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Assessment of iPerf as a Tool for LAN Throughput Prediction

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Abstract—**This article discusses whether iPerf can be used as an effective tool for wired and wireless LAN throughput estimation. The potential advantages of using iPerf in comparison to FTP are discussed. Finally, the article presents the throughput measurement results obtained with FTP, iPerf2 and iPerf3 in a simple experimental network.**

Keywords—**local area networks; throughput; FTP; iPerf**

I. Introduction

During the last years, we could observe rapid development of wireless local area networks compatible with IEEE 802.11 standard [1]. Since 2008, several standard amendments have been published and later incorporated into revisions, defining the new physical layers and also enhancements to the data link layer, allowing for higher transmission rates and for better channel utilization [2]. Some of these enhancements are listed in the Table I [1]-[3].

Table I
IEEE 802.11 Standard Enhancements

Version	Year	Max rate [Mbps]
IEEE 802.11g	2003	54
IEEE 802.11n (“WiFi 4”)	2009	600
IEEE 802.11ac (“WiFi 5”)	2013	3468
IEEE 802.11ax (“WiFi 6”)	2021	9607

On the other hand, the COVID-19 pandemic lockdown in March 2020 and the necessity of online work and education, as well as observation of the second-hand PC computer market, show that there may be many computers available in not quite up-to-date configurations, but still with enough resources (e.g., microprocessor speed and capabilities, memory capacity) to be used in modern applications. In fact, in September 2020 it was possible to successfully join Zoom meeting from a netbook running under Windows XP operating system (this possibility seems to no longer exist [4]). These old desktops or laptops are sometimes equipped with only a 100 Mbps Ethernet and 54 Mbps Wi-Fi interfaces.

Nowadays, home entertainment systems, such as digital TV sets, often offer the possibility to connect to a computer network. Among these devices, standalone TV receivers running under Linux operating systems deserve a special attention. They not only allow for recording from several terrestrial or satellite TV channels at a time, but also make it possible to download the recorded files using FTP protocol. It allows, for example, for processing of the recorded material on the PC-class computer, in order to remove commercial advertisements, archive the interesting recordings for future use, etc. Modern Linux-based TV receivers are equipped with Gigabit Ethernet port, and it’s also possible to use the built-in or USB Wi-Fi adapters.

There are several measures of the computer network quality, such as throughput, delay, jitter, packet loss ratio, etc [5]. During downloading of large files (a recording of 2 hours FullHD movie occupies approximately 3 to 6 GB), the most important network parameter is the effective throughput that can be observed at the application level. The throughput can be affected by many factors, such as physical layer transmission rate and protocol efficiency, but also microprocessor computing power and device drivers [6]. While there are some reports in the internet fora showing that increasing operational memory capacity and replacement of a hard disk with SSD bring some improvements to overall PC computer performance (e.g., [7]), there are hardly any systematic and exhaustive results regarding the upgrade of Wi-Fi adapter. Therefore, it seems reasonable to test if it makes sense for older PC computers. However, the results and conclusions presented in this paper are an unpredicted side-effect of the main research, which is not published yet.

There are multiple tools designed especially for throughput estimation in computer networks and multiple estimation methods. The work [8] precisely defines the metrics related to network throughput estimation and briefly describes end-to-end capacity estimation tools. In [9], available bandwidth estimation tools are listed and analysed. In turn, [10] compares different tools and compares them to iPerf, which is said to be a widely-used for end-to-end performance measurement and has become the unofficial standard in network measurement.

There are some papers describing the usage of iPerf for the measurement of network throughput. Among them, [11] seems the most interesting as it compares network measurement tools like iPerf and Network Weather Service to FTP, GridFTP and SCP transfers. Unfortunately, the aforementioned papers do not state precisely which version of iPerf and operating system was used. There are also some reports (eg.,[12]) showing that there can be a difference between results achieved with iPerf2 and iPerf3. However, we couldn’t find any paper that presents systematic and exhausting research on comparison of different versions of iPerf with a real data transmission application (e.g., FTP) for many different wired and wireless network adapters.

The rest of the article is organised as follows. In chapter II we describe the experimental network with regard to the hardware and software used to measure the throughput. In chapter III, we

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present the results and discuss them. Finally, summary discusses, among others, the achieved results and possible future directions of our work.

II. Experimental network

The experimental network was configured at home. This choice was justified by a low number and signal power of other Wi-Fi networks in the neighbourhood. The Wi-Fi network bands were scanned with inSSIDer 2.0 for Windows XP. In the 2.4 GHz band (channels 1 to 13), there were about 10 neighbour networks observed, with the signal power not exceeding -80 dBm in the experimental network location; in the 5 GHz band no other networks could be observed in the channels 36 to 64 and only one network in the channels 100 to 165; its signal power was about -90 dBm. The received signal power from the experimental network router was about -30 dBm in the 2.4 GHz and -40 dBm in the 5 GHz band. Therefore, neighbour networks influence on the obtained results can be regarded as negligible. Also, home location much better reflects the online work characteristics. On the other hand, the care was taken to run the tests only when the activity from other devices in the home network was minimal.

A. *Hardware used in tests*

During the tests, the following hardware was used:

- Linksys WRT32X router,
- Fujitsu A532 laptop,
- Asus EEE PC 1000 HG netbook
- Octagon SF8008 4K UHD digital TV receiver.

Linksys WRT32X router contains a 2-core Marvell 88F6820 microprocessor running at 1.8 GHz, 256 MB of flash and 512 MB of DDR3 RAM memory [13]. It contains a single 1Gbps Ethernet WAN port, 4 1Gbps Ethernet LAN ports, and 3 Wi-Fi adapters (officially, only 2). In the 2.4 GHz band, the router supports transmission rates of up to 600 Mbps, in the 5 GHz band – up to 2600 Mbps.

Octagon SF8008 TV receiver contains 4-core, 64-bit Hisilicon Hi3798MV200 microprocessor running at 1.6 GHz, 8 GB of flash and 1 GB of DDR4 RAM memories. It is also equipped with 1Gbps Ethernet port and 300 Mbps Wi-Fi adapter (802.11n standard). Additional optional Wi-Fi adapters can be installed in USB ports. It can store the recordings on microSD memory card [14].

The network structure is presented in Fig. 1. The tuner was connected to a router with 1 Gbps Ethernet cable (about 5 m long), while the communication between the router and the client was mostly wireless according to AC1200 standard, in either 2.4 GHz band with the maximum rate of 300 Mbps, or in 5 GHz band with a maximum rate of 867 Mbps. Some tests were also done for 1 Gbps Ethernet router-to-client link. The distance between the router and the client was about 2.5 m, with no obstacles between them.

During the tests, Linksys WRT32X router was running under OpenWRT software 19.07.2 version, while Octagon SF8008 receiver under OpenATV version 7.1.20221130.

Configuration of Fujitsu A532 and Asus EEE PC 1000HG is summarised in Table II.

In both A532 and 1000HG laptops, the Wi-Fi adapters were upgraded with the adapters listed in Table III.

TABLE II
LAPTOP CONFIGURATION

Model	Fujitsu A532	Asus 1000HG
Processor	Intel i5-2430M	Intel Atom N270
Frequency [MHz]	2400	1600
Memory	DDR3	DDR2
Memory type	PC3-12800	PC2-6400
Frequency [MHz]	666	266
Channels	Dual	Single
Ethernet	1 Gbps	100 Mbps

TABLE III
WI-FI ADAPTERS USED IN TESTS [15]

Name	Chipset	Class
Dell Wireless DW1540	Broadcom BCM43228	N600
SparkLAN WPEA-121N	Atheros AR9382	N600
Intel 6235ANHMW	Intel 6235	N600
Dell Wireless DW1550	Broadcom BCM4352	AC1200
ATH-QCA6174A	Atheros QCA6174A	AC1200
Intel 7260HMW	Intel 7260	AC1200
Intel 7265HMW	Intel 7265	AC1200
Intel 8260HMW	Intel 8260	AC1200
Intel 8265HMW	Intel 8265	AC1200

All of these adapters are available in the half-size mini-PCIe format. They were controlled by the most recent device drivers that could be found. Unfortunately, it's not sure whether they are the newest drivers, because some producers (e.g., Intel) have already withdrawn the support (and thus the driver files) for Windows XP and Windows 7 from their websites.

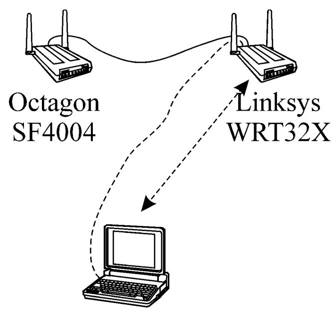

Fig. 1. Experimental network structure

Generally, it was not possible to use AC1200 class adapters under Windows XP. The only AC1200 adapter for which we could find the Windows XP drivers was DW1550, however it was not possible to start the device using the driver we had. Thus, it was not possible to reach wireless LAN rate higher than 300 Mbps in either 2.4 or 5 GHz band. It's worth admitting that similar situation occurs for Windows 7 – most, if not all 802.11ax adapters require at least Windows 10 operating system.

B. *Software used in tests*

As we mentioned above, the most important network parameter in this research is the effective throughput that can be observed by the user. As the download of the recording from the digital TV receiver is done using the FTP protocol, this was the primary choice for the throughput measurement tool. However, standard FTP application has some disadvantages:

- It must download an existing file. The file size should be carefully chosen – small files download will download too fast in high throughout networks, large files will download too slow in low throughput networks. Also, TCP slow start mechanism may affect the result.
- The throughput reported by FTP client is the average speed throughout the entire download. Thus, a temporal network problem may affect the final result, leaving no observable trace.
- It's not possible to achieve throughput graph without using additional network monitoring software, such as Wireshark [16].

Despite the aforementioned weaknesses, FTP is not useless as the throughput measurement tool. We have chosen the default system FTP client, however, the FTP client built into the FAR file manager [17] was also considered. The results achieved using FTP, FAR v. 2.0 and FAR v. 3 are practically the same, however, FTP windows client seems the fastest during download.

One of the popular tools for network measurement is iPerf [18]. Currently, there are two independent projects for iPerf development that do not interoperate with each other due to a different architecture and source code [19]. However, both can perform the measurements for TCP and UDP traffic. Some comparison of iPerf2 and iPerf3 features and options can be found in [20]. The advantages of iPerf over FTP are the following:

- The test duration can be set. As a result, iPerf measures the amount of data transmitted during the test, while FTP measures the transmission time of a given file.
- iPerf can report temporal throughput with the time interval as low as 100 ms. In many cases it should be sufficient to find whether the throughput was constant or variable during the test. As a result, it is possible to generate a throughput graph, however, with a slightly limited accuracy compared to the Wireshark.
- iPerf can omit a given time at the test start, thus omitting the TCP slow start mechanism (at the time of writing the paper, this option is present only in iPerf3).

The advantage of iPerf3 over iPerf2 is its availability for many operating systems, including, among others, Windows and various distributions of Linux. iPerf3 is available for Windows in 32- and 64-bit versions and for Linux including, among others, OpenWRT and OpenATV software. iPerf2 is available for Windows as a 32-bit application; we managed to install iPerf2 at OpenWRT, but not at OpenATV.

The iPerf versions used in tests were:

- iPerf 3.1.3 for Windows, in 32- and 64-bit versions,
- iPerf 2.1.8 for Windows (the most recent version that worked with Windows XP when the tests were performed; 2.1.9 version did not work with Windows XP),
- iPerf 3.11 at OpenATV,
- iPerf 3.7 and 2.0.13 at OpenWRT.

C. Test methodology

The FTP transmission is initiated by the client, and typically results in data transfer from the server to the client. This is explained in Fig. 2a. The default test in both iPerf2 and iPerf3 results in data transfer from the client to the server (Fig. 2b), which is the opposite to what we wanted to test. However, iPerf3 can perform the reverse test which runs similarly to the FTP transfer. In iPerf2 the reverse test runs in a different manner – first, the default (forward) test is run, and once it is finished, the reverse test starts. However, the reverse test is initiated by the server, and the data is transmitted from the server to the client (Fig. 2c). We believe it has no influence on the results.

The single test procedure is explained using a pseudo-code in Fig. 3. In any case, the tests were performed by running a series of 10 measurements separated by a 5 seconds pause. To decrease the possible negative influence of HDD operations during the FTP transmissions, the received file was saved to a RAM-disk created using ImDisk [21] or Gavotte RAMDisk [22] utilities. Generally, ImDisk was the first choice; Gavotte RAMDisk was used on Fujitsu A532 in 32-bit systems (both Windows 7 and Windows XP), because it allows to place the RAM-disk in the memory above 4GB limit in Physical Address Extension mode.

The FTP tests were preceded by an initial FTP download, to allow the server (digital TV receiver) to cache the file in the operational memory (the SD card read limit is about 27-28 MBps). Except the tests, Octagon SF8008 tuner was idle, i.e., no recording or playback was active. As the output from iPerf and FTP clients was directed to the text files, during the test we observed the current throughput reported by NetSpeedMonitor [23] utility in the Windows taskbar (similar function is implemented in Maxthon Browser).

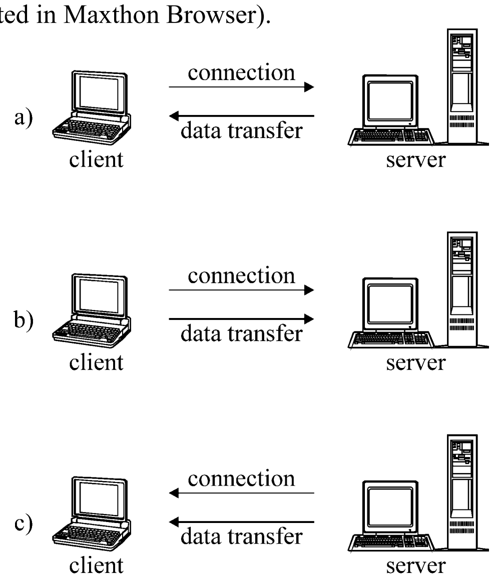

Fig. 2. iPerf default and reverse tests [24]

```
run FTP file download
for i=1 to 10 do
 run FTP file download
 pause 5 seconds
end for
for i=1 to 10 do
 run iPerf3 reverse test
 pause 5 seconds
end for
for i=1 to 10 do
 run iPerf2 reverse test
 pause 5 seconds
end for
```

Fig. 3. Throughput test procedure

The tests were performed using clients:

- Asus EEE PC 1000HG running under Windows XP and Windows 7 32-bit,
- Fujitsu A532 – as above, plus Windows 7 64-bit.

For each client, the first test was performed on Ethernet port. Then, for each Wi-Fi adapter, the test was performed for both 2.4 GHz and 5 GHz bands.

The Windows installations were not experimental – instead, we used the installations ready to work in office applications. The installed software includes, among others:

- ESET NOD32 Antivirus ver. 3.0.695.0 in Windows XP, ESET Endpoint Security 9.1.2063.0 in Windows 7,
- Microsoft Office 2003 in Windows XP and 2013 in Windows 7,
- Web browsers,
- FAR file manager in 2.0 and 3.0 versions,
- Cloud file synchronization applications (pCloud and Megasync still support Windows XP).

The Windows installations were cloned between the computers, so the application settings as well as hard disk structure were the same. All the necessary device drivers were also installed. The installed applications and services might generate some additional network traffic, although we believe its influence on the results was negligible.

III. Results and Discussion

The throughput measurement results in MBps for FTP, iPerf2 and iPerf3 utilities are presented in Tables IV to VIII.

The data gathered in the tables show that iPerf2 is much closer to FTP than iPerf3. It can be observed especially for Ethernet; Wi-Fi results are typically very much underestimated by iPerf3. The difference between FTP and iPerf3 results grows with increasing throughput and is bigger for 32-bit client version than for 64-bit one. There are, however, cases when iPerf3 is very close to the FTP result. For example, both iPerf2 and iPerf3 show practically the same throughput which is only a little lower than FTP; this can be seen in Table IV for 100Mbps Ethernet. On the other hand, the remaining results obtained for Ethernet show that iPerf3 is not always accurate in this case; for example, in Table VI it underestimates the FTP throughput by about 15%, in Table VII – is quite close to the FTP and in Table VIII – it overestimates FTP by as much as 60%. We must however take into account that the results in the Table VIII are obtained using 64-bit version of iPerf3, while the others – with 32-bit version.

Table IV
Throughput for Asus EEE PC 1000HG and Windows XP

Adapter	Band	FTP	iPerf2	iPerf3
Ethernet	100M	11.86	11.30	11.29
AR9382	11n	19.45	16.44	9.06
AR9382	11ac	21.19	21.68	10.87
DW1540	11n	18.16	17.84	10.41
DW1540	11ac	23.48	22.69	13.95
i6235	11n	7.60	10.26	6.17
i6235	11ac	8.57	10.19	7.28

Table V
Throughput for Asus EEE PC 1000HG and Windows 7 32-bit

Adapter	Band	FTP	iPerf2	iPerf3
Ethernet	100M	9.92	10.69	9.60
AR9382	11n	10.71	8.21	6.49
AR9382	11ac	8.06	6.61	5.47
DW1540	11n	7.76	6.55	5.42
DW1540	11ac	8.82	9.01	6.55
i6235	11n	2.27	2.12	1.78
i6235	11ac	2.22	2.29	1.97
DW1550	11n	8.42	7.68	5.82
DW1550	11ac	8.42	7.95	5.78
i7260	11n	7.70	7.63	5.18
i7260	11ac	7.56	8.56	6.23
QCA6174A	11n	7.84	6.56	4.70
QCA6174A	11ac	9.18	10.18	6.95
i8260	11n	8.88	12.64	7.51
i8260	11ac	4.78	7.86	2.79
i8265	11n	7.73	7.68	5.41
i8265	11ac	10.02	10.26	8.08

Table VI
Throughput for Fujitsu A532 and Windows XP

Adapter	Band	FTP	iPerf2	iPerf3
Ethernet	1Gbps	115.03	113.00	98.78
AR9382	11n	20.05	19.55	10.11
AR9382	11ac	23.05	22.81	12.59
DW1540	11n	19.49	14.30	11.41
DW1540	11ac	24.36	22.37	14.40
i6235	11n	12.32	4.35	7.45
i6235	11ac	14.96	17.56	10.42

Table VII
Throughput for Asus Fujitsu A532 and Windows 7 32-bit

Adapter	Band	FTP	iPerf2	iPerf3
Ethernet	1Gbps	69.42	79.19	65.77
AR9382	11n	23.54	12.76	9.93
AR9382	11ac	19.09	21.41	10.97
DW1540	11n	20.63	16.27	14.29
DW1540	11ac	20.78	19.93	14.53
i6235	11n		7.52	1.42
i6235	11ac	14.04	15.61	11.28
DW1550	11n	20.18	12.34	11.17
DW1550	11ac	64.85	63.16	18.26
i7260	11n	18.78	8.31	4.63
i7260	11ac	47.36	35.76	14.81
QCA6174A	11n	23.80	22.97	8.64
QCA6174A	11ac	65.42	62.46	10.73
i8260	11n	19.00	18.26	11.06
i8260	11ac	54.97	42.99	16.49
i8265	11n	20.95	19.83	10.78
i8265	11ac	74.03	63.51	17.57

Table VIII
Throughput for Asus Fujitsu A532 and Windows 7 64-bit

Adapter	Band	FTP	iPerf2	iPerf3
Ethernet	1Gbps	69.09	72.07	112.70
AR9382	11n	16.72	19.95	17.31
AR9382	11ac	20.55	22.26	19.82
DW1540	11n	23.14	20.36	7.80
DW1540	11ac	22.59	20.05	22.16
i6235	11n	5.45	7.71	7.56
i6235	11ac	16.11	13.12	16.61
DW1550	11n	15.61	18.99	14.99
DW1550	11ac	67.87	63.57	44.97
i7260	11n	15.98	8.79	15.43
i7260	11ac	49.79	38.30	29.31
QCA6174A	11n	24.45	20.76	15.46
QCA6174A	11ac	67.02	68.74	33.57
i8260	11n	15.30	17.11	12.86
i8260	11ac	52.28	65.67	33.49
i8265	11n	19.25	20.67	17.56
i8265	11ac	72.17	61.06	42.70

The reason of this difference is the iPerf version (32 or 64-bit), because in 64-bit Windows 7, the 32-bit iPerf3 version shows results comparable to those obtained in 32-bit Windows 7. Therefore, such a big difference is not a result of using a different version of the operating system.

iPerf2 results also vary; however, the maximum underestimation observed is about 2% (Table VI) and the maximum overestimation is about 14% (Table VII). Thus, for the Ethernet networks, iPerf2 is closer to FTP than iPerf3.

An interesting observation is such that, depending on the operation system, the results can be much different. It's surprising, or even disappointing, that Windows 7 in both 32- and 64-bit versions show generally a lower throughput than Windows XP. Indeed, both FTP and iPerf2 can reach the throughput of over 110 MBps in Windows XP running on Fujitsu A532 (Table VI), while Windows 7 can't reach over about 70 MBps (Tables VII and VIII). A similar phenomenon can be observed for Asus EEE PC 1000HG (Tables IV and V).

The results obtained for Wi-Fi adapters are more difficult to analyze. This is because their variability is much bigger than for Ethernet. One of the possible reasons could be the interference from other wireless networks operating in the same place as the experimental network. Another reason could be the influence from the environment other than wireless networks. On the other hand, as previously stated, there wireless communication conditions could be as good as could be achieved.

One of the interesting observations is relatively low throughput obtained for the older adapters based on Intel circuits, such as 6235. This circuit works in the N600 class, and theoretically offers 300 Mbps in either 2.4 or 5 GHz band. However, the results for this adapter are surprisingly disappointing; sometimes they are as low as only few MBps (Windows 7 32-bit, Tables V and VII). In any case, the throughput is lower than for other adapters in this class. During the tests, the bit rate reported by the OpenWRT software was very often much lower than the maximum of 300 Mbps and sometimes it dropped below 150 Mbps without any noticeable reason. During the test of other adapters in N600 class, the rate was mostly at its maximum and dropped a little only sometimes. As a result, FTP throughput could reach as high as about 23 to 24 MBps with DW1540 or AR9382 adapter, but only 14 MBps with Intel 6235. Due to these problems with Intel 6235, it's difficult to compare the results achieved using different tools.

For the other N600 adapters, one can clearly see that iPerf2 can predict the FTP throughput quite precisely, while this is unfortunately not the case for iPerf3. In fact, iPerf3 measures the throughput which is sometimes lower than 50% of the FTP throughput. This can be seen particularly well in the Tables IV, VI and VII which contain the results for 32-bit version of iPerf3. For example, iPerf3 throughput never exceeds about 14 MBps for N600 class adapters, while FTP can transmit as fast as about 24 MBps (Table VI, DW1540 adapter). For AC1200 class adapters, the highest throughput measured with iPerf3 is about 18 MBps, while FTP reaches over 64 MBps (Table VII, DW1550 adapter) which is quite well estimated by iPerf2 (62 MBps). However, iPerf2 results are sometimes not as good (Table VII, i8265 adapter) – FTP exceeds 74 MBps while iPerf2 shows less than 64 MBps (but still iPerf3 is much worse – it shows less than 18 MBps in this case). It seems that the 32-bit version of iPerf3 has major problems with proper throughput estimation for modern, fast networks, such as 1Gbps Ethernet and 300Mbps Wi-Fi networks.

The 64-bit version of iPerf3 gives the results that are much closer to FTP. In some cases (Table VIII, N600 class adapters) these results can be regarded as accurate – in these cases they are more accurate (i.e., closer to FTP) than iPerf2. However, this can result from the fact that iPerf3 is a 64-bit applications, while iPerf2 is still a 32-bit one. Unfortunately, with the increasing bit rate (AC1200 adapter class), iPerf2 becomes more accurate than iPerf3. In particular, the highest throughput measured with iPerf3 is about 45 MBps (Table VIII, DW1550 adapter) when FTP exceeds 67 MBps, which is again well estimated by iPerf2 (64 MBps). For the i8265 adapter, iPerf3 shows less than 43 MBps, while FTP exceeds 72 MBps and iPerf2 – 61 MBps. The comparison with similar results collected in the Table VII for 32-bit Windows shows that FTP and iPerf2 give comparable results regardless of operating system version (although iPerf2 underestimates FTP throughput by about 15% in both cases), while the throughput measured by iPerf3 is not only highly underestimated but the results depend on application version (the underestimation is by about 40% in 64-bit version and as much as about 75% in 32-bit version). As a result, iPerf3 not only gives in many cases the wrong results, but also may lead to the wrong conclusions. For example, the iPerf3 results collected in Tables IV and V may suggest that N600 or AC1200 Wi-Fi adapter will never offer the throughput as high as 100 Mbps Ethernet, therefore it's not worth it to upgrade the Wi-Fi adapters in old laptops. However, when we compare iPerf3 results with iPerf2 or FTP we can clearly see that with some Wi-Fi adapters it's possible to reach the throughput twice as high as with 100 Mbps Ethernet. However, the result also show that it depends on the operating system. In Windows 7 32-bit running at Asus EEE PC 1000HG, the throughput seems limited to about 10 MBps for both Ethernet and Wi-Fi. Probably this results from a very low microprocessor's computing power which limits Windows 7 capabilities. In fact, similar results for Fujitsu A532 are much better; nevertheless the throughput measured for Windows XP is still a little higher, not only for the same Fujitsu A532 laptop but also for much slower Asus EEE PC 1000HG!

Conclusion and Future Work

In this article, we presented and discussed the unpredicted test results that are a side effect of another research; nevertheless they seem interesting and important as we couldn't find any similar research. It's particularly important because iPerf is a popular network measurement tool used in scientific research. As we can see, depending on iPerf version, we can get completely different results, that may lead to completely different conclusions. Some of these conclusions may be correct, some not; it may also depend on the goal of the research.

The results clearly show that iPerf2 is much more accurate than iPerf3 (in either 32- or 64-bit version) when estimating the throughput of a local area network configured using up-to-date elements, such as 1Gbps Ethernet and 802.11ac wireless networks. The results achieved with iPerf2 do differ sometimes from FTP measurements; this may be the result of different measurement method used in these applications.

A better accuracy of iPerf2 when compared to iPerf3 may be the reason of the applications architectures. Some sources say [25] that iPerf2 is multi-threaded, while iPerf3 is singlethreaded. However, at the first glance, it seems it's not the case, because a single instance of iPerf3 uses 6 to 7 threads in Windows, while iPerf2 – 3 to 4 (FTP client uses 2 threads).

Finally, as stated in [5], iPerf measures available bandwidth. Our understanding of this statement is that iPerf is able to measure the absolute maximum real network throughput, or, in other words, the upper limit of the throughput. Therefore we expected that a real network application would show a lower throughput than iPerf. In our research it is sometimes the opposite – iPerf, especially iPerf3, shows much less throughput than FTP.

The results and conclusions presented here are, however, limited to this particular experimental network. It might happen that using other network hardware, operating systems, application versions, etc., completely different results could be achieved, leading to completely different conclusions. Therefore, it is important to continue the research with other network configurations, including more up-to-date operating systems, computer configurations, network elements (e.g., 802.11ax adapters), network measurement tools (e.g., nuttcp) and so on. Particularly, the results should be compared with Windows-to-Windows and Linux-to-Linux transmissions. It would allow to present more general conclusions.

Abbreviations

Mbps – Megabit per second
Gbps – Gigabit per second
MBps – Megabyte per second

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