Latency Analysis in IPv4/IPv6 Data Network

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Abstract—*New Network tools used in data networks, such as* ***Software Defined Networks*** *(SDN) allow precise control of all network segments, so that they can be used to optimize data networks in a global way.*

Networks have been optimized within the scope in which they are being analysed, for example:

1. WANs, the best path is determined based on metrics such as fewer hops, and sometimes bandwidth. This information from the point of view of algorithms is not complete, since it does not include all the variables: There could be better routes to reduce latency or to increase bandwidth.

2. In wireless networks, local bandwidth is increased, as users are assigned to those AP's that have fewer users and in the less congested frequencies.

3. LANs are not optimized by themselves, but it is possible to find a way to streamline the segmented bandwidth.

Nowadays we can count, in addition to different providers, with 2 protocols, ***IPv4*** *and* ***IPv6****, which increase the number of factors involved in the analysis.*

As the bandwidth is a parameter that remains constant, the variable that has been chosen to be analyzed is the latency because it is the best option.

Keywords—*Latency, IPv4, IPv6, SDN, Factorial experiments, ISP, WLAN, LAN, WAN*

I. INTRODUCTION

Latency is the time that the message remains within the means until it is received by the recipient. It is calculated as the sum of the propagation time, plus transmission time, plus queue time

$$Propagation\ Time = \frac{Distance}{Speed}$$

Where Distance is the link length and Speed is the displacement speed of the message. Generally it is a function of the speed of light multiplied by the spread index.

For UTP (copper) the index that is usually taken is 0.7, and foroptical fiber the basis for judgement is normally 0.79.

$$Trasmition\ Time = \frac{Packet\ size}{Transfer\ rate}$$

Queue time depends on the type and amount of equipment that transmit information across the path.

To characterize network latency, the test includes the (Customer) wireless network, the wired network (LAN) and the wide area network (WAN) [1].

The data obtained for the first part of the experiment was captured using a laptop with Windows 7, connected to a 5 GHz access point (AP). It was assured that at no time the AP was saturated to prevent the bandwidth from being affected by the number of users, and in the case of the Wi-Fi, alterations could occur since it is a shared medium.

In the second part of the experiment, an application was developed to obtain data directly from the border router. In this case, latency is only affected by the suppliers' link, since the local connections are not used. In general there is not usually much variation in the case of latency, as in the case of the local network, the latency between the computer devices, even in the wireless network and the border router is usually kept below 10 ms and the average is 8 ms.

II. FACTORIAL EXPERIMENTS.

The experiment followed the recommendations of Breyfogle and Forrest W[2] for factorial experiments.

The 5 selected factors were:

Table 1: Selected Factors and effects in latency

Factors	+	-	Value (ms.)
Protocol	IPv6	IPv4	1.5
Saturation	30%-9:00 am	15%-1:00 pm	-0.125
Size	Packet of 100 Bytes	Packet of 1200 Bytes	-1.125
Distance	2,662 Km.	1,568 Km.	48.875
Provider	ISP B	ISP A	-6.75

With these data we proceeded to calculate the effects of different factors in the latency time. The results are shown in the Value column of Table 1

Factorial Experiments permit study the different factors and the interaction between them. [8]

A. Protocol

Regarding the Protocol, the average latency with IPv4 and IPv6, IPv6 is slightly higher. Although it is supposed that this protocol is faster, the difference is probably due to more routers are required, especially on the local segment of routers.

This is consistent with measurements made by Cisco.[6]

B. Link Saturation

As for the saturation, the average latency tested at 9:00 am and at 1:00 pm is the least differenced, due because practically at these 2 times the bandwidth is not completely used, and the low utilization during the vacation period.

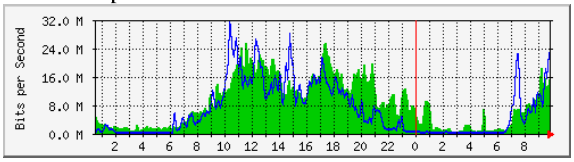

Image 1: ISP B Traffic 9:54 a.m.

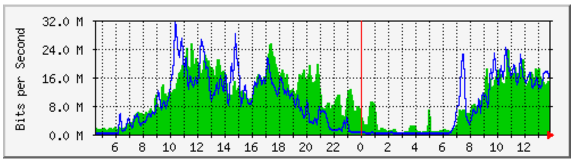

Image 2: ISP B Traffic 1:54 p.m.

The above two graphs show the same supplier in those 2 times. The bandwidth is 150 MB/s of dedicated Internet, saturation was never above 30%. In this sense it complies with the recommendations of best practices for links to keep them below 80% utilization.

C. Package Size

In relation to package size, it does not show the effect with respect to latency time. Percentiles of 500 packets sent from 2 different sizes (100 bytes and 1200 bytes) are shown in the following graph:

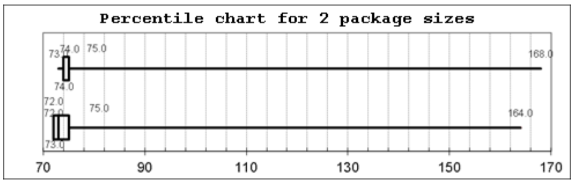

Image 3: Latency Percentile of 2 different package sizes (in milliseconds)

The chart above shows the size of 1200 bytes (upper line), and 100 bytes (lower line) and although in the minimal latency (72 vs 73 ms), the average (73 vs 74 ms) and the difference was only 1 ms, the maximum latency difference was 4 ms.

1. Example an ICMP package of size of 100 bytes

```
00A-A#ping target size 100
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to x.x.x.x,
timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-
trip min/avg/max = 72/73/80 ms
```

2. Example an ICMP package of size of 1200 bytes

```
00A-A#ping target size 1200
Type escape sequence to abort.
Sending 5, 1200-byte ICMP Echos to x.x.x.x,
timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-
trip min/avg/max = 73/74/86 ms
```

D. Distance

With respect to the distance of the connection point, this is the most influential factor in latency. This factor contributed in a 48 ms. difference between the averages of latencies. Measuring this factor, it is consistent with network theory, in the sense that propagation latency depends on the length of the medium and the propagation speed.

We proceeded to calculate the latency correlation in function of the distance. Each segment was identified using the Traceroute functions.

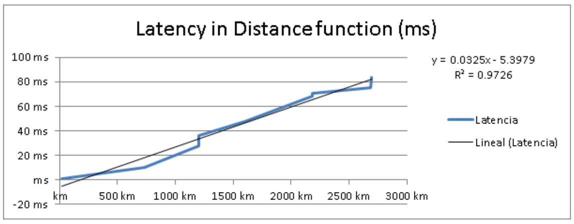

Image 4: Plot of latency and distance

The graph shows the correlation factor of 0.9726, indicating a good approximation with the equation shown. 3 zones can also be noticed in the graphic area:

• In the first area, the link between the user and the Local Provider (ISP B), latency is small, because the link is dedicated, for the exclusive use of the UP.

• The second area in the middle shows the most common behaviour of networks; stable latencies for long distances, as well as variations for different suppliers' connections, due to the very own latencies of each equipment.

• In the last zone, also you have a dedicated link, resulting slope very similar to the first zone.

E. Internet Service Provider

The ISP utilization has practically no influence on the latency, particularly on last network segments, since they are already international links.

Latencies differences may be due to the switches used, and although they are lower than the latencies of routers and links, in certain occasions they should be considered in the analysis. [3]

III. RESULTS OF FACTORIAL EXPERIMENTS

In Factorial Experiments there are 2 types of interactions: strong and weak.

A. *Strong Interaction*

Strong interaction occurs between two factors when their graphs intersect in the following cases:

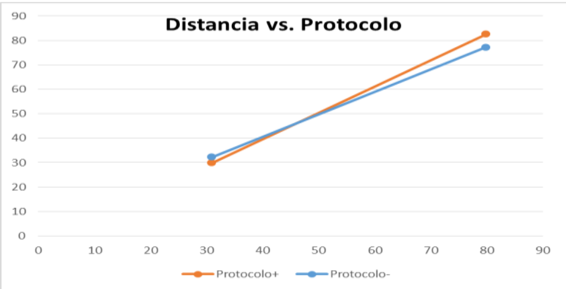

Image 5: Interaction Distance-Protocol.

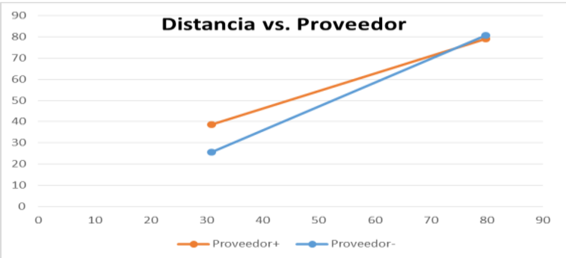

Image 6: Interaction Distance-Provider.

B. *Weak Interaction*

We have a weak interaction between two factors when there is a tendency to cross the lines representing two factors; they are not parallel but do not intersect at the range of data shown. This is the most common interaction.

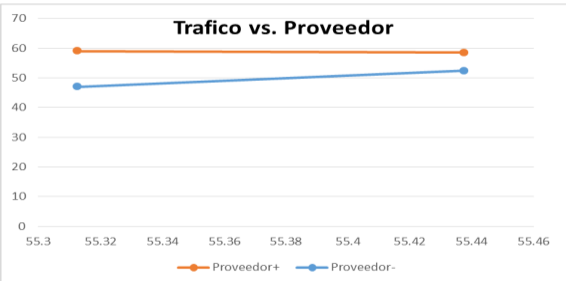

Image 7: Interaction Traffic-Provider.

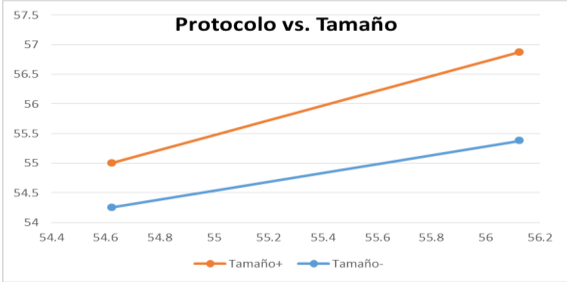

Image 8: Interaction Protocol-Size.

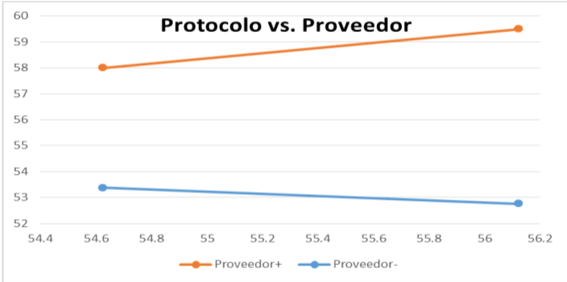

Image 9: Interaction Protocol-Provider.

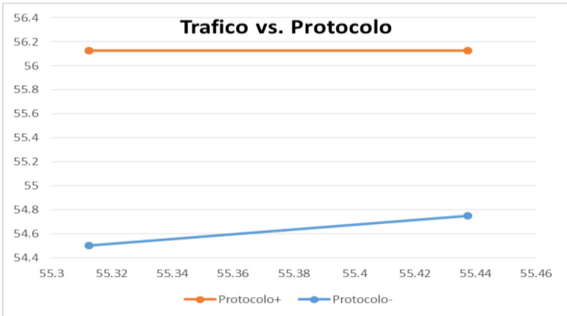

Image 10: Interaction Traffic-Protocol.

C. *Non Interaction*

It has also sometimes you do not have interaction between two factors if the graphs of these factors are parallel like the next 2 graphs.

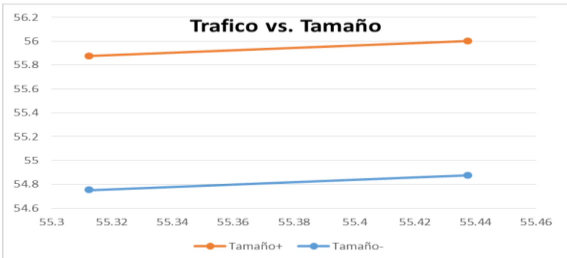

Image 11: Interaction Traffic-Size.

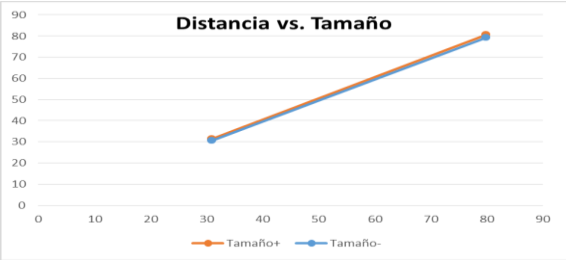

Image 12: Interaction Distance-Size.

IV. DISPERSIONS OF MEASURES

The following charts show the minimum, average and maximum latency performed every hour towards the same site (www.google.com). This latency was measured by sending 50 ICMP packets (ping) every 5 minutes from 10:30 until 13:25 the same day using 2 different ISP.

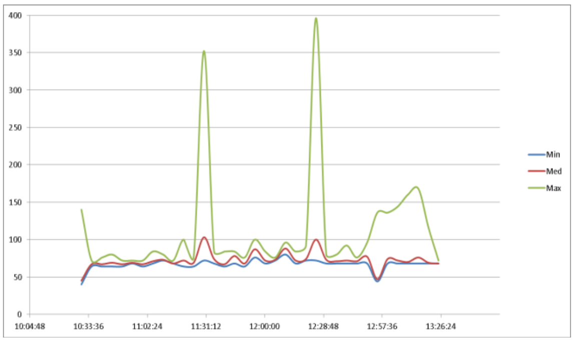

Image 13: Latency Minimum, average and Maximum of ISP A.

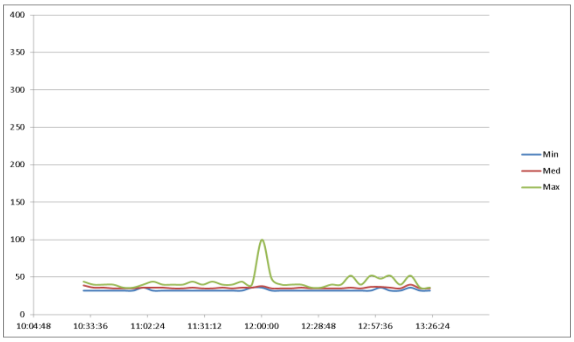

Image 14: Latency Minimum, average and Maximum of ISP B.

To obtain this information a Java application that connects every 5 minutes to the border router was developed, makes a number of 50 ping the destination with a data size of 1000 bytes and specifies the output interfaces for each vendor thus ensure that the direction and path of each of the suppliers used. The results of each test (% of packets received, minimum, average and maximum time) are saved to a text file for later processing.

In present there are many patents about improve network using latency [4]

For the above two providers, graphics adjusted to 400 ms. each, thus, one can observe that the dispersion of the first supplier is greater than the second.

Also by this test, it can be seen some hours data, which provider is better connected to the major sites are obtained. In this case, ISP B presented an average of 35 ms. compared ISP A to present an average of 72 ms., in this case more than twice as long. For reference, a third provider, presented in the same period an average of 28 ms., but in that time, 2 measurements of more than 400 ms. were found.

This is a fragment of code used to get the data using Java.

```
int Cant=10;
inttamanio=800;
 String destino="www.google.com";
write("terminal len 0");
readUntil(promptCompleteEna);
write("ping  "+destino+"  size  "+tamanio+"
source GigabitEthernet0/0 repeat "+Cant);
 a=readUntil(promptCompleteP);
write("ping  "+destino+"  size  "+tamanio+"
source GigabitEthernet0/1.8 repeat "+Cant);
 m=readUntil(promptCompleteP);
write("ping  "+destino+"  size  "+tamanio+"
source GigabitEthernet0/1.10 repeat "+Cant);
 b=readUntil(promptCompleteP);
```

This code performs the telnet to the router, and requests pings by different suppliers.

In the variables a, b and m store the time the router needs to contact the destination, in this case www.google.com.

V. DISCUSSION OF RESULTS

Lower latency compared to IPv4 to IPv6 latency is insignificant.[7] Even the low correlation between the protocol and the provider indicates that probably the two providers are using the same mechanisms of IPv6 traffic. We are convinced of the benefits of IPv6 over IPv4, even these tests can help determine if WAN connectivity is native or IPv6 is encapsulated in IPv4 tunnels.

The Wireless's Latency, has not importance compare to WAN's Latency.

Currently, the application to measure the latency connects to routers using Cisco OnePk, thesetool improve security because use TLScertificates instead of Telnet.

VI. CONCLUSIONS

With the above analysis, it can be shown that virtually latency is due to the distance, other factors such as protocol, percent saturation use or package size link and ISP, practically no influence on the response time.

The behavior of the networks, usually very stable under low traffic, and has some very scattered times, mainly due to changes in network topologies, application of new routes and occasionally the loss of one or 2 packages. These losses are usually retransmitted at the request of the applications that provide some capability for error detection.

In these tests, it could not assess the latency in case of saturation of the links, because even under normal conditions can be found peaks of 80% or more by using the links at this time, which does not have classes normal use by students is really very low.

The latencies are important to reduce, for that time savings for millions of packets circulating on the Internet, can reduce costs or even generate profits, as Google advantage.[5][9]

With these tests, it can be shown that the main factor is the distance and latency in normal conditions; little can be done to reduce it.

In general, you should look for suppliers that have low latency, but it is also important that your times are stable under the same conditions of traffic.

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