Performance Measures with IPV6

Subjects: Computer Science, Hardware & Architecture
Contributor: Gabriel Souto Fischer

This document presents some tests carried out to measure performance in IPv6 networks. At the same time, it describes the use of a Tunnel Broker Client for IPv6, used to perform latency measurements, through the ping command, and route determination, through the tracerout command, for 5 Internet sites that are available both via IPv6 as well as IPv4. Additionally, includes the measurements obtained and a comparison of the results between IPv4 and IPv6, presenting explanations for the data obtained.

Keywords: ipv4 ; ipv6 ; ping ; tracert ; performance

1. Introduction

IPv6 is the most current version of the Internet Protocol. It was designed to solve, among other issues, the problem of possible IPv4 address exhaustion. When the internet was designed, it was believed that it would be a predominantly academic network, with a few hundred interconnected computers. Initially, there was no use commercial that the internet has nowadays.

The 32-bit IP version 4 address space contains a range of 4,294,967,296 addresses (WIKIPEDIA, 2013), which despite being an extremely large number and at the time seemed to be unattainable, as the years and the exponential growth of the internet proved to be doomed to exhaustion.

In 2011, the much-feared burnout finally happened. Currently, there are no more IPv4 addresses available from the IANA (Internet Assigned Numbers Authority) (NRO, 2013). To get a sense of the speed of growth, in December 2007, there were around 42 /8 address blocks in the IANA central stock (NRO, 2007). Each /8 block holds 16 million IP addresses, and yet in less than 4 years, 42 /8 blocks were exhausted. As a solution to the problem of IPv4 protocol addresses, the IPv6 protocol was designed.

With the possibility of using IPv6, and the need to test the performance of IPv6 networks in comparison to IPv4 networks, the general objective of this work is to test the performance of 5 websites that are available via both IPv6 and IPv4, which consists of executing the PING and TRACEROUTE commands for the two IP protocols, with the objective to measure the latency of the IPv6 network and compare it with the latency of the IPv4 network and determine the route used to access the two networks.

For the tests, a common home computer with IPv4 connectivity was used, where a Tunnel Broker was established so that the computer could obtain IPv6 connectivity. This document will also present the results obtained in the tests and a comparison between the performance of IPv4 and IPv6.

2. IPV6 Protocol and Tunnel Broker Technique

To carry out performance tests on IPv6 networks, compared to IPv4 networks, the Tunnel Broker technique was used.

2.1. IPv6 Protocol

The IPv6 protocol is the most current version of the Internet Protocol. The construction of the protocol was necessary in view of the risk of IPv4 exhaustion, which ended up happening in 2011. This protocol, in addition to guaranteeing an extremely greater number of addresses, has several new features that make it more effective than the IPv4 protocol:

• Longer Address Space: IPv6 addresses have a size of 128 bits instead of 32, guaranteeing a range of 3.4x10 in 38 addresses.
• Header format: Simpler with 7 parameters instead of 13.
• Authentication and Encryption: Several extensions to IPv6 allow support for options such as authentication, integrity, encryption and data confidentiality.

• Quality of Service Support: Audio and video applications now establish appropriate connections taking into account their QoS requirements.
• Extension headers: Option support integrated into the header.
• Hierarchical addressing: Simplifies the routing tables of network routers, reducing their processing load.

IPv6 is gradually being rolled out across the Internet and should work alongside IPv4 for a while. In the long term, the goal is the complete replacement of IPv4 with IPv6. Therefore, IPv6 addresses can be mapped to IPv4, to this end, the 128 bits of IPv6 are divided as follows:

• 80-bit field set to 0.
• 16-bit field placed at F.
• 32-bit IPv4 address

So: **::FFFF:<IPv4 address>**

2.2. Tunnel Broker

Tunnel Broker is an alternative to connecting to the internet via IPv6, when the internet provider only offers IPv4 connectivity. This is a technique that allows IPv4 hosts to access IPv6 networks. The idea of Tunnel Broker is to establish a virtual provider that provides IPv6 connectivity for IPv4 users. Basically, a "tunnel" is created, which connects the IPv4 computer directly to an IPv6 virtual provider, which connects to the IPv6 internet.

3. Experimental Scenario and Testing Methodology

On a personal machine with Windows 7 Professional 64 bits, with a 15 Mb internet link provided by GVT, with the hardware described below, some IPv6 and IPv4 network performance tests were carried out to make a comparison between the two.

The machine used for testing has the following hardware configuration:

• Intel Core i7 3770 processor, 3.9 GHz.
• Ram memory: 16 GB 1600MHz.
• 3TB HDD.
• HD Radeon 6850 GPU.

To obtain IPv6 connectivity, the Hurricane Electric TunnelBroker provider was first used. Initially, there was a connectivity error, as the HE was unable to locate the IP of the machine used for the tests using the PING command. To solve the problem in question, the ports of the modem router were opened, directing traffic from the ports to the IP of the internal network of the testing machine; ICMP access was released, which was blocked by default on the router, and its firewall was disabled. Even so, HE was unable to locate the machine, so the Windows 7 firewall was disabled and HE was able to locate the machine and the Tunnel Broker could be established, however, despite the tunnel being active, it was not possible to connect the test machine to it, as it presented a connection error through the command prompt.
Therefore, the Tunnel Broker provider was changed to freenet6 from gogo6. To establish the tunnel, registration was carried out on the website to download gogoCLIENT, which created a virtual adapter in Windows for IPv6 connectivity. After the adapter was created, using the gogoCLIENT program itself, the connection was established with the Freenet6 provider and IPv6 connectivity was established on the test machine.

Then the commands PING were used, to measure the connection latency, and TRACEROUTE (tracert) to check the connection route both via IPv4 and IPv6, on the sites:

• http://www.google.com
• http://www.wikipedia.org
• http://br.youtube.com
• http://br.yahoo.com
• http://www.facebook.com

The commands were executed directly at the Windows prompt, to avoid overhead from other applications.

4. Presentation and Analysis of Results

The results obtained by executing each command, both by IPv6 and IPv4 for each site, are described below.

4.1. Tracert

4.1.1. www.google.com

IPv6:
C:/Users/Gabriel>tracert google.com
Tracing route to google.com [2800:3f0:4001:802::1008] over a maximum of 30 hops:
1 148 ms 338 ms 146 ms 2001:5c0:1000:a::14b8
2 144 ms 144 ms 143 ms ix-5-0-1.6bb1.MTT-Montreal.ipv6.as6453.net [2001:5a0:300::5]
3 177 ms 146 ms 146 ms if-ge-11-3-0.0.tcore2.MTT-Montreal.ipv6.as6453.net [2001:5a0:1900:100::d]
4 150 ms 150 ms 153 ms if-ae2.2.tcore2.NYY-NewYork.ipv6.as6453.net [2001:5a0:1900:100::6]
5 151 ms 150 ms 263 ms if-ae11.2.tcore1.NYY-NewYork.ipv6.as6453.net [2001:5a0:400:700::2]
6 152 ms 163 ms 150 ms if-ae5.5.tcore1.NTO-NewYork.ipv6.as6453.net [2001:5a0:400:200::e]
7 154 ms 151 ms 160 ms 2001:4860:1:1:0:1935:0:13
8 155 ms 156 ms 186 ms 2001:4860::1:0:755
9 169 ms 162 ms 157 ms 2001:4860::8:0:4397
10 160 ms 164 ms 161 ms 2001:4860::8:0:3cd9
11 166 ms 166 ms 170 ms 2001:4860::8:0:3005
12 209 ms 223 ms 242 ms 2001:4860::8:0:2f03
13 186 ms 201 ms 186 ms 2001:4860::1:0:245b
14 286 ms 287 ms 290 ms 2001:4860::1:0:468b
15 295 ms 294 ms 297 ms 2001:4860::1:0:4f24
16 406 ms 442 ms 458 ms 2001:4860:0:1::36b
17 406 ms 452 ms 460 ms 2800:3f0:4001:802::1008
Trace complete.

IPv4:
C:/Users/Gabriel>tracert google.com
Tracing route to google.com [74.125.234.65] over a maximum of 30 hops:
1 1 ms 1 ms 1 ms 192.168.1.1
2 7 ms 7 ms 6 ms gvt-l0.b8.can.gvt.net.br [177.41.172.1]
3 6 ms 6 ms 7 ms gvt-host.gvt.net.br [200.175.124.194]
4 9 ms 11 ms 7 ms gvt-ge-3-1-3.rc02.pae.gvt.net.br [189.59.252.245]
5 27 ms 23 ms 23 ms 189.59.253.62.static.host.gvt.net.br [189.59.253.62]
6 27 ms 23 ms 23 ms 187.115.213.82.static.host.gvt.net.br [187.115.213.82]
7 23 ms 23 ms 23 ms 72.14.198.181
8 22 ms 22 ms 22 ms 209.85.254.74
9 24 ms 24 ms 24 ms 209.85.248.203
10 24 ms 24 ms 24 ms gru03s07-in-f1.1e100.net [74.125.234.65]
Trace complete.

4.1.2. www.wikipedia.com

IPv6:
C:/Users/Gabriel>tracert wikipedia.com
Tracing route to wikipedia.com [2620:0:860:ed1a::1] over a maximum of 30 hops:
1 244 ms 212 ms 148 ms 2001:5c0:1000:a::14b8
2 146 ms * 157 ms ix-5-0-1.6bb1.MTT-Montreal.ipv6.as6453.net [2001:5a0:300::5]
3 148 ms 147 ms 146 ms if-ge-11-3-0.0.tcore2.MTT-Montreal.ipv6.as6453.net [2001:5a0:1900:100::d]
4 172 ms 160 ms 161 ms if-ae5.2.tcore2.NYY-NewYork.ipv6.as6453.net [2001:5a0:400:700::5]
5 161 ms 157 ms 179 ms if-ae11.2.tcore1.NYY-NewYork.ipv6.as6453.net [2001:5a0:400:700::2]
6 160 ms 160 ms 160 ms if-ae5.5.tcore1.NTO-NewYork.ipv6.as6453.net [2001:5a0:400:200::e]
7 174 ms 173 ms 176 ms if-ae8.2.tcore2.NTO-NewYork.ipv6.as6453.net [2001:5a0:12:100::2e]
8 174 ms 179 ms 168 ms xe-7-1-2.nyc30.ip6.tinet.net [2001:668:0:3::8000:2361]
9 166 ms 163 ms 165 ms xe-3-0-0.was10.ip6.tinet.net [2001:668:0:2::1:1741]
10 * * * Esgotado o tempo limite do pedido.
11 280 ms 286 ms 290 ms xe-1-1-0.cr1-sdtpa.wikimedia.org [2620:0:861:fe02::2]
12 272 ms 273 ms 272 ms wikipedia-lb.pmtpa.wikimedia.org [2620:0:860:ed1a::1]
Trace complete.

IPv4:
C:/Users/Gabriel>tracert wikipedia.com
Tracing route to wikipedia.com [208.80.152.201] over a maximum of 30 hops:
1 1 ms 1 ms 1 ms 192.168.1.1
2 6 ms 7 ms 6 ms gvt-l0.b8.can.gvt.net.br [177.41.172.1]
3 7 ms 7 ms 7 ms gvt-host.gvt.net.br [200.175.124.194]
4 21 ms 21 ms 21 ms gvt-ge-1-0-3.rc02.rjo.gvt.net.br [189.59.244.221]

5 22 ms 22 ms 22 ms xe-4-2-0.ar4.gru1.gblx.net [64.214.61.37]
6 144 ms 144 ms 143 ms po8-30G.ar5.NYC1.gblx.net [67.17.72.114]
7 * * * Esgotado o tempo limite do pedido.
8 151 ms 152 ms 152 ms vlan60.csw1.NewYork1.Level3.net [4.69.155.62]
9 154 ms 151 ms 152 ms ae-61-61.ebr1.NewYork1.Level3.net [4.69.134.65]
10 152 ms 153 ms 152 ms 4.69.201.66
11 153 ms 153 ms 153 ms ae-1-100.ebr1.Washington12.Level3.net [4.69.143.213]
12 151 ms 151 ms 151 ms ae-6-6.ebr1.Atlanta2.Level3.net [4.69.148.105]
13 152 ms 152 ms 153 ms ae-1-100.ebr2.Atlanta2.Level3.net [4.69.132.34]
14 152 ms 152 ms 152 ms ae-2-2.ebr2.Miami1.Level3.net [4.69.140.141]
15 153 ms 153 ms 155 ms ae-1-100.ebr1.Miami1.Level3.net [4.69.151.253]
16 166 ms 151 ms 152 ms ae-3-5.bar1.Tampa1.Level3.net [4.69.148.214]
17 152 ms 152 ms 188 ms ae-5-5.car1.Tampa1.Level3.net [4.69.133.13]
18 261 ms 213 ms 211 ms ae-13-13.car3.Tampa1.Level3.net [4.69.133.18]
19 153 ms 152 ms 152 ms level3.co1.as30217.net [4.71.0.30]
20 153 ms 153 ms 153 ms te3-4.co2.as30217.net [84.40.24.50]
21 177 ms 177 ms 180 ms 10ge5-1.csw5-pmtpa.wikimedia.org [84.40.25.102]
22 178 ms 177 ms 178 ms wikipedia-lb.pmtpa.wikimedia.org [208.80.152.201]
Trace complete.

4.1.3. br.youtube.com

IPv6:
C:/Users/Gabriel>tracert br.youtube.com
Tracing route to youtube-ui.l.google.com [2607:f8b0:400c:c03::5d] over a maximum of 30 hops:
1 155 ms 301 ms 158 ms 2001:5c0:1000:a::14b8
2 158 ms 333 ms * ix-5-0-1.6bb1.MTT-Montreal.ipv6.as6453.net [2001:5a0:300::5]
3 155 ms 242 ms 157 ms if-ge-11-3-0.0.tcore2.MTT-Montreal.ipv6.as6453.net [2001:5a0:1900:100::d]
4 176 ms 172 ms 173 ms if-ae2.2.tcore2.NYY-NewYork.ipv6.as6453.net [2001:5a0:1900:100::6]
5 160 ms 160 ms 161 ms if-ae11.2.tcore1.NYY-NewYork.ipv6.as6453.net [2001:5a0:400:700::2]
6 165 ms 204 ms 162 ms if-ae5.5.tcore1.NTO-NewYork.ipv6.as6453.net [2001:5a0:400:200::e]
7 163 ms 161 ms 160 ms 2001:4860:1:1:0:1935:0:13
8 158 ms 159 ms 162 ms 2001:4860::1:0:755
9 160 ms 160 ms 160 ms 2001:4860::8:0:4398
10 170 ms 167 ms 167 ms 2001:4860::8:0:3cda
11 180 ms 179 ms 183 ms 2001:4860::8:0:33b3
12 187 ms 183 ms 183 ms 2001:4860::2:0:3a3
13 * * * Esgotado o tempo limite do pedido.
14 178 ms 177 ms 173 ms vc-in-x5d.1e100.net [2607:f8b0:400c:c03::5d]
Trace complete.

IPv4:
C:/Users/Gabriel>tracert br.youtube.com
Tracing route to youtube-ui.l.google.com [74.125.234.110] over a maximum of 30 hops:
1 1 ms 1 ms 1 ms 192.168.1.1
2 7 ms 6 ms 6 ms gvt-l0.b8.can.gvt.net.br [177.41.172.1]
3 7 ms 6 ms 6 ms gvt-24-80.rd01.can.gvt.net.br [200.175.124.193]
4 9 ms 11 ms 7 ms gvt-ge-3-1-1.rc01.pae.gvt.net.br [189.59.252.241]
5 33 ms 23 ms 23 ms 177.99.251.dynamic.adsl.gvt.net.br [177.99.251.10]
6 33 ms 23 ms 23 ms gvt-te-0-0-2-0-rt01.spo.gvt.net.br [189.59.249.5]
7 23 ms 23 ms 39 ms 72.14.198.181
8 23 ms 22 ms 22 ms 72.14.235.222
9 24 ms 23 ms 23 ms 64.233.174.115
10 23 ms 23 ms 22 ms gru03s08-in-f14.1e100.net [74.125.234.110]
Trace complete.

4.1.4. br.yahoo.com

IPv6:
C:/Users/Gabriel>tracert br.yahoo.com
Tracing route to ds-br-fp3.wg1.b.yahoo.com [2001:4998:f00b:1fe::3000] over a maximum of 30 hops:
1 142 ms 143 ms 143 ms 2001:5c0:1000:a::14b8
2 142 ms 142 ms 142 ms ix-5-0-1.6bb1.MTT-Montreal.ipv6.as6453.net [2001:5a0:300::5]
3 145 ms 142 ms 146 ms if-ge-11-3-0.0.tcore2.MTT-Montreal.ipv6.as6453.net [2001:5a0:1900:100::d]
4 150 ms 149 ms 151 ms if-ae2.2.tcore2.NYY-NewYork.ipv6.as6453.net [2001:5a0:1900:100::6]
5 150 ms 150 ms 152 ms if-ae11.2.tcore1.NYY-NewYork.ipv6.as6453.net [2001:5a0:400:700::2]
6 183 ms 163 ms 153 ms if-ae5.5.tcore1.NTO-NewYork.ipv6.as6453.net [2001:5a0:400:200::e]

7 156 ms 150 ms 150 ms 10gigabitethernet4.switch3.nyc4.he.net [2001:470:0:1a3::1]
8 151 ms 150 ms 150 ms PAT1.nyc.Yahoo.com [2001:504:f::18]
9 150 ms 152 ms 151 ms r1.ycpi.vip.nyc.yahoo.net [2001:4998:f00b:1fe::3000]
Trace complete.

IPv4:
C:/Users/Gabriel>tracert br.yahoo.com
Tracing route to ds-br-fp3.wg1.b.yahoo.com [200.152.175.146] over a maximum of 30 hops:
1 1 ms 1 ms 1 ms 192.168.1.1
2 6 ms 6 ms 6 ms gvt-l0.b8.can.gvt.net.br [177.41.172.1]
3 7 ms 7 ms 7 ms gvt-24-80.rd01.can.gvt.net.br [200.175.124.193]
4 8 ms 11 ms 11 ms gvt-at-2-0-1.rd02.pae.gvt.net.br [189.59.252.49]
5 33 ms 23 ms 23 ms 177.99.251.dynamic.adsl.gvt.net.br [177.99.251.10]
6 25 ms 23 ms 23 ms gvt-te-0-0-0-7-rt01.spo.gvt.net.br [187.115.214.214]
7 23 ms 23 ms 23 ms as28122.sp.ptt.br [187.16.218.22]
8 24 ms 23 ms 23 ms UNKNOWN-200-152-175-X.yahoo.com [200.152.175.195]
9 22 ms 22 ms 22 ms r1.ycpi.vip.br1.yahoo.net [200.152.175.146]
Trace complete.

4.1.5. www.facebook.com

IPv6:
C:/Users/Gabriel>tracert facebook.com
Tracing route to facebook.com [2a03:2880:2110:df07:face:b00c:0:1] over a maximum of 30 hops:
1 153 ms 152 ms 152 ms 2001:5c0:1000:a::14b8
2 194 ms 151 ms 151 ms ix-5-0-1.6bb1.MTT-Montreal.ipv6.as6453.net [2001:5a0:300::5]
3 151 ms 152 ms 153 ms if-ge-11-3-0.0.tcore2.MTT-Montreal.ipv6.as6453.net [2001:5a0:1900:100::d]
4 158 ms 206 ms 158 ms if-ae5.2.tcore2.NYY-NewYork.ipv6.as6453.net [2001:5a0:400:700::5]
5 158 ms 158 ms 164 ms if-ae11.2.tcore1.NYY-NewYork.ipv6.as6453.net [2001:5a0:400:700::2]
6 162 ms 158 ms 158 ms if-ae5.5.tcore1.NTO-NewYork.ipv6.as6453.net [2001:5a0:400:200::e]
7 170 ms 159 ms 163 ms 10gigabitethernet4.switch3.nyc4.he.net [2001:470:0:1a3::1]
8 164 ms 165 ms 166 ms xe-1-1-0.br01.lga1.tfbnw.net [2001:504:f::3:2934:1]
9 165 ms 164 ms 164 ms ae1.bb01.lga1.tfbnw.net [2620:0:1cff:dead:beee::232]
10 165 ms 174 ms 171 ms ae32.bb02.iad1.tfbnw.net [2620:0:1cff:dead:beee::405]
11 185 ms 183 ms 182 ms ae8.bb04.frc1.tfbnw.net [2620:0:1cff:dead:beef::12ab]
12 175 ms 197 ms 174 ms ae4.dr03.frc1.tfbnw.net [2620:0:1cff:dead:beef::1cb]
13 175 ms 177 ms 176 ms po1020.csw13c.frc1.tfbnw.net [2620:0:1cff:dead:beef::12c5]
14 * * * Esgotado o tempo limite do pedido.
15 175 ms 177 ms 174 ms edge-star6-shv-13-frc1.facebook.com [2a03:2880:2110:df07:face:b00c:0:1]
Trace complete.

IPv4:
C:/Users/Gabriel>tracert facebook.com
Tracing route to facebook.com [173.252.110.27] over a maximum of 30 hops:
1 1 ms 1 ms 1 ms 192.168.1.1
2 6 ms 6 ms 6 ms gvt-l0.b8.can.gvt.net.br [177.41.172.1]
3 7 ms 7 ms 6 ms gvt-24-80.rd01.can.gvt.net.br [200.175.124.193]
4 31 ms 23 ms 23 ms 189.59.253.62.static.host.gvt.net.br [189.59.253.62]
5 26 ms 23 ms 23 ms gvt-te-0-0-2-0-rt01.spo.gvt.net.br [189.59.249.5]
6 23 ms 23 ms 23 ms ae7.br01.gru1.tfbnw.net [103.4.96.112]
7 151 ms 154 ms 151 ms ae37.bb02.iad1.tfbnw.net [204.15.22.110]
8 160 ms 162 ms 160 ms ae8.bb02.frc1.tfbnw.net [31.13.24.46]
9 168 ms 168 ms 168 ms ae2.dr04.frc1.tfbnw.net [31.13.27.82]
10 * * * Esgotado o tempo limite do pedido.
11 * * * Esgotado o tempo limite do pedido.
12 160 ms 160 ms 160 ms edge-star-shv-13-frc1.facebook.com [173.252.110.27]

4.2. Ping

4.2.1. www.google.com

IPv6:
C:/Users/Gabriel>ping -6 google.com
Pinging google.com [2800:3f0:4001:802::1006] with 32 bytes of data:
Reply from 2800:3f0:4001:802::1006: tempo=298ms
Reply from 2800:3f0:4001:802::1006: tempo=304ms
Reply from 2800:3f0:4001:802::1006: tempo=307ms
Reply from 2800:3f0:4001:802::1006: tempo=303ms

Ping statistics for 2800:3f0:4001:802::1006: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 298ms, Maximum = 307ms, Average = 303ms

IPv4:
C:/Users/Gabriel>ping google.com
Pinging google.com [74.125.234.100] with 32 bytes of data:
Reply from 74.125.234.100: bytes=32 tempo=23ms TTL=55
Reply from 74.125.234.100: bytes=32 tempo=23ms TTL=55
Reply from 74.125.234.100: bytes=32 tempo=23ms TTL=55
Reply from 74.125.234.100: bytes=32 tempo=23ms TTL=55
Ping statistics for 74.125.234.100: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 23ms, Maximum = 23ms, Average = 23ms

4.2.2. www.wikipedia.com

IPv6:
C:/Users/Gabriel>ping -6 wikipedia.com
Pinging wikipedia.com [2620:0:860:ed1a::1] with 32 bytes of data:
Reply from 2620:0:860:ed1a::1: tempo=275ms
Reply from 2620:0:860:ed1a::1: tempo=280ms
Reply from 2620:0:860:ed1a::1: tempo=274ms
Reply from 2620:0:860:ed1a::1: tempo=274ms
Ping statistics for 2620:0:860:ed1a::1: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 274ms, Maximum = 280ms, Average = 275ms

IPv4:
C:/Users/Gabriel>ping wikipedia.com
Pinging wikipedia.com [208.80.152.201] with 32 bytes of data:
Reply from 208.80.152.201: bytes=32 tempo=178ms TTL=53
Reply from 208.80.152.201: bytes=32 tempo=178ms TTL=53
Reply from 208.80.152.201: bytes=32 tempo=179ms TTL=53
Reply from 208.80.152.201: bytes=32 tempo=178ms TTL=53
Ping statistics for 208.80.152.201: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 178ms, Maximum = 179ms, Average = 178ms

4.2.3. br.youtube.com

IPv6:
C:/Users/Gabriel>ping -6 br.youtube.com
Pinging youtube-ui.l.google.com [2607:f8b0:400c:c03::5b] with 32 bytes of data:
Reply from 2607:f8b0:400c:c03::5b: tempo=200ms
Reply from 2607:f8b0:400c:c03::5b: tempo=190ms
Reply from 2607:f8b0:400c:c03::5b: tempo=203ms
Reply from 2607:f8b0:400c:c03::5b: tempo=185ms
Ping statistics for 2607:f8b0:400c:c03::5b: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 185ms, Maximum = 203ms, Average = 194ms

IPv4:
C:/Users/Gabriel>ping br.youtube.com
Pinging youtube-ui.l.google.com [74.125.234.99] with 32 bytes of data:
Reply from 74.125.234.99: bytes=32 tempo=23ms TTL=55
Reply from 74.125.234.99: bytes=32 tempo=24ms TTL=55
Reply from 74.125.234.99: bytes=32 tempo=24ms TTL=55
Reply from 74.125.234.99: bytes=32 tempo=24ms TTL=55
Ping statistics for 74.125.234.99: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 23ms, Maximum = 24ms, Average = 23ms

4.2.4. br.yahoo.com

IPv6:
C:/Users/Gabriel>ping -6 br.yahoo.com
Pinging ds-br-fp3.wg1.b.yahoo.com [2001:4998:f00b:1fe::3000] with 32 bytes of data:
Reply from 2001:4998:f00b:1fe::3000: tempo=151ms
Reply from 2001:4998:f00b:1fe::3000: tempo=150ms
Reply from 2001:4998:f00b:1fe::3000: tempo=150ms
Reply from 2001:4998:f00b:1fe::3000: tempo=150ms
Ping statistics for 2001:4998:f00b:1fe::3000: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 150ms, Maximum = 151ms, Average = 150ms

IPv4:
C:/Users/Gabriel>ping br.yahoo.com
Pinging ds-br-fp3.wg1.b.yahoo.com [200.152.175.146] with 32 bytes of data:
Reply from 200.152.175.146: bytes=32 tempo=22ms TTL=54
Reply from 200.152.175.146: bytes=32 tempo=23ms TTL=54
Reply from 200.152.175.146: bytes=32 tempo=22ms TTL=54
Reply from 200.152.175.146: bytes=32 tempo=22ms TTL=54
Ping statistics for 200.152.175.146: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 22ms, Maximum = 23ms, Average = 22ms

4.2.5. www.facebook.com

IPv6:
C:/Users/Gabriel>ping -6 facebook.com
Pinging facebook.com [2a03:2880:2110:df07:face:b00c:0:1] with 32 bytes of data:
Reply from 2a03:2880:2110:df07:face:b00c:0:1: tempo=165ms
Reply from 2a03:2880:2110:df07:face:b00c:0:1: tempo=166ms
Reply from 2a03:2880:2110:df07:face:b00c:0:1: tempo=166ms
Reply from 2a03:2880:2110:df07:face:b00c:0:1: tempo=165ms
Ping statistics for 2a03:2880:2110:df07:face:b00c:0:1: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 165ms, Maximum = 166ms, Average = 165ms

IPv4:
C:/Users/Gabriel>ping facebook.com
Pinging facebook.com [173.252.110.27] with 32 bytes of data:
Reply from 173.252.110.27: bytes=32 tempo=161ms TTL=81
Reply from 173.252.110.27: bytes=32 tempo=161ms TTL=81
Reply from 173.252.110.27: bytes=32 tempo=161ms TTL=81
Reply from 173.252.110.27: bytes=32 tempo=162ms TTL=81
Ping statistics for 173.252.110.27: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss).
Approximate round trip times in milli-seconds: Minimum = 161ms, Maximum = 162ms, Average = 161ms

4.3. Analysis

Based on these tests, it can be seen that in most cases, the route with the highest number of hops is always the IPv6 route (except in the case of Wikipedia, where IPv4 had more hops). As for latency, also based on these tests it can be seen that sites with IPv6 have higher latency than those with IPv4.

5. Conclusion

Based on the study of the problem and the performance tests carried out on the network, although IPv6 has several positive points in relation to IPv4, it is currently still slower than its predecessor. This could be the result of several factors, one of which would be the fact that there are fewer routers with IPv6 than IPv4 and as the protocol has not yet become widely used, its data propagation technologies may not be able to reach your target. peak.

Finally, currently using an IPv6 network via Tunnel Broker only has disadvantages, in terms of performance, compared to an IPv4 network. However, with the passage of time and the popularization of IPv6, these results will probably change for the better, making IPv6 a much more efficient protocol than IPv4.

References

1. WIKIPEDIA. IPv6. Available in: . 2013.
2. GOGO6. freenet6. Available in: . 2013.
3. CEPTRO. Túnel via Freenet 6. Available in: . 2013.
4. SIXXS. SixXS IPv6-IPv4 and IPv4-IPv6 Website Gateway/Proxy. Available in: . 2013.
5. HURICANE ELECTRIC INTERNET SERVICES. Hurricane Electric IPv6 Tunnel Broker. Available in: . 2013.
6. TUTORIAIS WEB. IPv6 - Tunnel Broker. Available in:. 2013.
7. BERGAMIN, E.; FERREIRA, J. O. IPv6 - Tunnel Broker. Available in: . 2013.
8. NRO. Internet Number Resource Status Report. Available in: . 2013.
9. NRO. Internet Number Resource Status Report. Available in: . 2013.

10. NRO. Internet Number Resource Status Report. Available in: . 2013.

11. NRO. Internet Number Resource Status Report. Available in: . 2013.