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A Comparative Study of Existing & Emerging Wireless Technology

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Abstract: *The explosive growth in wireless networks over the last few years are rapidly becoming popular, and user demand for useful wireless applications is increasing. We are using Wi-Fi and Wi-Max for the faster internet facility of Mbps speed. According to data rates, we already allowed Gigabyte Fidelity (Gi-Fi) and Light Fidelity (Li-Fi) technology of more than 1 Gbps speed. In this paper I have work to examine and assess the possibilities on wireless technology improvement in terms of how would be apply to Wi -Fi, Wi-Max, Gi-Fi and Li-Fi technology for creation of a wireless access desire infrastructure by comparing of technical data and key characteristics of these technology.*

Key Words: *Wi-Max, Wi-Fi Li-Fi, Gi-Fi, wireless Technologies ,Qos (Quality of service) , ZigBee*

1.0 Introduction:

Recently broadband wireless access (BWA) is increasingly gaining in popularity as an alternative in last mile implementations to DSL lines and cable modems. Some of the deployed wireless standards are 802.11(Wi-Fi), 802.16(Wi-Max), 802.15.3c (Gi-Fi). Recently a new standard 802.15.7 (Li-Fi) has been proposed and which is still under development The Wi-Max is 100 times faster than Wi-Fi which is generally used in business purpose. Whether the Wi-max worked in microwave interoperability in Post Wi-Fi technology, the light fidelity (Li-Fi) can be complemented of RF communication and subset of visible light communication LIFI is 1000 times faster than Wi-Fi and much efficient than Wi-Max. Li-Fi and Gigabyte Fidelity (Gi-Fi) technologies are not allowed to used in the daily life just because these two technologies are operated in 10m light communicating ranges. This paper presents a description of the existing and emerging wireless technologies Wi-Fi, Wi-Max, Gi-Fi and Li-Fi find out the best technology, we should take care some parameter like efficiency, easy technology, low cost and easy to operate and find out the best among them, which will be the future choice in communication industry.

The purpose of this paper is to provide a technical and market comparison of Wi-Fi, Wi-Max, Gi-fi and Li-fi technologies in order to highlight that which technology will be better to build a wireless access infrastructure. The first part of the paper examines all of these wireless technologies in order to understand all technologies and their underlying concepts. Then, we have discussed some key characteristics to compare all these technologies. The last part concludes and presents a conclusion of which will be the best technology to build a wireless access infrastructure.

2.0 Conceptual Briefings on Wireless – Technology :

A brief information about technical analysis of alternatives by the comparison for implementing last-mile wireless services to new technology .

2.1 IEEE 802.11 (Wi-Fi) :

Wi-Fi stands for "wireless fidelity". Wi-Fi networks, where contention is possible, high signal strength in indoor access Wi-Fi networks is an indicator of a fast and reliable Wi-Fi connection However since most of our WLANs are based on those standards, the term Wi-Fi is used generally as a synonym for WLAN. Wi-Fi is a popular technology which allows any electronic device to exchange and transfer data wirelessly over the network giving rise to high speed internet connections. Any device which is Wi-Fi enabled (like personal computers, video game consoles, Smartphone, tablet etc.) can connect to a network resource like the internet through a wireless network access point. Now such access points also known as hotspots have a coverage area of about 20 meters indoors and even a greater area range outdoors, this is achieved by using multiple overlapping access points.

However with all such features, Wi-Fi also suffers from certain shortcomings. Wi-Fi is known to be less secure than wired connections (such as Ethernet) because an intruder does not need a physical connection. Web pages that use SSL are secure but unencrypted internet access can easily be detected by

intruders. Because of this, Wi-Fi has adopted various encryption technologies.

A primary challenge for Wi-Fi is interference. Since Wi-Fi's spectrum is unlicensed, it is subjected to maximum possibility of interference from other wireless devices .There are three well known 802.11 wireless family standard widely used today.

- **The IEEE 802.11b**
- **The IEEE 802.11g**
- **The IEEE 802.11a**

The IEEE 802.11 standard is a set of media access control (MAC) and physical layer

(PHY) specifications for implementing wireless local area network (WLAN) computer communication in the 2.4, 3.6, 5, and 60 GHz frequency bands.

2.1.1 Wi-Fi Radio Spectrum :

802.11b and 802.11g use the 2.4 GHz ISM band, operating in the United States under Part 15 Rules and Regulations. Because of this choice of frequency band,802.11b and 802.11g equipment may occasionally suffer interference from microwave ovens, cordless telephones, and Bluetooth devices. And 802.11a operates in the 5GHz band with a maximum data rate of 54Mbps.

2.1.2 Interference :

Wi-Fi connections can be disrupted or the internet speed lowered by having other devices in the same area. Many 2.4 GHz 802.11b and 802.11g access-points default to the same channel on initial startup, contributing to congestion on certain channels. Wi-Fi pollution, or an excessive number of access points in the area, especially on the neighboring channel, can prevent access and interfere with other devices' use of other access points, caused by overlapping channels in the 802.11g/b spectrum, as well as with decreased signal (SNR) between access points. This can become a problem in high-density areas, such as large apartment complexes or office buildings with many Wi-Fi access points. It is advised to only use channel 1-6-11.
The major disadvantage in deploying 802.11a with the other 802.11 standards b and g is that, they cannot co-exist, as they operate on different frequency bands.

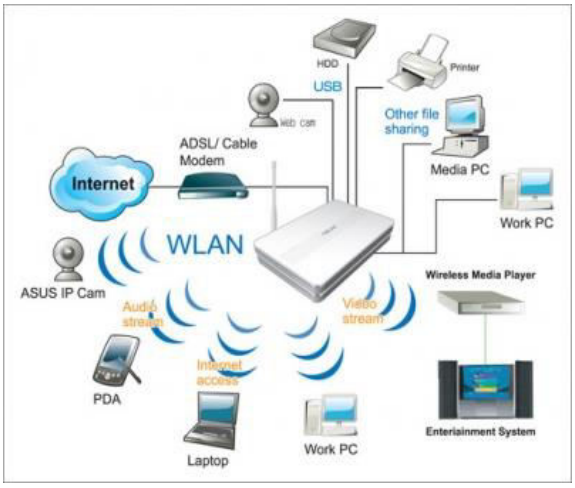


Figure 2.1: The Wi-Fi Network

2.2 IEEE 802.16 (Wi-Max) :

The world with interoperability for microwave access (Wi-Max) is intended to handle high-quality voice, data and video services while offering a high QoS with lower cost. Wi-Max is gaining popularity as a technology which delivers carrier-class, high speed wireless broadband at a much lower cost while covering large distance than Wi-Fi .

Wi-Max operates in between 10 and 66 GHz Line of Sight (LOS) at a range up to 50 km (30 miles) and 2 to 11GHz non Line-of-Sight (NLOS) typically up to 6 - 10 km (4 - 6 miles) for fixed customer premises equipment (CPE). Both the fixed and mobile standards include the licensed (2.5, 3.5, and 10.5 GHz) and unlicensed (2.4 and 5.8 GHz) frequency spectrum. However, the frequency range for the fixed standard covers 2 to 11 GHz while the mobile standard covers below 6 GHz. Depending on the frequency band, it can be Frequency Division Duplex (FDD) or Time Division Duplex (TDD) configuration. The data rates for the fixed standard will support up to 75

Mbps per subscriber in 20 MHz of spectrum, but typical data rates will be 20 to 30 Mbps. The mobile applications will support 30 Mbps per subscriber, in 10 MHz of spectrum, but typical data rates will be 3 - 5 Mbps.

2.2.1 Development :

The IEEE 802.16m-2011 standard was the core technology for Wi-Max 2. The IEEE 802.16m standard was submitted to the ITU for IMT-Advanced standardization. IEEE 802.16m is one of the major candidates for IMT-Advanced technologies by ITU. Among many enhancements, IEEE 802.16m systems can provide four times faster

data speed than the Wi-Max Release 1. Wi-Max Release 2 provided backward compatibility with Release 1. Wi-Max operators could migrate from release 1 to release 2 by upgrading channel cards or software. The Wi-Max 2 Collaboration Initiative was formed to help this transition.

2.2.2 Uses Of Wi-Max :

The bandwidth and range of Wi-Max make it suitable for providing portable mobile broadband connectivity across cities and countries through a variety of devices. And providing a wireless alternative to cable and digital subscriber line (DSL) for "last mile" broadband access, providing data, telecommunications (VoIP) and IPTV services (triple play), Providing a source of Internet connectivity as part of a business continuity plan, Smart grids and metering .

Wi-Max can provide at-home or mobile Internet access across whole cities or countries. In many cases this has resulted in competition in markets which typically only had access through an existing incumbent DSL (or similar) operator.

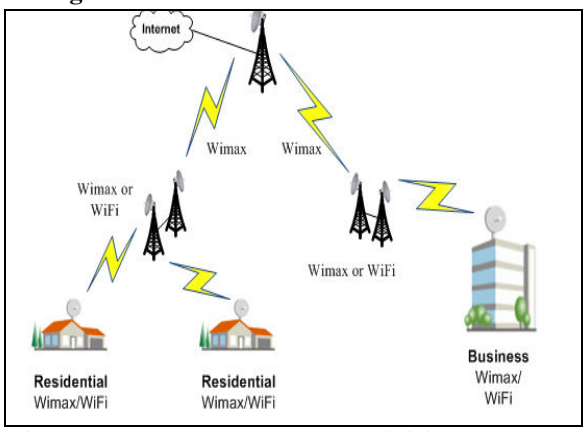
Additionally, given the relatively low costs associated with the deployment of a

Wi-Max network (in comparison with 3G, HSDPA, xDSL, HFC or FTTx), it is now economically viable to provide last-mile broadband Internet access in remote locations

2.2.3 Limitations of Wi-Max :

Wi-Max cannot deliver 70 Mbit/s over 50 km (31 mi). Like all wireless technologies, Wi-max can operate at higher bitrates or over longer distances but not both. Operating at the maximum range of 50 km (31 mi) increases bit error rate and thus results in a much lower bit rate. Conversely, reducing the range (to under 1 km) allows a device to operate at higher bitrates. A city-wide deployment of Wi-Max in Perth, Australia demonstrated that customers at the cell-edge with an indoor Customer-premises equipment (CPE) typically obtain speeds of around 1–4 Mbit/s, with users closer to the cell site obtaining speeds of up to 30 Mbit/s.

Figure 2.2 : The Wi-Max Network



Wi-Max can be Frequency Division Duplex (FDD) or Time Division Duplex (TDD) configuration. The MAC layer used by Wi-Max is based on a time division multiple access (TDMA) mechanism to allow a homogeneous distribution of the bandwidth between all the devices which is more effective and support several channels compared to the mechanism used by Wi-Fi (CSMA-CA). This makes it possible to obtain a better optimization of the radio spectrum with better efficiency (bits/seconds/Hertz).The Wi-Max is 100 times faster than Wi-Fi.

2.3 IEEE 802.15.7 (Li-Fi) :

Light Fidelity (Li-Fi) is a bi-directional , high-speed and fully networked wireless communication technology that uses light emitting diodes (LEDs) for transmission of data. It is a light-based Wi-Fi, which uses light waves instead of radio waves for data transmission. And instead of Wi-Fi modems, it uses transceiver-fitted LED lamps which can lighten a room as well as transmit and receive information.

Li-Fi is basically the subset of Visible Light communication (VLC) a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. Fast pulses are used for wireless transmission.

2.3.1 General Working Principle

Light emitting diodes (LEDs) can be switched on and off faster than the human eye can detect since the operating speed of LEDs is less than 1 μs, thereby causing the light source to appear to be continuously on. This invisible on-off activity enables data transmission using binary codes. Switching on an LED is binary '1', switching it off is binary '0'. It is possible to encode data in light by varying the rate at which LEDs flicker on and off to give different

strings of 1s and 0s. Modulation is so rapid that humans cannot notice it.

A light sensitive device (photo detector) then receives the signal and converts it back into original data. This method of using rapid pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC).The term Li-Fi has been inspired due to its

potential to compete with conventional Wi-Fi.

The VLC uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as the optical carrier for data transmission and for illumination. Data rates of greater than 100 Mbps can be achieved by using high speed LEDs with adequate multiplexing. Parallel data transmission using arrays of LEDs where each LED transmits a separate stream of data can be used to increase the VLC data
rate. Though the lights have to be kept on in order to transmit data, they can be dimmed to the point that they are not visible to humans but still be capable of transmitting data.

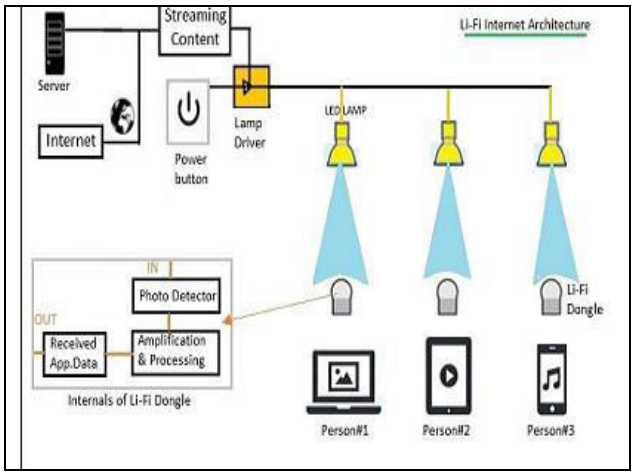


Figure2.3.1: Working Principle of (Li-Fi)

2.3.2 Application Of Li-Fi :

Li-Fi technology can find application in a wide variety of fields. A detailed discussion of its various applications is given below.

- Medical and Healthcare & Airlines and Aviation.
- Power Plants and Hazardous Environments.
- Underwater Explorations and Communications.
- Traffic & Smart Lighting.
- Giga Speed Technology.
- Mobile Connectivity & Indoor Wireless Communication.
- RF Spectrum Relief & RF Avoidance & Line of Sight Applications.
- Hidden Communications & Smart Classes.

The Li-Fi Consortium provides the fastest wireless data transfer technology presently available. Our current solutions offer
effective transmission rates of up to 10 Gbps, allowing a 2 hour HDTV film to be transferred in less than 30 seconds. This can
be extended to several 100 Gbps in future versions.

2.3.3 Limitations of Li-Fi :

Li-Fi is 1000 times faster than Wi-Fi and much efficient than Wi-Max. But light signals cannot penetrate walls. So the person needs wired bulb in that room also. Only works if there is direct line of sight between source and receiver. Used for broadcast and it is difficult to uplink.

One problem is that OLEDs emit a fairly broad spectrum of light, and different wavelengths will pass through the grating at different angles, forming a rainbow. To minimize this, the team searched for OLEDs with very narrow emission characteristics. OLEDS constructed with the rare earth element europium offer narrow emission, but they aren't very efficient. Samuel says his team has managed to raise the efficiency—the amount of input energy that comes out as light—to 4.3 percent. Another option is to add quantum, which have narrow emission spectra, as a color conversion layer in the OLED, Samuel says. The underlying OLED would cause the dots to emit the desired color of light.

2.4 IEEE 802.15.3C (Gi-Fi) :

Gi-Fi is one of the most important wireless technology that enhances our personal
environment, either work or private, by means of networking or a variety of personal and wearable devices within the space and with the outside world. In optical fibres, Gi-Fi played an important role for
its high speed large files transfers within seconds.

It is a scalable wireless platform for constructing alternative and complementary broadband networks and it operates at 60 GHz on the CMOS process. It will also allow the transfer of wireless audio and video files within a range of 10 meters. The installation of cables in optical fibre caused a greater difficulty and thus led to wireless access. Initially wireless technology includes infrared which was a very slow technology further inventions were done to

make wireless technology a better for communication and the invention of Bluetooth, Wi-Max moved wireless communication to a new era.

2.4.1 Working principle of Gi-Fi :

Here Gi-Fi technology use time division duplex for both transmission and receiving. Here data files are up converted from IF range to RF 60 Ghz range by using 2mixers and we will feed this to a power amplifier, which feeds millimetre wave antenna.

The incoming RF signal is first down converted to an IF signal entered at 5 GHz and then to normal data ranges. Here heterodyne construction use for this process to avoid leakages due to direct conversion and due to availability of 7 GHz spectrum the total data will be will be transferred within seconds.
However, two channels are required and this may not always use the available spectrum efficiently. As there is a frequency

separation between the uplink and downlink directions, it is not normally possible to
reallocate spectrum to change the balance between the capacity of the uplink and downlink directions if there are changing capacity requirements for each direction.

An 802.15.3c based system often uses small antenna at the subscriber station. The antenna is mounted on the roof. It supports line of sight operation. It transmits multiple signal simultaneously across the wireless transmission paths within separate frequencies to avoid interference with using ultra wide frequency band.

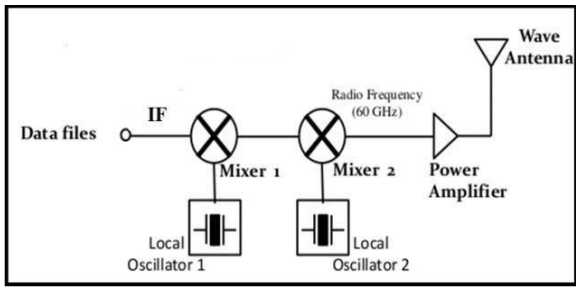


Figure 2.4.1 Data Up linking

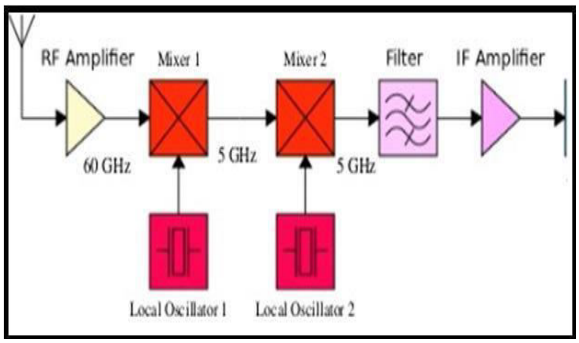


Figure 2.4.1 Data Downlinking

2.4.2 Advantages Of Gi-Fi Technology :

High Speed of Data Transfer As the name indicates, data transfer of Gi-Fi technology is in Gigabits per second. Speed of Gi-Fi is 5 Gbps; which is 10 times the data transfer

of the existing technologies. As the high data transfer rate could be transmitted in cellular networks and mobile phones. Low Power Consumption The power consumption of Gi-Fi wireless technology is low as in a range of tiny one- millimetre- wide antenna and it has less than 2 milli watts of power consumption that in comparison to the current wireless technologies. Secure Gi-Fi technology has to be more secure as compared to other wireless technologies such as Bluetooth. Operating systems of 60 GHz have been used for years by intelligence companies for security reasons and by the militants for satellite to satellite communications. Cost Effective coming to the point of cost perspective, it makes use of low cost chipsets, which drops down the rates dramatically and results in wireless technology with high speed and low prices. Re- use of high frequency levels is enabled which makes it easier to communicate with a wide range of customers within a specific geographic region and it makes them cost efficient. Portability As the Gi-Fi is highly portable, which makes it very convenient to construct it wherever we need it and it also installs the line of sight operations having a short coverage area, as it offers a versatile architecture. It is highly portable in accessing devices such as in internal radio modules, network interface cards, network transmission units, in household appliances.
High Mobility as the Gi-Fi offers high mobility and portability, it provides a better coverage area which allows this technology to go higher and it provides a better data rates at higher speed.

2.4.3 Applications :

Gi-Fi offers a wide number of applications in today's scenario. Let us take a look of these applications:

- Household Appliances.

- Inter- Vehicle Communication.
- Wireless PAN Networks.
- Broadcasting video signal Transmission system in sports stadium.
- Gi-Fi Access Devices.
- Video Information Transfer.
- Media Access Control (MAC), Imaging and others.
- Office Appliances.

2.4.3 Limitations of Gi-Fi :

- The range of communication is limited ,so can be use in shorter distances only, we can expect the broad band with more speed and low power consumption.
- Gi-Fi is more critical connection than other.
- Encryption technology in Gi-Fi ensures privacy and security of content. About 70 per cent of firms have deployed their WLAN in a secure firewall zone but are still using the old WEP protocol, which does not protect the application layer effectively, so better encryption is urgently needed.

3.0 Network Evolution of Various Wireless Technology :

The shifts in social paradigm can trigger diversified communication technologies. Therefore, technical "seeds" must be fostered to meet these needs. This entails building an infrastructure for communication technologies for users.
We can observe significant developments in transmission systems, in which the characteristics of technological "seeds" in optical transmission , wireless transmission, Bluetooth, ZigBee, Wi-Fi, Wi-Max and now
Gi-Fi meet these requirements. Furthermore, it is expected that the communication network infrastructure will evolve towards greater reliability and contain more intelligen functions by modification of the Network Evolution. Bluetooth is a wireless technology standard for exchanging data over short distances (using short wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices,building PANs. The IEEE standardized of Bluetooth is 802.15.1.

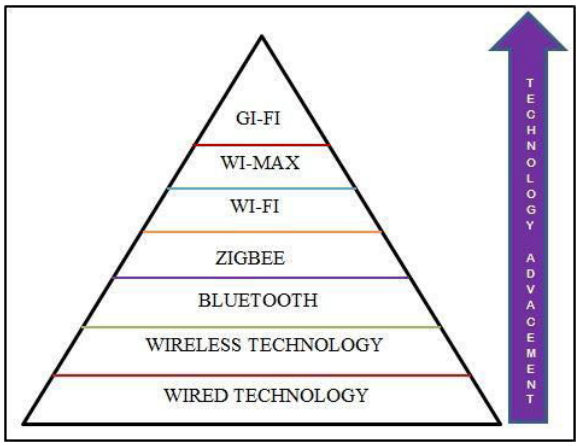


Figure 3. Network Evolution

4.0 Comparative Study :

After review all the technology, we found the best technology is Wi-max. There are some reasons are mainlined below:

- Wi-Fi has very low speed. Wi-Max has 100 times faster than Wi-Fi. Li-Fi is 10 times faster than Wi-Max.
- Li-Fi is very costly than Wi-Max
- Li-Fi operating range is only 10 meters.
- Gi-Fi is more critical connection than Wi-Max.
- Reliability, Flexibility, is much better of Wi-Max.

Characteristics	**Wi-Fi**	**Wi-Max**	**Li-Fi**	**Gi -Fi**
Network	Wireless Lan	Wireless Man	Wireless Pan	Wireless Pan
Band width	20 Mhz	20 Mhz	1 to 1.3 Gps	5Gps
Range	20-100 m	50km	10m	10m
Security	High hHigh	High	Very High	High
Frequency Band	2.4 to 5 Ghz	2 to 11 Ghz	100 times of Tera Hz	57-64 Ghz
Latency	50ms	20 to 40 ms	N/A	N/A
Cost	High	High	Low	Low
Speed	Fast	100 times of Wi-Fi	1000 times of Wi-Max	10 times of Li-Fi

4.0 Table of technical data & some key characteristics.

5.0 Conclusion :

In this paper I have examine and assess the possibilities on wireless technology improvement in terms of how would be apply to Wi -Fi, Wi-Max, Gi-Fi and Li-Fi technology for creation of a wireless access desire infrastructure by comparing of technical data and key characteristics of these technologies. Whether one wireless technology provides a better solution than any other or whether a combination of technologies is needed to create the desired infrastructure. So, after study, i recommended that, Wi-Max is going to be the best technology in future ,if its infrastructure combine with Li-Fi Gi-Fi to create desired needs of access data.

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