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A PRACTICAL PERFORMANCE COMPARISON BETWEEN 802.11N AND 802.11AC STANDARDS

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Abstract

It is well known that the technological performance level of wireless communications in open frequency bands has increased considerably in the last years. Today, many devices that we use is based on wireless communications. This article aims to achieve a practical comparison between 802.11n and 802.11ac performance standards. Practical determinations were made through performance measurements in a wireless communications infrastructure, built by interconnecting pairs of wireless access point equipment, located in close proximity, to ensure maximum performance. The performances of IEEE 802.11ac and 802.11n standards were studied using the traffic measurement method, observing the necessary bandwidth and the response time for different sizes of data packets generated in the testbed communication infrastructure. An important aspect that was taken into consideration refers to the constant monitoring of resources load used for communication processes (CPU load from routers used in test process), to ensure that determinations were not compromised by hardware limitations of the equipment used.

Keywords: 802.11n; 802.11ac; wireless standards; performance measurements; monitoring resources.

1. Introduction

The IEEE 802.11ac is nowadays the most advanced standard for data transmission over a wireless environment. This communication standard can be briefly characterized by the following significant features:

- providing high-throughput communications, reaching Gbit/s speed level;
- proposing the migration to a cleaner 5GHz spectrum;

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- offering the opportunity for the implementations having mixed frequency bands for data transmission, in the 2.4 GHz and 5GHz;
- supports more performant MIMO (Multi-User Multiple-Input Multiple-Output) mode for transmission antennas, that can be used to send information simultaneously to multiple clients, up to four simultaneous MU-MIMO (Multi-User Multiple-Input Multiple-Output) downlink clients;
- superior Modulation and Coding Schemes (MCS) with high signal modulations as QAM - Quadrature amplitude modulation (QAM 256);
- space multiplexing thought SDMA (Space Division Multiple Access), up to eight spatial streams (compared with for in 802.11n MIMO);
- commonly, the 802.11ac standard has 10 MCS (Andrew von Nagy, 2013).

Wireless technologies are widely implemented in the most diverse devices (IEEE, 2016). Wireless chips are currently encountered on tablets, smartphones, TVs, game consoles, printers and the list could continue. In parallel, to support the equipment growth, multiple wireless networks must be deployed in various places, which include institutions, schools, shopping malls, universities and others. Wireless hotspots with Internet access are also commonly installed in public areas, where any user can connect and access resources it needs (Ong et al., 2011).

Lately, with the passing years, it is found that one of the trends of communications market development is represented by the IT services migration into the cloud, to ease the use of resources. In the early era of data communications, the first services were not very specific requirements on parameters, but in our time, there are some services that require certain parameters to be within certain limits (delay, jitter, packet loss) to function properly. In this sense, we can exemplify with the streaming video services, which are very popular today (Park, 2011).

2. Purpose of the Study

The Wi-Fi standards have evolved over time, aiming to surmount the 802.3 Ethernet standard performances, by providing the necessary resources and support to the current communication services. (Punal, Escudero, & Gross, 2011; Cha et al., 2012; Bellalta et al.,2012).

This article is proposing a performance appraisal of IEEE 802.11ac, having the previous standard, 802.11n, as a reference (Dianu, Riihijarvi, & Petrova, 2014). Performance measurements regarding traffic speeds, available bandwidth, volume of date packets sent or lost over data links having various physical medium characteristics, such as frequency and channel bandwidth are presented in the following sections.

2.1. Research Methodology

To achieve the proposed objectives there was used an operational stand based on two wireless routers, provided by the company Asus, RT-AC66U series. The technical specifications of this device state that the maximum global amount of wireless traffic that can be delivered is 1.7Gbit/s. Since there are wireless connections and technologies, the expected effective throughput is normally beyond this maximum data transfer value. For example, in any wireless link, it will be traffic control sessions necessary to maintain the connection flows.

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In the proposed experiments one router was used as configured in the AP (Access Point) mode. And a different firmware than the default was used, to increase the communication capabilities, compared with those provided by the standard firmware version. On the AP mode router was used a DD-WRT firmware version because it permits to test communication facilities on both concern frequency bands, 2.4 GHz and the 5 GHz separately. The second router was used in the AP-Client mode, so the WAN port was not used and the IP allocation facility, the DHCP server was disabled. For the client router, the configuration was realized with the original firmware, since that it is providing sufficient resources for the Media Bridge mode interconnection. Two usual laptops with Intel processor i3 / i5 and 4GB / 8GB of available RAM have been used for generating and receiving the testing data traffic.

2.2. Generic Testbed

The first idea of this practical evaluation is to test the maximum transport capacity of the wireless testbed system. For obtaining a ground reference, in the initial phase, an Ethernet cable was used between laptops. The maximum transport capacity obtained was 720Mbit/s.

For a synthetic overview, in Figure 1 is presented a representative image of the evaluation infrastructure used for practical determinations.

To generate packets between the two test laptops there was used the *iperf* utility (Tirumala, Qin, Dugan, Ferguson, & Gibbs, 2016) a common Linux connections testing application, with five parallel sessions.

The command used for starting the *iperf* server:

#iperf -s -i 1

For the client mode was used in the following form:

#iperf –c server_ip –i 1 –P 5 –t 60

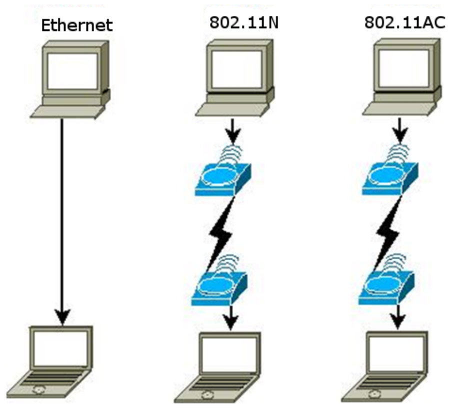

Fig. 1. Specific testbed representation.

The second idea of the evaluation method is to determine the transport capacity, taking into consideration the maximum number of packages that can be transported by the wireless link. For this matter, another Linux utility was used the well-known *ping* tool. With this utility, the response time from source to destination can determine and the packet loss where there are any. Considering that this model of router has a MIPS processor at a frequency of 600 MHz, a special attention was focused on monitoring

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resources (the processor load level), to ensure the no hardware limitations will affect the testing process. In the following determination, there will be notices about the router's processor load during the tests.

In conducted experiments, 802.11ac showed better results in terms of data traffic values, as expected. What is important is to notice the reached performance level and the differences in other standards. The general results are presented in Table 1.

Table 1. General results

Standard	Channel Width (MHz)	CPU (%)	Bandwidth (Mbit/s)
802.11N 2.4Ghz	20	14	64.6
	40	18	116
802.11N 5Ghz	20	32	134
	40	43	176
	80	60	234
802.11AC	20	50	216
	40	60	234
	80	60	238

As it could be observed, in terms of response time and packet loss we can pull some conclusions. During the tests, there was obtained satisfactory results for the minimum package size (64 bytes). Our practical determinations were stopped at the 10,000 PPS (packets per second) level, where the response time parameter was presenting a good value (1-2 ms) and there were no losses.

The next sets of tests were made at the maximum level of package size parameter that can be enforced with the ping utility (65,508 bytes). The results showed that the 802.11n in 20 MHz band did not achieve satisfactory results, and were not included in those presented in this paper, as can be identified in following tables (Tables 2-8) and graphically interpreted in Figures 3-6:

Table 2. Results for 802.11n, 40 MHz channel band.

Cpu %	pps	avg	Loss
20	100	233.6	26
22	200	230.75	54

Table 3. 802.11n, 5 GHz, 20 MHz bandwidth

Cpu %	Pps	avg	Loss
44	100	260.2	19
49	200	287.2	23

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Table 4. 802.11n, 5GHz, 40MHz bandwidth.

Cpu %	Pps	avg	Loss
35	100	10.7	0
40	200	142.9	22
44	300	177.5	36

Table 5. 802.11n, 5 GHz, 80 MHz bandwidth

Cpu %	Pps	avg	Loss
50	100	12.3	0
50	200	164.9	23
50	300	184.2	35

Table 6. 802.11ac, 20 MHz bandwidth

Cpu %	pps	avg	Loss
30	100	20	0
31	200	20	0
38	300	298	30
48	400	315	32

Table 7. 802.11ac, 40 MHz bandwidth

Cpu %	pps	avg	Loss
25	100	20.34	1
28	200	232.34	18
60	300	319	25

Table 8. 802.11ac, 20 MHz bandwidth

Cpu %	pps	avg	Loss
30	100	12.63	0
31	200	21.4	0
38	300	143	15
44	400	417	34

3. Results Interpretation

The general results from Table 1 can be graphically represented as in Figure 2. It can be seen that the CPU load is increasing according to the growth of used bandwidth.

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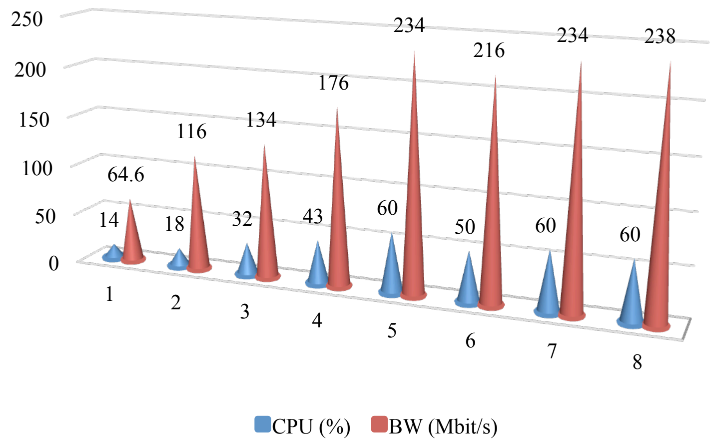
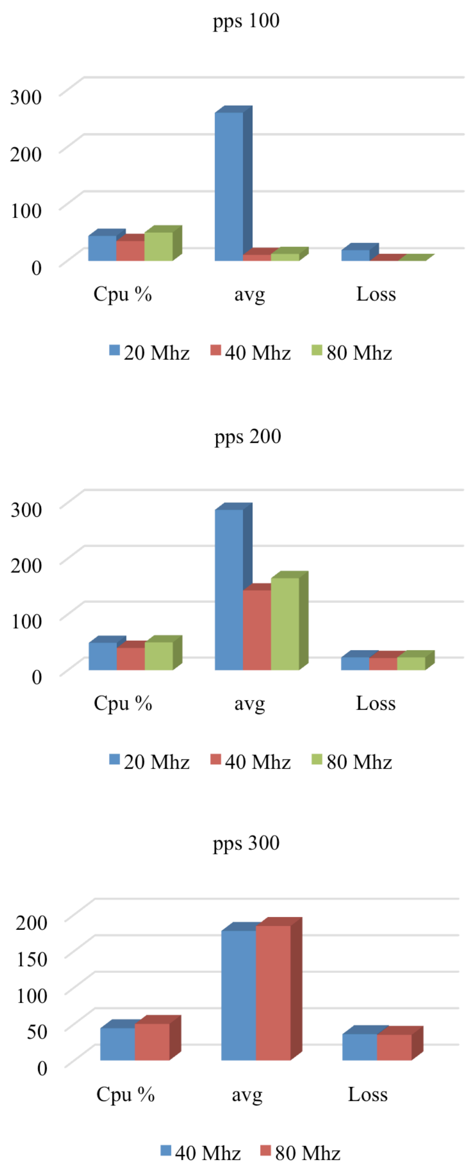


Fig. 2. CPU resource utilization and available bandwidth.



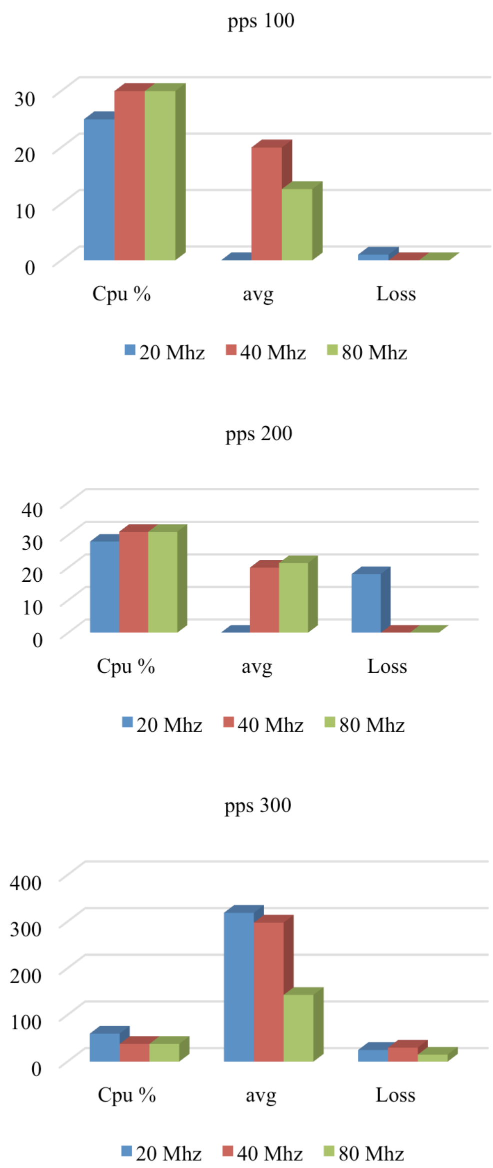


Fig. 3. 802.11N in 5 GHz, PPS 100, 200 and 300 cases

Fig. 4. 802.11AC in 5 GHz, PPS 100, 200 and 300 cases

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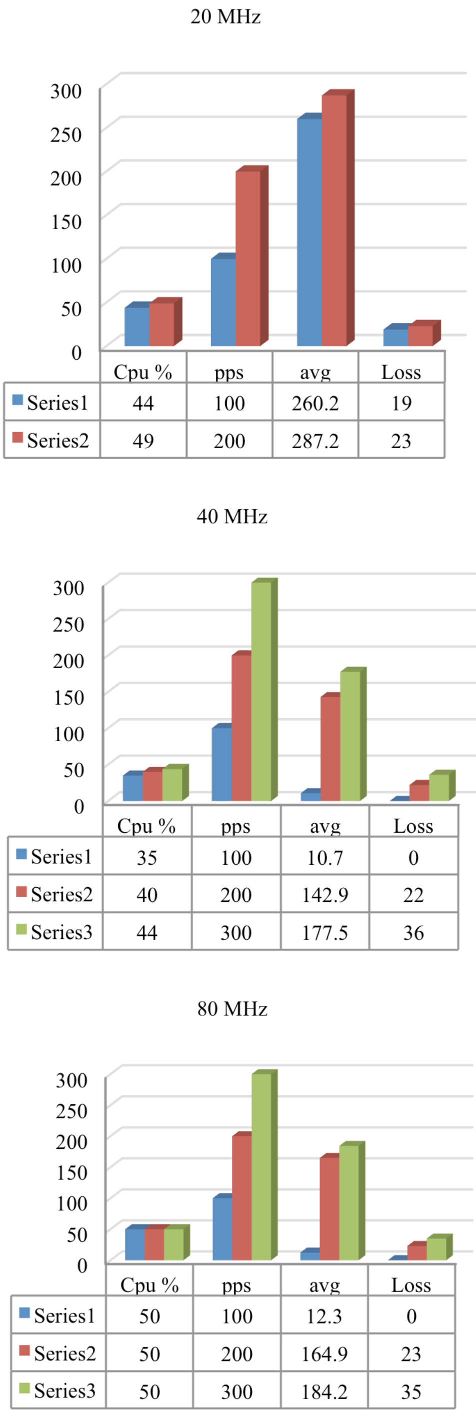

Fig 5. 802.11N results for 20, 40 and 80 MHz

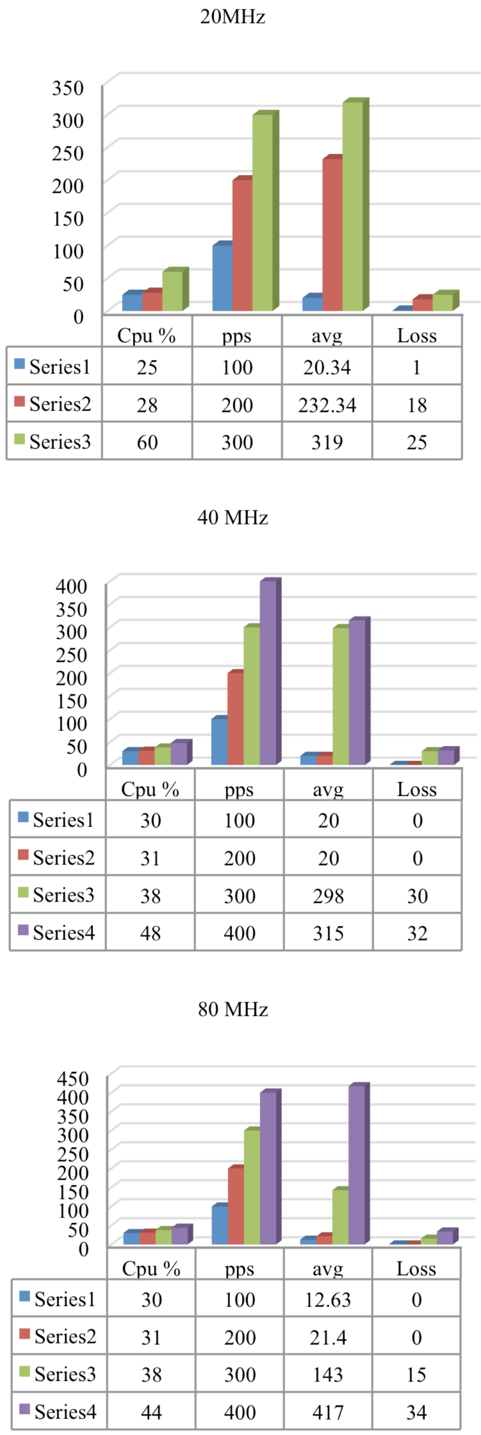

Fig 6. 802.11AC results for 20, 40 and 80 MHz

4. Conclusions

In this paper, there are presented the results from an analysis study over the communication performances provided by the IEEE 802.11ac standard. Although IEEE 802.11ac is an evolved wireless

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standard, regarding IEEE 802.11a, as shown by the practical determinations from this paper, there are considerable performance differences to pull through in the future implementations regarding the Ethernet standard, which is being still the preferable solution for reliable data communications.

Given the order of the WiFi standards development, it is in the offing that the results to be better for newer standards. Experiments showed in this article are made under real conditions and have shown important practical differences between the widely and common used wireless standards, that can be taken into consideration at the projecting and deployment of new wireless network infrastructures.

The article can be viewed as a basis for future similar comparative measurements when new waves and generation of wireless standards will be available (802.11ax, 802.11ad, LiFi and others communication standards that will be developed).

References

Bellalta, B.; J. Barcelo, D. Staehle, A. Vinel, and M. Oliver, (2012). On the Performance of Packet Aggregation in IEEE 802. 11ac MU-MIMO WLANs. *IEEE Communications Letters,* vol. 16, no. 10, pp. 1588-1591, October.

Cha, J.; H. Jin, B. C. Jung, and D. K. Sung, (2012). Performance comparison of downlink user multiplexing schemes in IEEE 802. 11ac: Multi-user MIMO vs. frame aggregation. *in Proc. of IEEE WCNC'12. IEEE,* pp. 1514-1519.

Dianu, M. D.; J. Riihijarvi and M. Petrova, (2014). Measurement-based study of the performance of IEEE 802.11ac in an indoor environment, *Communications (ICC), 2014 IEEE International Conference on*, Sydney, NSW, pp. 5771-5776, doi: 10.1109/ICC.2014.6884242

Ong, E. H.; J. Kneckt, O. Alanen, Z. Chang, T. Huovinen, and T. Nihtila, (2011). IEEE 802. 11ac. Enhancements for very high throughput WLANs. *in Proc. of IEEE PIMRC'11. IEEE,* pp. 849-853.

Park, M. (2011). IEEE 802. 11ac: Dynamic bandwidth channel access . *in Proc. of IEEE ICC'11. IEEE,* pp. 1-5.

Punal, O., H. Escudero, and J. Gross, (2011). Performance comparison of loading algorithms for 80 MHz IEEE 802. 11 WLANs. *in Proc. of IEEE VTC Spring'11. IEEE,* pp. 1-5.

Tirumala, A.; F. Qin, J. Dugan, J. Ferguson, and K. Gibbs (2016), Iperf: The TCP/UDP bandwidth measurement tool. Current version available online at *http://code. google. com/p/iperf/.*

Von Nagy, Andrew (2013). Aerohive High-Density Wi-Fi Design &Configuration Guide v2, *Aerohive Networks*.