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A Comparison between IEEE 802.11 n and ac Standards

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Abstract: *The IEEE802.11ac specified a number of improvements over the IEEE802.11n such as: 80 MHz and (iii) multi-user MIMO on the downlink, these improvements mainly improve the per-link throughput on the downlink. In order to satisfy the requirements of future high density deployments of Wi-Fi, it is important to consider other metrics for system performance. This paper gives the most important feature technology comparison between IEEE802.11ac and IEEE802.11n in wire-less LAN technologies and how the IEEE802.11ac ad-vanes wireless LAN throughput beyond gigabit rate.*

Keywords: *IEEE802.11, networking, communications, WiFi, WLAN, LAN*

I. Introduction

In the recent years, there has been a dramatic increase in using mobile communication devices such as smartphones and tablet devices. Mobile users have been trafficking more data than voice while using these mobile devices. According to [1], the number of mobile devices subscription outlook between 2014 - 2020 will be as shown in Table 1.

Table 1: Mobile subscription outlook as stated by [1]

Subscriptions	**2014**	**2020**
Total mobile	7.1 billion	9.2 billion
Mobile broadband	2.9 billion	7.7 billion
Smartphones	2.6 billion	6.1 billion
Mobile PCs, tablets and routers	250 million	400 million

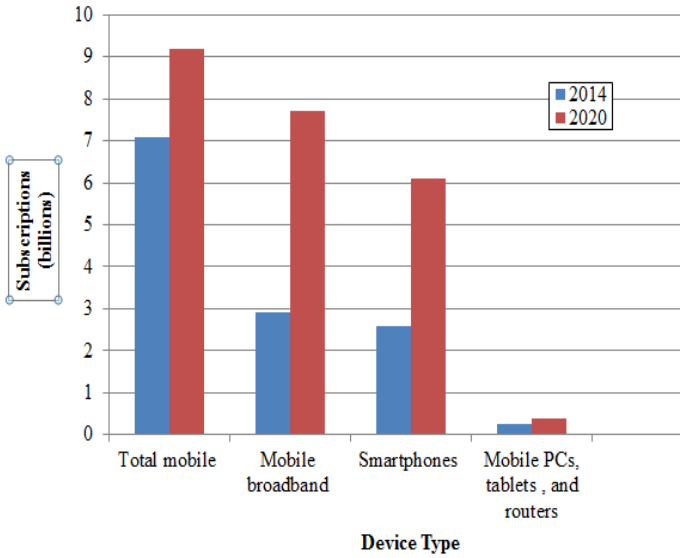

Fig 1: Mobile subscription outlook as stated by [1]

From Table 1 and Fig.1, the vast number of mobile devices as well as the rapid growth of subscribers are evident. Also, it worth noting that the mobile PCs, tablets, and routers growth is much slower than mobile broadband devices and smart phones. To support the aforementioned growth, new connectivity technologies have emerged in the communication market. These include the WLAN, WiFi, 3G,4G, 4G LTE, WiMax, etc… These technologies follow various standards on how systems are built and how they communicate. The broadband mobile devices utilize the WiFi with IEEE802.11 standards. The smartphones utilize the 3G, 4G, and LTE technologies.

Table 2. Comparison Between IEEE802.11n and ac[2]

802.11 network PHY standards								
802.11 protocol	**Release date**	**Frequency**	**Band-width**	**Stream Data Rate**	**Allowable MIMO streams**	**Modulation Antenna Tech.**	**Approx.**	
							In	**Out**
		(GHz)	**(MHz)**	**Min-Max**			**(m)**	**(m)**
802.11	Jun 1997	2.4	22	1-2	1	DSSS, FHSS	20	100
n	Oct 2009	2.4/5	20	7.2 -72.2 (6.5- 65)	4	OFDM (MIMO)	70	250
			40	15 - 150 (13.5 - 135)			70	250
ac	**Dec 2013**	**5**	**20**	**7.2 - 96.3 (6.5 - 86.7)**	**8**	**OFDM (MU-MIMO)**	**35**	
			40	**15 - 200 (13.5 - 180)**			**35**	
			80	**32.5 - 433.3 (29.2 - 390)**			**35**	
			160	**65 - 866.7 (58.5 - 780)**			**35**	

The IEEE802.11 standard was released by the IEEE (LAN/MAN) standard committee on June 1997. Since then multiple upgrades have been released to catch up with advancements in the communication technologies mentioned earlier. In this paper, a comparative study of the IEEE802.11a, b, g, n, and ac standards will be presented where each standard features is discussed individually. The paper will have a final section that compares these standards and list benefits and limitation of each standard. The Table 2. shows the technical specification list of IEEE802.11[2] versions a, b, g, n, and ac versions that will be the focus of this work.

II. Details Of Ieee802.11n, And Ac Standards

The IEEE802.11 has released multiple set of standards for various operating frequency, and ranges specification. In this section, we will describe the IEEE802.11n and IEEE802.11ac in details as they are the most recently released standards.

A. IEEE 802.11n

The IEEE802.11n standard was ratified in 2009 and it utilizes multiple wireless antennas in tandem to transmit and receive data[3-4]. The IEEE802.11n standard employs OFDM modulation technique. The antenna technology used with the IEEE802.11n standard is known as Multiple Input, Multiple Output (MIMO). This technology refers to the ability of the IEEE802.11n and similar technologies to coordinate multiple simultaneous radio signals. The MIMO increases both the range and throughput of a wireless network. An additional technique employed by the IEEE802.11n involves increasing the channel bandwidth from 20MHz to 40MHz. The IEEE802.11n standard support maximum theoretical network bandwidth up to 300 Mbps. The IEEE802.11n indoor/outdoor ranges are 75m, and 250m respectively.

B. IEEE 802.11ac

The IEEE802.11ac is the fifth generation in Wi-Fi networking standards released December 2013[5-6]. This standard operating frequency is 5GHz, and bandwidth of 20, 40, 80, 160MHz sectors. The stream rates ranges for these bandwidth sectors are 7.2 - 96.3Mbps for 20MHz, and 15 – 200Mbps for 40MHz, 32.5 - 433.3Mbps for 80MHz, and 65 - 866.7Mbps for 160MHz. This standard exhibits better performance, and better coverage compared to IEEE802.11n standards. The IEEE802.11ac standard uses a wider channel and an improved modulation scheme that also supports more clients. The IEEE802.11ac standard utilizes a modulation technique known as multi-user MIMO. This technique allows a set of users or wireless terminals, each with one or more antennas, o communicate with each other. The indoor range is 35m, and there is no recorded max for outdoor range.

III. Ieee802.11 N, Ac Standard Detailed Comparison

Table. 3 provide a qualitative comparison between the standards of IEEE802.11 n, and ac on the aspects of beamforming, coverage, capacity, interference, quality, backward compatibility. In this section more details on these qualities will be presented.

A. Speed:

The IEEE802.11n devices give a maximum link rate of 450 megabits per second at close range. the new the IEEE802.11ac standard can achieve more than three times the performance of the current standard, with speeds up to 1.35 Gigabits per second.

B. Beamforming:

The IEEE802.11n,APs can only transmit and receive omnidirectional signals. beamforming is a standard feature, and all products that implement it will be interoperable and thereby able to operate at maximum range and coverage for the IEEE802.11ac network.

C. Frame Aggregation:

In particular, it proposes mandatory use of frame aggregation via A-MPDU (Aggregate-MAC Protocol Data Unit);MAC(Media Access Control), which was introduced in the IEEE802.11n. A-MPDUs are enhanced in the IEEE802.11ac by increasing their size thus packing several MPDUs within a single PPDU. This in turn increases channel utilization and MAC efficiency.

D. Coverage and Capacity

As discussed earlier, the IEEE802.11ac exhibits wide area coverage when compared to other standard. The IEEE802.11ac equipped with MUMIMO and multi spatial streams which allows higher stream rates. Table. 4 shows IEEE802.11ac Maximum Achievable PHY Data Rates for bandwidth/spatial streams supported ranges.

E. Interference and Quality:

The IEEE802.11ac is exclusively a 5GHz interface, the benefit of being 5GHz-only is a significant reduction in interference. While the 2.4GHz spectrum is littered with interference from other devices. The IEEE802.11ac doubles the capacity of traffic that can be processed; multiple antennas increase the reach and the quality of reception at further distances; and faster processing provides up to triple the speeds that are possible with the IEEE802.11n.

D. Backwards Compatibility:

The IEEE802.11ac standard enables coexistence with the IEEE802.11n/a devices by requiring a backwards compatible preamble that has a section which is understandable by the IEEE802.11n/a devices.

Table 3. Comparison Between IEEE802.11a,b,g,n and ac additional features

Feature	802.11n	802.11ac
Speed	450Mbit per second	**1.35 Gigabits per second**
Beamforming	Supported But Not Standardized	**Standardized**
Frame Aggregation	A single PPDU	**Several MPDUs**
Coverage	Low	**High**
Capacity	Low	**High**
Interference	More on 2.4GHz Less on 5GHz	**Less**
Quality	Low	**High**
Back Ward-Compatible With	802.11g,802.11b, 802.11a	802.11n

Table 4: IEEE802.11ac Maximum Achievable PHY Data Rates (Mbps) bandwidth/spatial streams[6].

BW(MHz) #SP. Str.	20MHz	40MHz	80MHz	160MHz
1	86.7	200	433.3	866.7
2	173.3	400	866.7	1733
3	288.9	600	1300	2340
4	346.7	800	1733	3466
5	433.3	1000	2166	4333
6	577.8	1200	2340	5200
7	606.7	1400	3033	6066.7
8	693.3	1600	3466	6933

IV. Conclusions

This paper describe the enhancement and improvement of the IEEE802.11ac when compared to the IEEE802.11n. The IEEE802.11ac is expected to deliver a data rate connection of at least three times that of the IEEE802.11n and the IEEE802.11ac will be backward-compatible with IEEE802.11n networks operating in the 5GHz range. It is also expected to offer dramatic improvements in Wi-Fi reliability, throughput, range, low latency, performance improvements stems from wider bandwidth, more spatial streams, higher order modulation, dynamic bandwidth management, and multi-user MIMO. In addition, the 5 GHz operation allows for reduced interference.

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