Internet connection speed change depending on number of networks on one Wi-Fi channel

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Abstract

Wi-Fi networks are now becoming the main method of connecting to the Internet. At the same time, when deploying and designing networks, the fact that network bandwidth is reduced when there are several networks on one channel is not taken into account. This factor is as important as walls and ceilings, which reduce the signal coverage area. The article presents the results of an experiment on measuring bandwidth when connecting to the Internet via a WI-FI network with a different number of networks on one channel. The fact of a decrease in network throughput with a different number of networks is confirmed. With twenty access points, the Internet connection speed is reduced by a factor of three. Thus, the number of networks on one channel should be taken into account when deploying a network and managing traffic.

KeyWords:WI-FI network, bandwidth, network speed, traffic control.

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Introduction

Currently, Wi-Fi networks have become very popular not only in the private environment, but also in the corporate one. At the moment, Wi-Fi is the main method for connecting various portable devices to the Internet [1]. Many laptops, tablets computers and smartphones do not have an Ethernet interface, and Wi-Fi remains the only way to connect the device not only to the global, but also to the local network [2].In addition, the number of networks are growing. In apartment buildings, the number of networks is almost equal to the number of apartments. Considering the walls and partitions,there are from 5 to 20 networks nearby [3]. These are networks deployed in neighboring apartments. In shopping centers, airports, up to 50 networks are available at one point, including private access points.

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Wi-Fi networks use two frequencies to operate - 2.4 GHz and 5 GHz. At the same time, most networks operate at a frequency of 2.4 GHz [4]. The next parameter in the network operation is the frequency channel on which the network operates. Consider a network operating at 2.4 GHz. It has 13 availablechannels in the RF (Table 1, Figure 1) with different frequencies, while only three channels are not intersecting: 1, 6, 11 (Figure 2) [5]. This allocation is based on the IEEE requirement to provide a minimum of 25MHz [6] for center spacing of non-overlapping Wi-Fi frequency channels. The channel width is 22MHz.

Table 2
Elongation and strain rate when testing different yarns

Wi-Fi channel	Lower frequency	Center frequency	Upper frequency
1	2.401	2.412	2.423
2	2.406	2.417	2.428
3	2.411	2.422	2.433
4	2.416	2.427	2.438
5	2.421	2.432	2.442
6	2.426	2.437	2.448
7	2.431	2.442	2.453
8	2.436	2.447	2.458
9	2.441	2.452	2.463
10	2.446	2.457	2.468
11	2.451	2.462	2.473
12	2.456	2.467	2.478
13	2.461	2.472	2.483

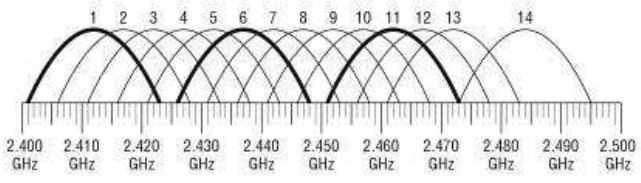

Figure 1. Frequency channels

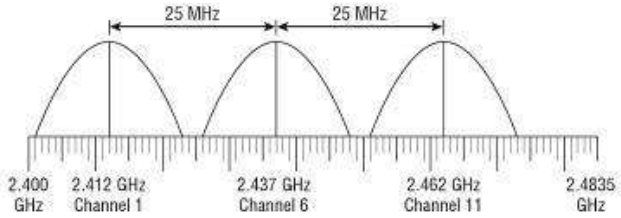

Figure 2. Non-overlapping channels

In the router settings, it is possible to select a channel, but by default, the channel is selected automatically [7]. At the same time, there are applications that allow you to see the busyness of the channel, more precisely, the presence and number of networks on one channel. One such application is the Wi-Fi Analyzer (Figure 3). In this example, there are only three networks, they are on channels 6, 9 and 11.

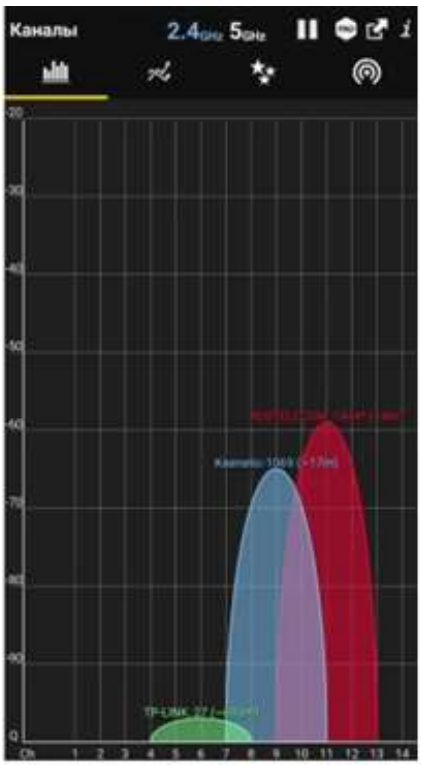

Figure 3. Example of Wi-Fi Analyzer operation

At the same time, it is well known that Wi-Fi is an

environment with a common collision domain. That is, the more devices operate on one channel (±2 adjacent) [8], the higher the probability of a collision - a simultaneous attempt to transmit a packet. Each such collision requires a delay before retrying the transmission and reduces the overall speed of the entire channel. It does not matter if clients are connected to one or more access points, the collision domain is one per channel [9]. Losses of the total throughput are usually taken as 3-5% for each subsequent device in the same or in adjacent channels, while this is not mentioned in the documentation for the equipment [10].

The theoretical throughput reduction as a percentage can be calculated using the formula:

$S = (1-k1/100)\ (n-1)$, (1)

Where n – number of networks on one channel;

k1 - reduction factor bandwidth primordial (3-5%).The total throughput can be calculated using the following formula:

$$P = p_{connection} * S \ ,(2)$$

Where $P = p_{connection}$ is the initialthroughput equal to connection speed.

By doing an experiment. We have a Wi-Fi network that is located on an uninterrupted channel with an initial bandwidth

$P = p_{connection}$ = 37 Mbps. Can calculate the throughput ability with a different number of networks on one channel (table 2, figure4). As a result of the calculation, with 20 devices, throughput is reduced by 54%.

Table 2

Bandwidth calculation for different number of networks

Number of networks per channel	Check point ability =5%	Check point ability =3%
1	37.0	37.0
2	35.2	35.9
3	33.4	34.8
4	31.7	33.8
5	30.1	32.8
6	28.6	31.8
7	27.2	30.8
8	25.8	29.9
9	24.5	29.0
10	23.3	28.1
11	22.2	27.3
12	21.0	26.5
13	20.0	25.7
14	19.0	24.9
15	18.0	24.2
16	17.1	23.4
17	16.3	22.7
18	15.5	22.0
19	14.7	21.4
20	14.0	20.7

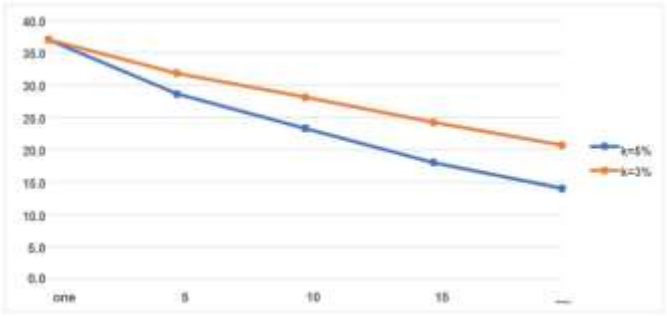

Figure 4. Theoretical throughput reduction

An experiment was carried out to compare the theoretical reduction in throughput with the actual one. We will measure the Internet connection speed on a computer connected to a Keenetinc-1916 Wi-Fi router with a different number of networks on the same channel (2.4 MHz network, 802.11n standard), the dependence is shown in Figure 5.

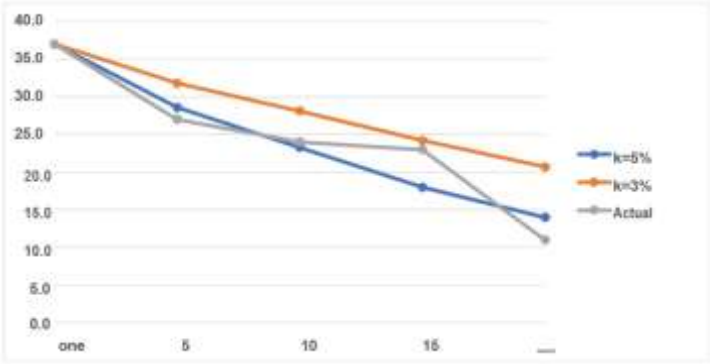

Figure 5. Results of the experiment

Conclusion

The experiment was carried out with the gradual connection of routers on channel 6. The routers were turned on the channel

one by one, the first 5 routers were TP-Link TL-MR150, the second 5 routers were Keenetinc-1916, the remaining 10 routers TP-Link TL-MR6400. Each router had an independent 4G internet connection. The decrease in throughput most likely depends

on the type of equipment, but with 20 access points, the speed drops to 11Mb, i.e. more than three times. At the same time, the throughput decreased unevenly. This experiment proves the occurrence of collisions, and the significance of this parameter when designing Wi-Fi networks, in the case of choosing a channel for traffic management, it is also worth setting a reduction factor of about 7-15% depending on the number of networks andthe type of building (private house, office building, airport).

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