit the data Led work on ON and OFF mechanism the speed of this mechanism is so high that a human eye cannot make differentiate weather led is getting ON and OFF or it is continuously emitting the light. The ON and OFF mechanism is managed by a voltage regulator. At the receiving side the photo detecting unit is attached with laptop and it will senses light to transform it into particular pulses. These pulses are then amplified and processed to achieve the original data stream. [5]

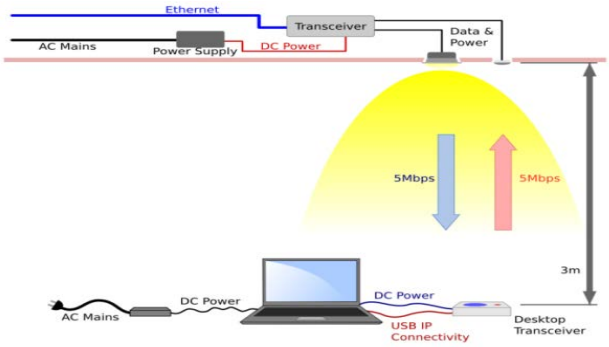

Fig. 5 Shows the working Mechanism of Li-Fi

Lifi Application: Following are some sort of lifi system [6]

1. Smart Lighting:
2. In Vehicles Light
3. Undersea Water
4. In Home Appliances:
5. In Health
6. Indoor Navigation
7. In Hospitals
8. In Petrochemical Industry
9. Security

4. Comparision Between Existing and Forthcoming WLAN Technologies

From above whole discussion now it time to compare both of technologies with respect to their General features, Technical Parameter and Advantages and Disadvantages [7-8].

Table 2: Shows Technical Parameter difference of Wi-Fi and Li-Fi

TECHNICAL PARAMETER DIFFERENCE		
Parameters	**Wi-Fi**	**Li-Fi**
Standardization	IEEE. 802.11 (‘a’,’b’,’g’,’n’)	IEEE 802.15.7 draft standard
Maximum bandwidth	54 to 600 Mbps	1 Gbps
Modulation technique	OFDM, DSSS and CCK	On-off keying (OOK), Variable pulse position modulation (VPPM) Colour shift keying (CSK)
RF band/wav band	2.4 GHz, 3.6 GHz, 4.9 GHz, 5 GHz, and 5.9 GHz	400 THz and 800 THz
Channel bandwidth	20 to 40 MHz	Its channel bandwidth depend upon deployment scenario i.e. An LED whose 3 –dB bandwidth is 60 MHz
Range	32 Meters	10 Meters
Security	(WEP, WPA without encryption and WPA2 use encryption 256,	Under research
Connection medium	Radio waves	Light
No of Users	Depend upon the Wi-Fi coverage campus wise or city wise	Depend upon the Led bulbs installed in campus or office
Implementation	World wide	Under research

Table 3: Shows difference of Wi-Fi and RF

Topics	**LIFI (Light Fidelity)**	**RF**
Standardization	In Progress (Previously It was IEEE 802.15.7m TG task group and now changed to IEEE802.15.11 LC SG	Matured
Transmitter	LED/LD(combined LDs with Optical diffuser)	Antenna
Receiver	PD	Antenna
Modulation	Amplitude and Phase Modulation Techniques cannot be applied for information needed to be modulated in the varying of intensity of the light wave. On-off Keying (OOK) CMDA color Shift Modulation CSK ETC. ARE APPLICABLE [20],[21],[22]	ASK,PSK,FSK,PM,CDMA,OFDMA etc. are applicable
OFDM	Yes [20]	Yes
MIMO	Yes[23]	Yes
Communication Distance	10m [24]	More than 100 km using microwave link
Interference level	Low m[24]	Very High
Noise	Sun plus ambient lights sources	All electrical and electronic appliance
Environmental Effects	Indoor: No. Outdoor: yes	yes
Data Rate	10 Gbps using LED and 100 Gbps using LD[26]	6 Gbps [25] (IEE 802.11 ad at frequencies around 60 Ghz)
Security	High	low
Spectrum	IR/VL/UV	Radio waves
Spectrum Regulation	No	Yes (not always e.g Wi Fi)
Path Loss	Medium (very high for NLOS)	High
Illumination	Yes	No
Main purpose	Illumination and Communication	Communication and positioning
Main Limitations	Short Distance Communication and (iii) not suitable in outdoor	Interference

Table 4: Shows Problems of Li-Fi and Wi-Fi

Problems	Light Fidelity	Wireless Fidelity
Transmission and reception medium	VL for downlink and VL or IR for UV for uplink	RF waves
Maximum Data rate	10 Gbps using LED and 100 Gbps using LD (combined with Optical diffuser)	6 GBPS using IEEE 802.11 ad
Communication distance	10 m	100 m
Interference level	Low	High
Transition	Directional	Omnidirectional
IEEE Standard	802.15.7m	802.11
Infrastructure Cost	Less	More
Modulation technique	Direct Current biased optical Orthogonal Frequency Division Multiplexing (DCO-OFDM)	Direct Sequence Spread Spectrum (DSSS)
Power consumption for communication purpose	Very Small	Comparative High
Human harmness [27]	No	Yes

Table 5: Acronyms

Terms	Acronyms
VLF	Very low frequency
LF	Low frequency
HF	High Frequency
VHF	Very High Frequency
UHF	Ultra-High Frequency
SHF	Super High Frequency
EHF	Externally high Frequency
MW	Millimeter wave
FIR	Fair Infrared
TIR	Thermal infrared
LER	Long-wavelength infrared
MWIR	Mid-wavelength infrared
SWIR	Short-wavelength Infrared
NIR	Near Infrared
UV-A	Ultraviolet A
UV-B	Ultraviolet B
UV-C	Ultraviolet C
N-VU-C	Near Ultraviolet C
M-UV	Middle ultraviolet
F-UV	Far ultraviolet
HL-A	Hydrogen Lyman-Alpha
EUV	Extreme Ultraviolet
V-UV	Vacuum Ultraviolet
S X-Ray	Soft X-ray
H X-Ray	Hard X-ray
G-Ray/ C-Ray	Gamma ray / Cosmic ray

Table 6: Spectrum Classification of Wi-Fi and Li-Fi

Spectral Classification			Frequency	Wavelength
Radio Wave		VLF	3-30 Khz	100-10 km
		LF	30-300	10 - 1 km
		MF	0.3-3	1000 - 100 m
		HF	3-30 Mhz	100 - 10 m
		VHF	30-300 MHz	10 - 1 m
		UHF	0.3-3 Ghz	1- 0.1 m
		SHF	3-30 GHz	100 - 1mm
		EHF/Mw	30- 300 GHz	10 -1 mm
	Microwave	**Band**	**Frequency**	**Wavelength**
		P	0.225-0.39	1330-769 mm
		L	0.39 -1.55	769 -139 mm
		S	1.55- 5.2	139-57.7 mm
		C	3.9 - 6.2	76.9-48.4 mm
		X	5.2 - 10.9	57.7-27.5 mm
		Ku	12 - 18 GHz	25.5 1667 mm
		K	10.9 - 36	27.5-8.33 mm
		Q	36 - 46 GHz	8.33 – 6.52 mm
		V	46 - 56 GHz	6.50-5.35 mm
		W	56 - 100 GHz	5.35-3 mm
Optical	IR	FIR	0.3 - 20 THz	1-0.015-0.0 03 mm
		TIR		
		LER	20 -37.5 THz	0.015-0.008 mm
		MWIR	37 – 100 THz	0.008-0.003 mm
		SWIR	100 -241.3 THz	300000- 1400 nm
		NIR	214.3 – 349.7 THz	1400 – 760 nm
	Visible Light	Red	349.7 - 491.8 THz	760 -610 nm
		Orange	491.8 – 507.6 THz	610 – 591 nm
		Yellow	507.6 – 526.3 THz	591-570 nm
		Green	526.3 – 600 THz	570 – 500 nm
		Blue	600 – 600.7 THz	500 – 360 nm
		Violet	600.7 – 833.3 THz	450 – 360 nm
	Ultra Violet	UAV	750 – 952.4 THz	400 - 315 nm
		UVB	952.4 – 1071 THz	315 1 280 nm
		UVC	1.071-3 PHz	280 100 nm
		VUC	0.750 - 1 PHz	400 -300 nm
		MU	1-1.5 PHz	300 – 200 nm
		FU	1.5 – 2.459 PHz	200 -122 nm
		HLA	2.459 – 2.479 PHz	122-121 nm
		EUV	2.479 – 30 PHz	212 – 10 nm
		VU	1.5 – 30 PH	200 – 10 mm
X-ray		S X-ray	30 -3000 PHz	10 – 1 pm
		HX-ray	3 – 300 EHz	100 - 1
G- Ray / C-Ray			300-30000 EHZ	1000 – 10fm

Table 7: Advantages and Disadvantages of Wi-Fi and Li-Fi

ADVANTAGES AND DISADVANTAGES		
Technology	**Advantages**	**Disadvantages**
Existing WLAN Wi-Fi	For 2.4 GHz dos not required licenses	Power consumption is high
	Allow to build fast LAN as there no need for cabling	Wifi network has limited range
	Wifi Network can Support Rooming	Free access point can threat for intruders
	It allows the cheaper deployment of LAN	Backward compatibility issue between versions
Forthcoming WLAN Li-Fi	Li- Fi works on lights	LI-FI requires Line of Sight
	VLC can be used in aero plans without disturbing their communication devices	Weather can effect on Li-Fi device
	It can be widely uses in health science to make communication between devices which cannot operate on radio waves	We cannot shift the Li-Fi indoor receiver easily as it can be fixed
	Radio waves do not work under water so this is the best option for making communication under water with devices as light can travel in the water	Receiver retransmit problem still exists
	Upgrading just existing conventional bulb to LED and you will have wide coverage	Light eave cannot pass through wall so coverage will be limited
	As the light cannot pass through the wall it is benefit with respect to security as there will be no signal outside your vicinity	In case of Power failure there will be no internet

5. Open Research Issues

The future research seeks attention towards the UWOC (underwater wireless optical communication). In the modern age applications like: investigation of pipelines, offshore investigation, environmental monitoring and high-speed long-range links are required and appropriate model or architecture proposed which provide the better platform for underwater communication. The new techniques about coding and modulation could be explored that could be used for underwater communication environments [148]

6. Conclusion

In this study of WLAN technologies the major factor is bandwidth .The forthcoming WLAN (Li-Fi) has advantage over Existing WLAN (Wi-Fi) as it provide throughput in GHz. Life will be amazing if someone wish to download a high definition file in micro seconds while moving by using Li Fi technology. It had studied that Wi-Fi is fully mature technology working on radio waves and successfully deployed worldwide. Likewise the benefits it has some future encounters that could be focused. It works on line of sight so users who have no proper line of sight may fell connectivity problem. To maximize the coverage the more access point needed. The Li- Fi technology could be explored to make communication with devices where radio waves are not permitted.

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