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5th Generation Wi-Fi

Shatha Ghazal[1], Raina S Alkhlailah[2]

Al- Balqa' Applied University (BAU) [1, 2]

Abstract: Technology is evolving rapidly for making things easier. Due to innovative ideas at the customer and manufacturers level, new networking methods are introduced. Nowadays, these networking methods are concentrating on wireless technology (wi-fi) where it is the most acceptable and flexible one. It became popular for all, which wireless communications standards continue to evolve, to provide ever-increasing data throughput capabilities. Today, two of the hottest wireless standards are IEEE 802.11ac in wireless-local-area-network (WLAN) products and 3GPP LTE-Advanced in cellular communications. IEEE 802.11ac is the new draft standard for Gigabit wifi. IEEE 802.11ac promises data rates of up to 1.73Gbps between an access point and a wireless client. In this paper, we'll take a basic knowledge about IEEE 802.11ac. More specifically, we'll look at how features such as Video Streaming and Data Syncing and Backing Up. Finally, we'll look technical detail and its application.

Keywords: Wi-Fi, LTE, IEEE Standard, SS Id.

I. INTRODUCTION

IT STANDS as perhaps the signal success of the computer industry in the last few years, a rare bright spot in a bubble-battered market: Wi-Fi, the short-range wireless broadband technology. Tens of millions of Wi-Fi devices are sold every year, including the majority of laptop computers. Homes, offices, colleges and schools around the world have installed Wi-Fi equipment to blanket their premises with wireless access to the internet. Wi-Fi access is available in a growing number of coffee-shops, airports and hotels too. Yet merely five years ago wireless networking was a niche technology. How did Wi-Fi get started, and become so successful, in the depths of a downturn?

Wi-Fi seems even more remarkable when you look at its provenance: it was, in effect, spawned by an American government agency from an area of radio spectrum widely referred to as "the garbage bands". Technology entrepreneurs generally prefer governments to stay out of their way: funding basic research, perhaps, and then buying finished products when they emerge on the market. But in the case of Wi-Fi, the government seems actively to have guided innovation.

"Wi-Fi is a creature of regulation, created more by lawyers than by engineers," asserts Mitchell Lazarus, an expert in telecoms regulation at Fletcher, Heald & Hildreth, a law firm based in Arlington, Virginia. As a lawyer, Mr Lazarus might be expected to say that. But he was also educated as an electrical engineer—and besides, the facts seem to bear him out.

Nowadays, wireless network is one of the essential phenomena that we deal with every moment in our lives. The use of wireless network had started in pcs and Laptops to provide flexibility towards connection location and reached to the level of interconnection of all of our devices (mobile phones, notepads, ipods, play consoles even tvs). The situation is now very different.

II. HISTORY OF WI-FI

The invention of Wi-Fi was found fifteen years earlier where the purpose of it was to provide scanning facilities for warehouse, and PC wireless connection to small LAN within an office space within the limit of 1Mbps and 2Mbps under the standard of IEE802.11, the same was known as the 1st generation. Two years later, the data rate for the same had been increased to 11 Mbps, which was known under the 2nd generation, which was known as 2nd generation (IEEE801.11b), the same popularly used for e-mail applications. Third generation Wi-Fi was introduced in 2002 with a data rate of 54Mbps (IEEE801.11g/a) which was called the 3rd generation of Wi-Fi. The same was widely used for rich-data web experience. 4th generation was introduced in the year of 2007 under the standard IEEE 802.11n providing a data rate 600Mbps (on average and most common to be 150Mbps). The same had provided medium resolution video streaming. Due to the high demand of use to the Wi-Fi technology, through multiple devices inside a single home, the 5th generation was developed to cover the extreme users demand in regard of full web accessibility featuring full resolution video streaming. The data rate offered is up to 3.6 Gbps and the governing standard known as IEEE802.11ac.

Figure one below illustrates the time line evolution for the Wi-Fi technology. The typical Wi-Fi setup contains one or more Access Points (aps) and one or more clients. An AP broadcasts its SSID (Service Set Identifier, Network name) via packets that are called beacons, which are broadcasted every 100ms. The beacons are transmitted at 1Mbps, and are relatively short and therefore are not of influence on performance. Since 1Mbps is the lowest rate of Wi-Fi it assures that the client who receives the beacon can communicate at least 1Mbps. Based on the settings (i.e. The SSID), the client may decide whether to connect to an AP. In addition, the firmware running on the client Wi-Fi card is of influence. Say two AP's of the same SSID are in range of the client, the firmware may decide based on signal strength

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(Signal-to-noise ratio) to which of the two AP's it will connect. The Wi-Fi standard leaves connection criteria and roaming totally open to the client. This is strength of Wi-Fi, but also means that one wireless adapter may perform substantially better than the other.

Since Windows XP there is a feature called zero configuration which makes the user show any network available and let the end user connect to it on the fly. In the future wireless cards will be more and more controlled by the operating system. Microsoft's newest feature called softmac will take over from on-board firmware. Having said this, roaming criteria will be totally controlled by the operating system. Wi-Fi transmits in the air, it has the same properties as a non-switched ethernet network. Even collisions can therefore appear like in non-switched ethernet LAN's.

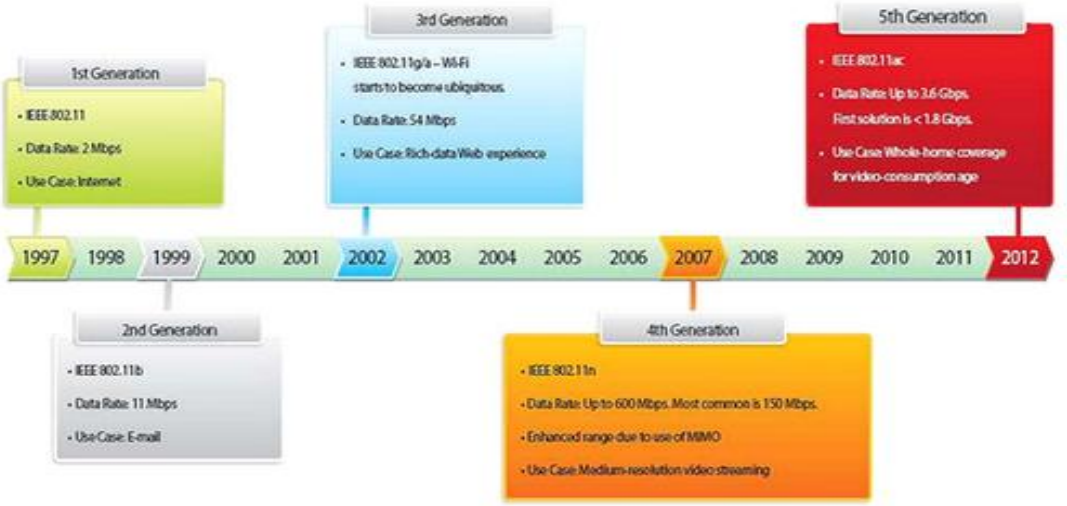

Figure (1): Wi-Fi time line

Wi-Fi offers many advantages for the communication systems which some of them are:

- Unlike packet radio systems, Wi-Fi uses unlicensed radio spectrum and does not require regulatory approval for individual deployers.
- Allows lans to be deployed without cabling, potentially reducing the costs of network deployment and expansion. Spaces where cables cannot be run, such as outdoor areas and historical buildings, can host wireless lans.
- Wi-Fi products are widely available in the market. Different brands of access points and client network interfaces are interoperable at a basic level of service.
- Competition amongst vendors has lowered prices considerably since their inception.
- Wi-Fi networks support roaming, in which a mobile client station such as a laptop computer can move from one access point to another as the user moves around a building or area.
- Many access points and network interfaces support various degrees of encryption to protect traffic from interception.
- Wi-Fi is a global set of standards. Unlike cellular carriers, the same Wi-Fi client works in different countries around the world.
- Table (1) Below illustrates the features development for all type of Wi-Fi generations.

III. COMPARISON OF ALL GENERATIONS OF MOBILE TECHNOLOGIES [5].

Technology → / Features ↓	1G	2G	3G	4G	5G
Start/ Deployment	1970 – 1980	1990 - 2004	2004-2010	Now	Soon (probably 2020)
Data Bandwidth	2kbps	64kbps	2Mbps	1 Gbps	Higher than 1Gbps
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA 2000 (1xRTT, EVDO) UMTS, EDGE	WiMax LTE Wi-Fi	WWWW(coming soon)
Service	Mobile Telephony (Voice)	Digital voice, SMS, Higher capacity packetized data	Integrated high quality audio, video and data	Dynamic Information access, Wearable devices	Dynamic Information access, Wearable devices with AI Capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, Packet	Packet	All Packet	All Packet
Core Network	PSTN	PSTN	Packet N/W	Internet	Internet

TABLE 1
COMPARISON OF ALL GENERATIONS OF MOBILE TECHNOLOGIES

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III. IEEE 802.11AC – THE 5TH GENERATION

5G Wi-Fi offers providing higher capacity and capability for all users to view and stream high resolution videos. Also, due to the high dependability of users to use the internet and the necessity to be able in connecting multiple devices at the same time, 5G Wi-Fi featuring the same with the maximum speed. 5G Wi-Fi overcomes the problems in the earlier versions of Wi-Fi related to slow and discontinued connection for data (especially video streaming).
5G Wi-Fi provides higher speed which will lead to lower download time. The same will improve battery life time for smart phones and Laptops.

IV. FEATURES OF IEEE 802.11AC

•Video Streaming
Despite the fact that the Laptops were invented to replace the use of desktop pcs, nowadays, the same (along with smart phones) are used for specific use which is related to video entertainment. These devices are replacement for TV. Accordingly, higher bandwidth and data rates are provided with 5G Wi-Fi to meet the demand.

•Data synchronization and backup
Every one now are relaying on his PC as a central hub for data storage and backup which might be available at our smart phones. Visa versa, we might require to upload or copy some data from our pcs (such as movies and music) prior travel or leave of our house. Such process might require a lot of time which might be reduced by using the new technology of 5G Wi-Fi.

V. ADVANTAGES OF 5G Wi-Fi

1. Speed
The 5th generation Wi-Fi is providing higher speed compared to the previous version of 802.11n. The previous version maximum link rate was 450Mbps, while 802.11ac is providing link rate up to 1.35Gbps. In addition, such rate is maintained at any range and not like its predecessor where the rate was declining when the range increases.
This increase in speed is achieved by providing wider frequency bands, faster processing, and multiple antennas.
Table (2) below, illustrates the speed difference between 802.11ac and 802.11n. It is clear that 802.11ac, will provide the same 3-antenna 802.11n system speed. In addition, power consumption for the systems still the same.

Table (2): Wireless Performance comparison between 802.11n and 802.11ac

Wireless Performance Comparison		
Antenna Configuration	802.11n	802.11ac
Single Stream (1x1) 150 Mbps 450 Mbp	Mbps 150	Mbp 450
Dual Stream (2x2) 300 Mbps 900 Mbp	Mbps 300	Mbp 900
Three Stream (3x3)	Three Stream (3x3)	Gbps 1.3

2. Reliability
5G Wi-Fi provides higher capabilities for connection in term of coverage area and minimizing the effect of "dead spots". This is due to the feature of beam-forming which overcome the problems resulted from the building structure (i.e. Concrete walls,…etc).

Figure (2) below illustrates 802.11ac coverage and data rates compared with 802.11n

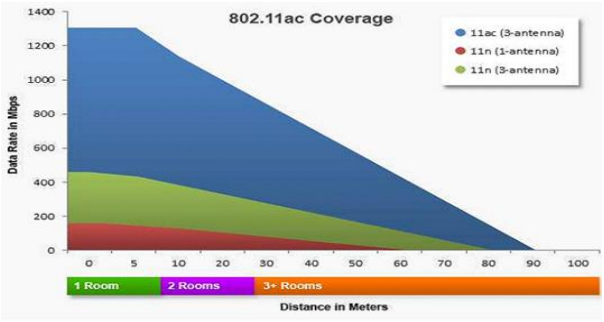

Figure (2): 802.11ac coverage and data rate

Wi-Fi 5th generation provides directional signal transmission and reception. Previous standards can only receive and transmit omnidirectional signals, which are subject to significant levels of interference, because the signals are transmitted indiscriminately in every possible direction. With beamforming, there's an understanding of the relative location of the device, and the signal is correspondingly strengthened in that direction. Figure (3) below indicate in a rough way the differences in connection approach and methodology for new Wi-Fi (using beamforming technology) compared to the predecessor one.

Figure (3): 802.11ac and 802.11n differences in connection approach and methodology

3. Quality
In addition to its increased capacity and range, the 802.11ac standard operates in the 5 ghz wireless spectrum, which is less prone to interference. Though more widespread in usage (all 802.11b and g devices operate exclusively in the 2.4 ghz spectrum), 2.4 ghz only has three non-overlapping channels for transmission, which are crowded due to the vast number of interfering devices, including other wifi access points, microwave ovens, cordless phones, Bluetooth devices, and baby monitors. As a result, the environment is noisy, which increases interference and degrades performance.

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In contrast, the 5 ghz channel is much cleaner with less interference, with 23 non-overlapping channels − 8 times more than what is available in the 2.4 ghz spectrum − which makes it far more suitable for applications such as video streaming and gaming, which are very sensitive to packet loss and delays.

Table (2) below illustrates the main two differences between the 2.4ghz wifi band and 5ghz Wi-Fi band.
Finally, the main advantages of 802.11ac are:
1. Speed is three times higher, compared to the predecessor technology.
2. Minimal dead spots allowing for enhanced performance.
3. Beamforming allows for reliable streaming and connection.
4. Higher mobile bandwidth
5. Using the 5ghz allows for lower noise connection.
6 .Compatible with 802.11 a & n.
Table (3): Differences between 802.11n and 802.11ac bands

2.4ghz Band (802.11n)	5ghz Band (802.11ac)
More widespread usage	Less interface
High interface	8x more channels than 2.4ghz
Minimum WLAN feature required for connectivity	Ideal for video streaming and gaming

VI. DETAILS OF 5G WI-FI

For 802.11ac, the maximum throughput might reach 4900Mbps at 16mhz bandwidth (for Wave 2) while 2400Mbps at 80mhz bandwidth (for Wave 1).
Both waves are providing 8 spatial streams and the modulation technique is 256qamr5/6. Figure 4 below illustrates the major physical layer specifications for both wave 1 and 2.

Nominal Configuration	Bandwidth (MHz)	Number of Spatial Streams	Constellation Size and Rate	Guard Interval	PHY Data Rate (Mbps)	Throughput (Mbps)*
Amendment max	40	4	64QAMr5/6	Short	600	420
802.11ac wave 1						
Min	80	1	64QAMr5/6	Long	293	210
Low-end product	80	1	256QAMr5/6	Short	433	300
Midtier product	80	2	256QAMr5/6	Short	867	610
High-end product	80	3	256QAMr5/6	Short	1300	910
80 MHz amendment max	80	8	256QAMr5/6	Short	3470	2400
802.11ac wave 2						
Low-end product	160	1	256QAMr5/6	Short	867	610
Midtier product	160	2	256QAMr5/6	Short	1730	1200
High-end product	160	3	256QAMr5/6	Short	2600	1800
Ultra-high-end product	160	4	256QAMr5/6	Short	3470	2400
Amendment max	160	8	256QAMr5/6	Short	6930	4900

*Assuming a 70% efficient MAC, except for 802.11a, which lacks aggregation.
*Assuming 40 MHz is not available due to the presence of other APs.

802.11ac coverage and data rate

802.11ac has introduced new capability for MIMO which is called Multi-user MIMO (MU-MIMO) allowing for multiple streams to multiple clients increasing the total bandwidth that can be transmitted at the same time. Figure (5) illustrates the difference between the single MIMO (for 802.11n) and the multiple MIMO related 802.11ac.

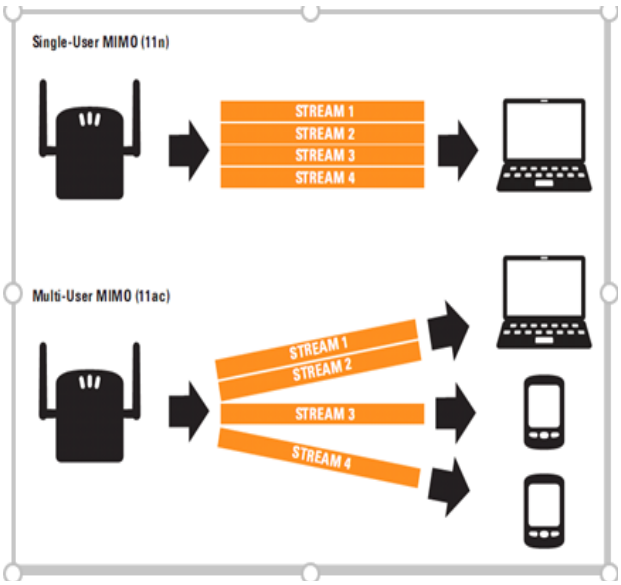

Figure (5): SU-MIMO Vs. MU-MIMO

VII. NEW WI-FI ROUTER SPECIFICATIONS

IEEE 802.11ac is wireless computer network with standard 802.11.it is made by Wi-Fi brand name developed in IEEE standard Associations. It provides high bandwidth of wireless local area network (WLAN) with 5GHz. This standard was developed from 2011 thought 2013and approved in January 2014.

IEEE 802.11ac router supports dual band (2.4GHz +5GHz) simultaneous and it can give you speed up to 450Mbps+1300Mbps. It is also known as "cloud router". It can access router via android or iOS settings.
The 802.11ac Wi-Fi standard is the latest in market and offers the speed up to 1300Mbps (1.3Gbps) of wireless connections. This router makes the capability comes with wireless N (Wi-Fi N or 802.11n) and it supports all existing Wi-Fi clients. Wi-Fi technology is used with fastest bandwidth of network.

Few years ago, the standard of Wi-Fi technology has been created in version 802.11n, that is a wireless transmission protocol. It can send the data up to 600Mbps.but in new technology of Wi-Fi can send the data up to 1300Mbps. In the Ac router technology we can use multiple inputs and multiple outputs in concurrently mode.
There are so many features in the 802.11ac router (AC router), which is useful for wireless communications.

1. 80MH Extended channel binding with bandwidth.
2. Eight spatial streams.

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3. Multiuser-MIMO (MU-MIMO) - each with one or more antennas, transmits or receive data stream concurrently.
4. Multiple access streams not speared by frequency.
5. 256 QMM, rate 3/4 , and 5/6 added s optional.
6. Beam forming with standard sounds for capability between vendors
7. MAC Modifications
8. 800ns regular guard interval
9. Single spatial streams

VIII. CONCLUSION

802.11ac, which is known as the 5th generation of Wi-Fi technology, will be providing a data rates 3 times minimum of the 802.11n. 802.11ac will be backward compatible with the earliest technologies of the Wi-Fi but with improved reliability, throughput and range. By 2015, it is expected that all products will be based on 802.11ac technology.
802.11ac will provide new hub for video streaming and gaming. The bandwidth provided by the new technology allows for HD video streaming without choppy playback. Gaming had become an increasing demand for many users, where wireless connection between game consoles (such as PS4) is required to maintain online gaming experience.
Smart phones and tablets will get advantage of this new technology. Current situation has many frustrations in poor connection. The new Wi-Fi technology solves the current problem allowing for enhanced, high speed and reliable connection.
In addition to meeting today's growing needs such as streaming video, the new standard will also enable a variety of new use cases such as simultaneous HD video streams to multiple receivers, wireless displays, and large file wireless transfers. It's also better equipped to handle the seemingly boundless growth in the number and type of wifi devices (even many appliances are becoming wifi equipped) as well as the corresponding traffic that comes with that growth. In short, 802.11ac will have the capability to handle our insatiable demand for robust, high-speed connectivity – from a wide range of devices.

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