Thursday, June 16, 2016, 12:00 - 12:45
IPv6 Business Conference, Sihlcity, Zürich

Performance Benchmarking in Switzerland and IPv6

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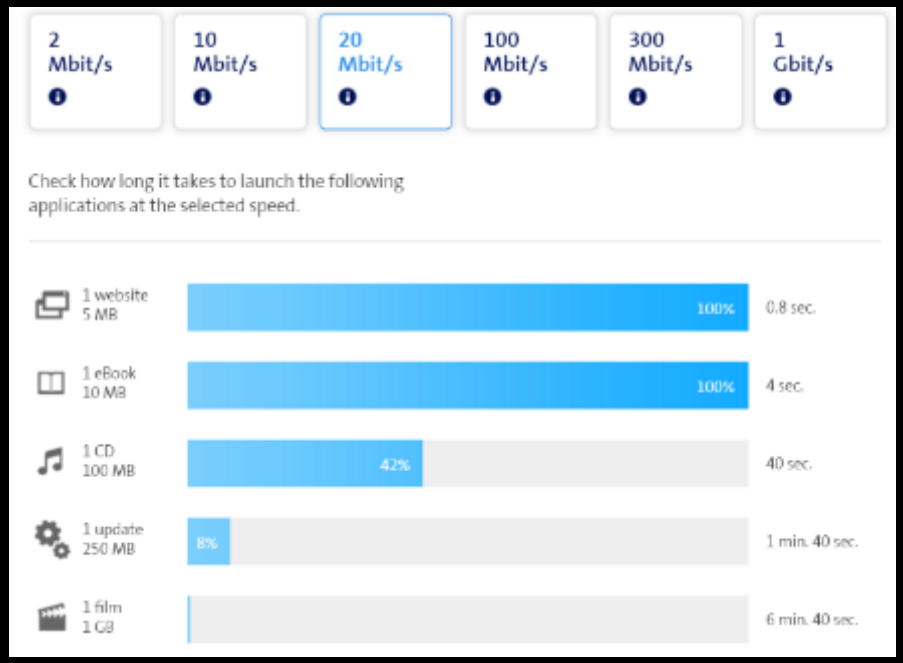
Internet Service Providers Advertise “Speed”: Upload and Download Data Rate

www.upc.ch/en/internet/subscriptions



www.swisscom.ch/en/residential/internet/speed.html

Users Want to Check their Speed

cnlab

information technology research | performance | software | security

Performance

Products and services
- Speedtest
- Performance Monitoring
- Application Benchmarking
- Performance Engineering

Publications

Performance FAQ & Wiki

About cnlab Performance
- Crew
- Customers
- Contact
- Milestones

cnlab performance

Performance is one of the differentiating qualities of Internet service providers. A high end-to-end performance requires an excellent network infrastructure (including peering), appropriate server platforms and efficient applications. Cnlab AG offers performance analysis services as well as periodic (long term) performance measurement systems, both at network and at server (application) level. A good example for our publicly available benchmarking services is our Performance Test.

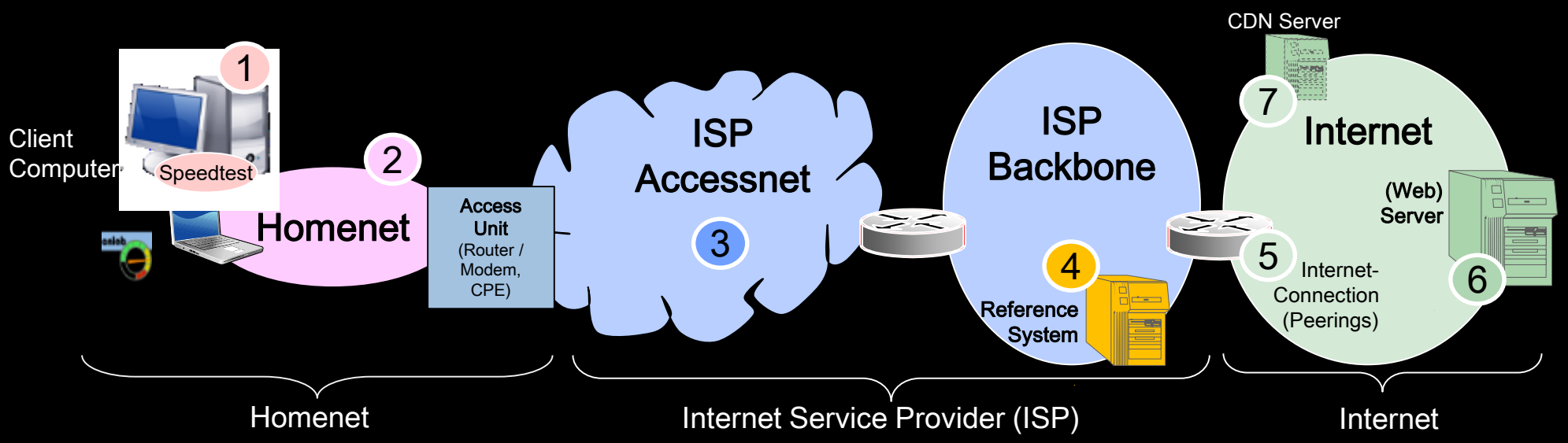
swisscom
upc
Sunrise
colt
WZ
green.ch
Rii-Seez-Net
thurcom
leucom
net+
TELECOM Liechtenstein

Agenda

1. Performance Benchmarking with Speedtests
2. Personal Accessnet Benchmarking (PAB) and IPv6
3. Controlled Accessnet Benchmarking (VAB) and IPv6
4. Performance Benchmarking and «User Experience»
5. Conclusion

1. Performance Benchmarking with Speedtests

Performance Pinpoints



Homenet

1. Client Computer
- Parallel Processes (Background Traffic)
- Operating System, Browser, Software, Hardware Limitations
- Ethernet Interface Settings (100Mbit/s or 1Gibt/s Data Rate, Duplexmode)

2. Homenet
- WLAN Data Rate Limitations
- WLAN Load by Other Users
- WLAN Radio Interference
- Network Component Limitations (Router WAN-LAN Throughput)
- Buffer Problems 1Gbit/s-100Mbit/s (in Switches)
- Ethernet Interface Settings
- Ethernet Cables (4-Wire Cable)
- Usage by other computer users in the network (PC, Mobile, Tablet)
- Digital TV Sets (xDSL)

ISP

3. Accessnet
- Configuration Errors (Account Settings)
- Overload (Cell, DSLAM/CMTS or Backbone Connections)
- Interfrence, Noise (Cablenet)
- Cable Length (xDSL)
- Aceess Unit (CPE, Router/Modem)

4. Reference System & Backbone
- Data Rate Control Settings
- Capacity (Overload), Location

Internet

5. Connections, Peerings
- Overload at ISP-to-Internet
- Overload on International Links
- Overload on Network Devices)

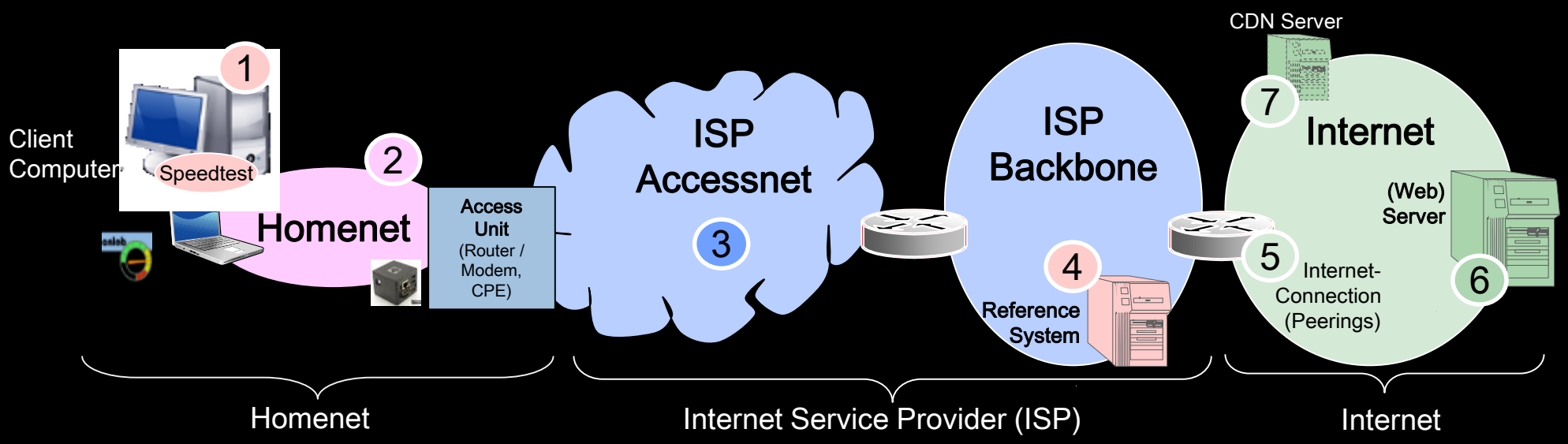
6. Webserver
- Overload
- Data Rate Limitations
- Configuration (Congestion Control, Window Scaling)

7. Content Distribution (CDN)
- Capacity
- Server Assignments

Performance Parameters to Check (to Define) when you Run a Speedtest

- **Download and Upload Data Rate**
  - Reference Server location
  - Measurement duration
  - File type (compressable)
  - Number of parallel TCP streams
  - TCP congestion control schemes
  - TCP window size schemes
- **Response Time**
  - ICMP
  - TCP connect time
- Packet loss
- DNS Response Time
  - 1st request
  - 2nd request after x seconds (expected from DNS caches)
- Reference System Access
  - IPv4 and IPv6
  - http, http2.0
  - https

Speedtests: Solutions



Client Side Tests

Browser
- with Flash (Ookla)
- with Java Applet (cnlab)
- with HTML5/JavaScript (cnlab, …)

PC Programs (cnlab)

Mobile Apps (Ookla, cnlab, …)

Probes

cnlab Controlled Accessnet Benchmarking (CAB)

Access Unit Tests

ISP

Monitoring Software

Internet Backbone Probes

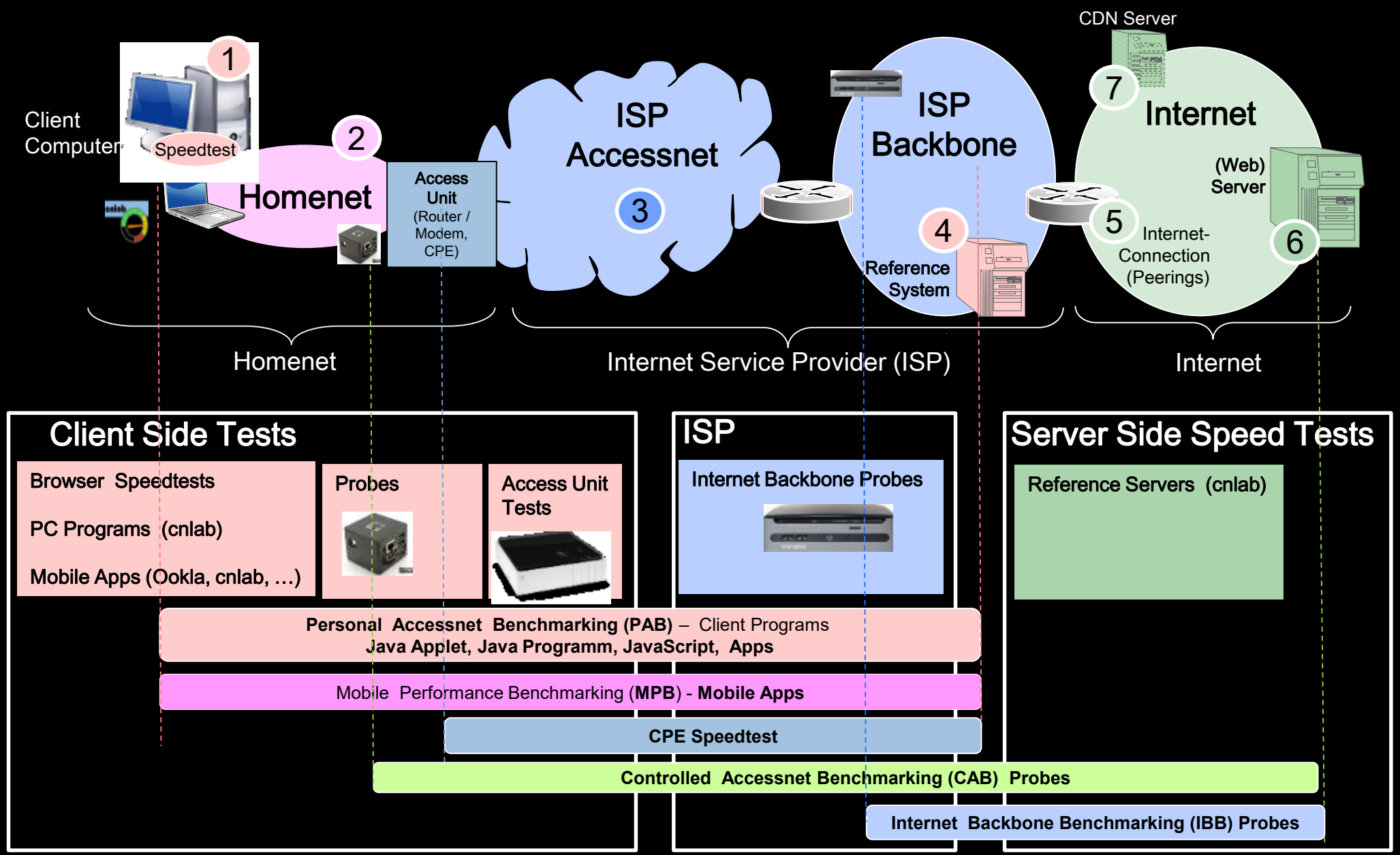
- Cnlab Internet Backbone Benchmarking
- Cnlab Page Load Time Benchmarking

Server Side Speed Tests

Reference Servers (cnlab)

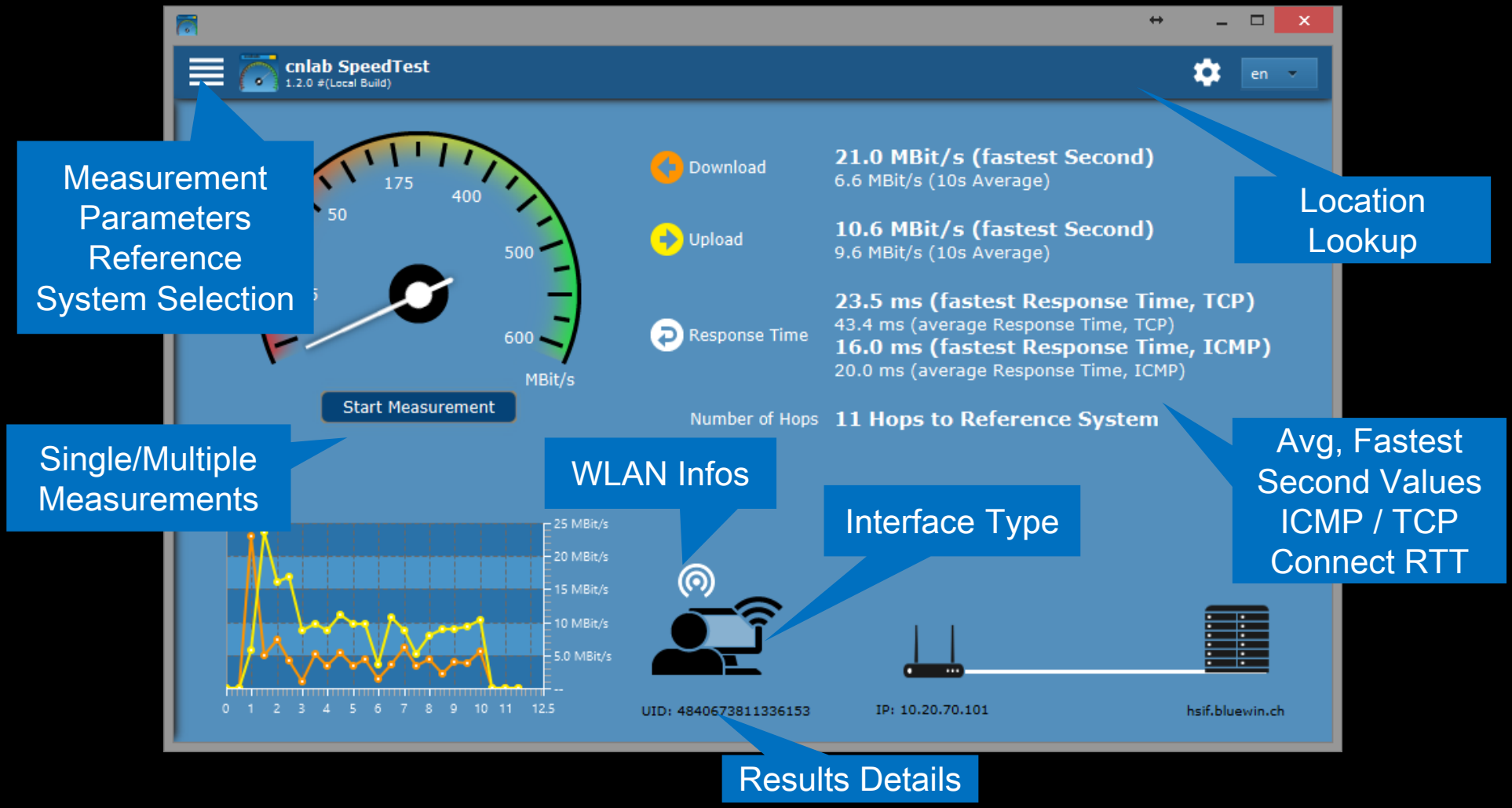
Performance Monitoring Servers
- YouTube
- Akamai
- Netflix
- ….

Speedtests: Network / System Coverage



2. Cnlab Personal Accessnet Benchmarking (PAB) and IPv6

speedtest.cnlab.ch hsi.bluewin.ch hsi.upc.ch speed.sunrise.ch



Personal Data Analysis and Helpdesk Support

cnlab **Internet Performance Benchmark - your Results**

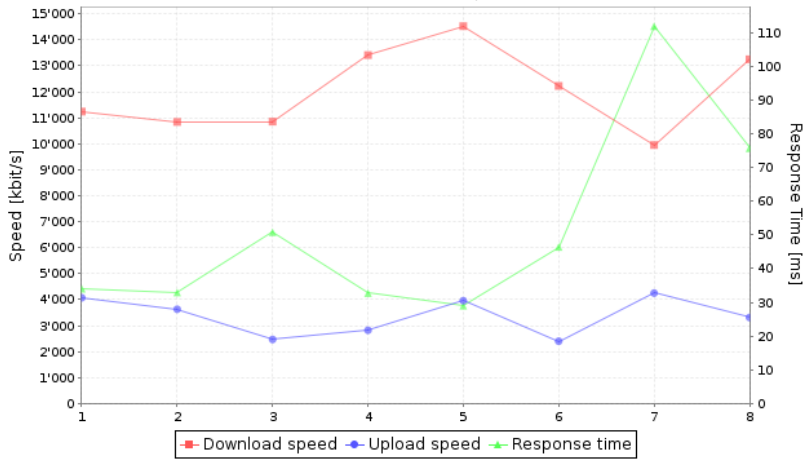
Sequence | Chronological sequence | Daytime sequence | Map | Test Details

Overview

Sequence

Number of measurements carried out: 8 (15-06-2016 23:56:44 - 16-06-2016 00:07:42)

Reference Server: hsi.upc.ch



	Minimum	Average	Maximum
Download speed [kbit/s]	9'953	12'040	14'533
Upload speed [kbit/s]	2'400	3'367	4'253
Response Time (Round Trip Time, RTT) [ms]	29.0	51.7	112.0

Filter

Only measurements with the following data:

Start: End:

Series: hsi.upc.ch (Serie 10) | Domain: - | Connection Type: - | Connected via: -

Apply Filter | Clean Filter

Export displayed measurements: Excel(CSV)-Format , TXT-Format

Data for measurement of 16-06-2016 00:07:42

Client ID (UID): 9165532511842330624

Reference Server: hsi.upc.ch

Your data

Connection Type: Cable

Connection Speed: other

Connected via: Other

Technical date of your system

Operating System:	Windows 10
Browser:	Firefox
Java:	1.8.0_91-b14 (Oracle Corporation)
Performance Test Version:	1.3.0-34551c2
Public IP Address:	62.2.156.88 (Provider: cnlab)
Local IP:	10.20.30.61 (4C:34:88:88:45:96)
Default Gateway:	192.168.192.1 (20:d5:bf:83:1d:b9)
DNS Server:	automatix.cnlab.ch (10.20.30.32)
Network Interface Speed:	104 Mbit/s (Connected via WLAN)

WLAN

Chip:	Intel(R) Dual Band Wireless-AC 7265
Radio Type:	802.11n
Channel:	11
Signal Pegel:	87
Rec/Trans Rate:	144 / 144 Mbit/s
Client MacAddress:	4c:34:88:88:45:96
Router MacAddress:	5c:a3:9d:b8:21:98

Your TCP options:

Number of download/upload streams: 4/2

Initial Receive Window Size: 16384 (scaled, multiplied by 256)

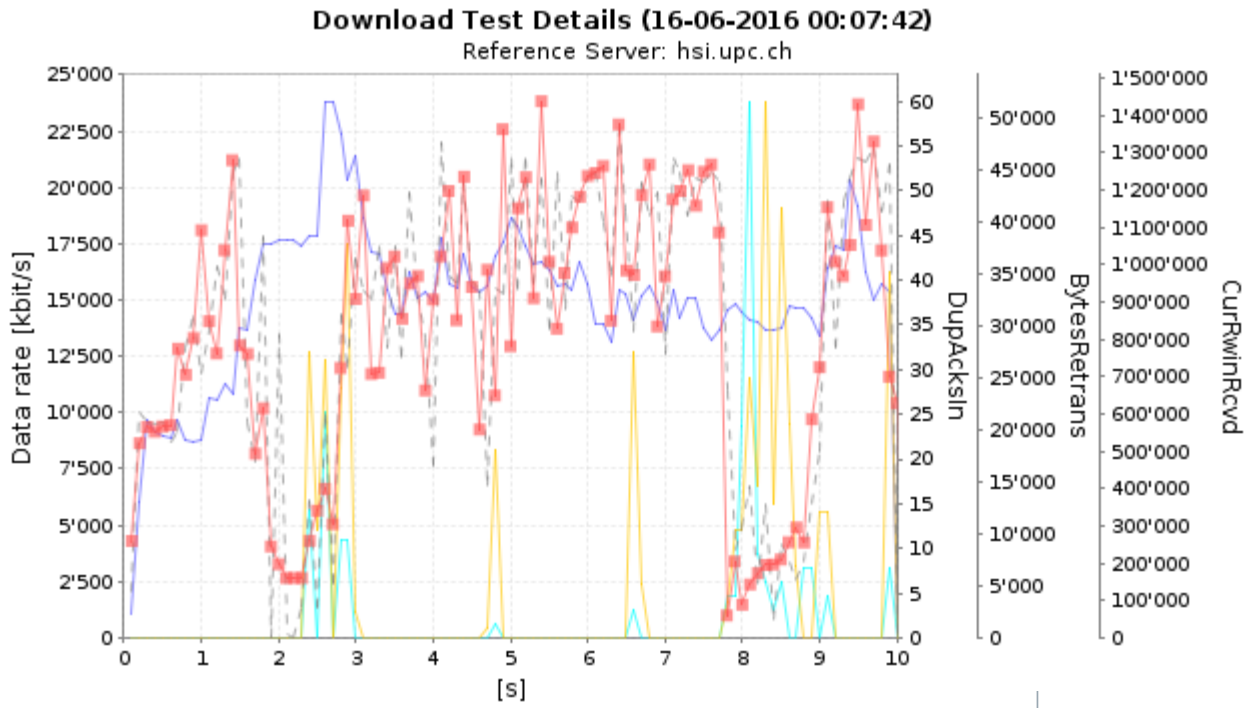
Maximum Segment Size (MSS): 1360

TCP Timestamps Option (TSopt): set

Selective Ack (SACK): set

Test Details for Download Stream: Sum

Show Download Details for Test: 16-06-2016 00:07:42 (Down: 13'253kbit/s, Up: 3'317kbit/s)



Show Web100/Web10G Parameters

Statistic for this measurement:
Reference Server: hsi.upc.ch
Duration of measurement: 10 s
Total of transmitted bytes: 16'743 kBytes
Interval: 100 ms
Period of Longest Download Pause : 1 ms

Per second	Minimum	Average	Maximum	Standard Deviation	Std/AVG
Download speed[kbit/s]	3'016	13'253	19'160	6'228	47 %
Upload speed [kbit/s]	0	3'317	14'047	4'948	149 %
Response time [ms]	30.2	75.7	119.2	-	-

Web100 Parameter:
Data packets (sent by server): 0
ACK packets (received at server side): 0
Data packets / ACK packets ratio: ?
Bytes retransmitted (sent by server): 0 Bytes (Packetloss: 0.0 ‰)

Public Statistics

https://www.cnlab.ch/speedtest/stats.jsp

Ranking by Domain (ISP) | Ranking by Top Level Domain (TLD) | Usage | Connection | Platform

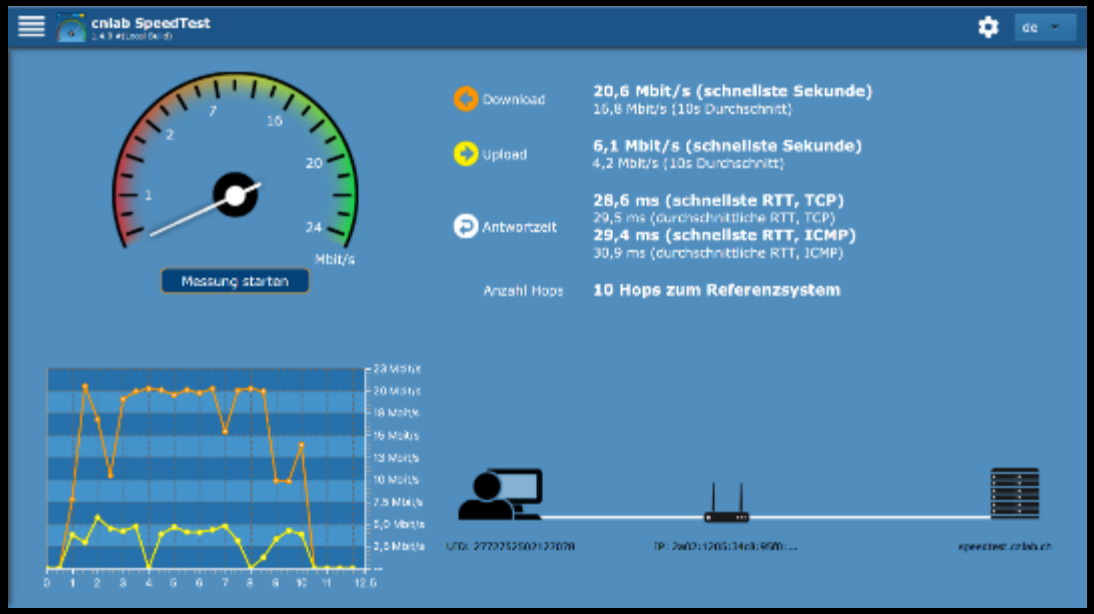
Top domains by download speed (last 30 days)

Rank	Provider		Major Technology	Domain	Average Download [Mbit/s]	Average Upload [Mbit/s]	Up / Down Ratio	Average RTT [ms]	Measurements	Users (>100)	Measurements per User
1	upc cablecom	upc cablecom	Cable	hispeed.ch	**126.0**	18.3	1:7	24	68,596	10,045	6
2		Finecom	Cable	fcom.ch	**93.4**	12.4	1:8	14	1,506	253	5
3	WZ	WWZ	Cable	datazug.ch	**80.5**	11.5	1:7	17	1,051	261	4
4	Citycable	citycable	Cable	lsne.ch	**56.2**	2.6	1:21	16	850	191	4
5		flashcable	Cable	flashcable.ch	**54.9**	11.1	1:5	19	5,177	105	49
6	green.ch	Green	DSL	green.ch	**34.3**	6.5	1:5	29	565	137	4
7	swisscom	Swisscom	DSL	swisscom.ch	**32.9**	14.5	1:2	29	50,742	9,710	5
8	Sunrise	Sunrise	DSL	adslplus.ch	**30.8**	14.2	1:2	25	8,849	1,414	6
9		vodafone	DSL	vodafone-ip.de	**24.5**	7.0	1:4	32	5,829	125	46
10		Deutsche Telekom	DSL	t-ipconnect.de	**22.2**	7.3	1:3	38	1,805	112	16

(*) Only Domains with more than 100 users are listed.

appr. 200’000 measurements per month

Measurement to cnlab IPv6 Reference System with Swisscom Vivo S (20/4 Mbit/s) Account, Rapperswil

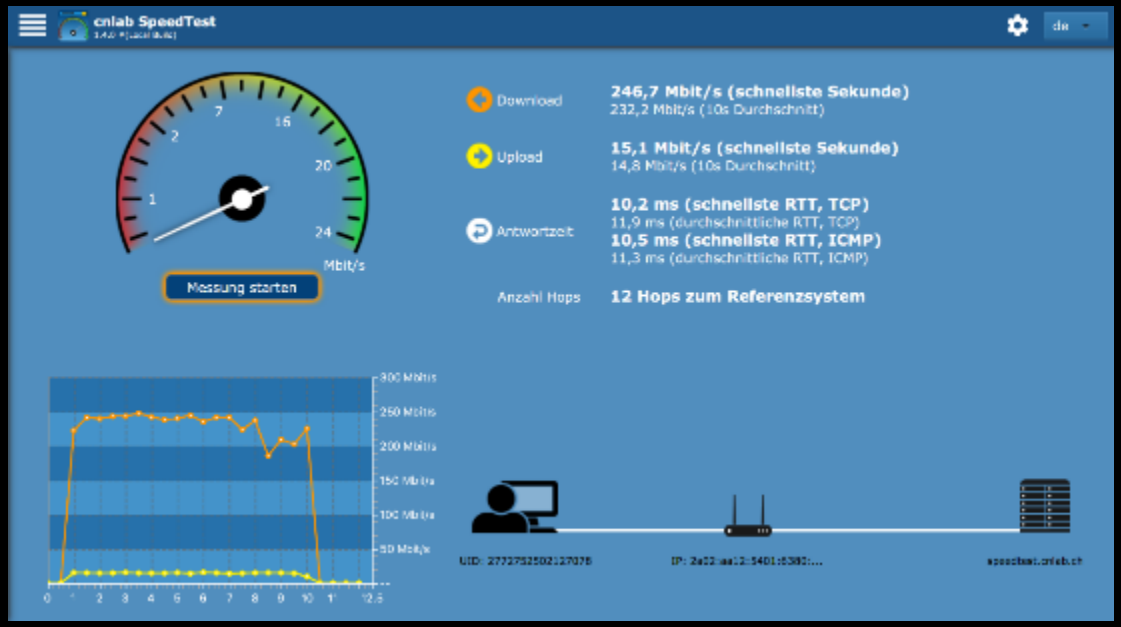


Swisscom
appr. 60% of probes do run IPv6 tests

ch.cnlab.speedtest.library.data.traceroute: hopCount: 10

1 internetbox.home	[2a02:1205:34c8:95f0:7eb7:33ff:fe9e:df3b]	0.5 ms
2 ae60-60.ipc-lss690-m-pe-48.bluewin.ch	[2001:4d98:bffd:1e::2]	24.3 ms
3 ae60-60.ipc-lss690-m-pe-48.bluewin.ch	[2001:4d98:bffd:1e::2]	24.8 ms
4 be11-v6.i68geb-025.bb.ip-plus.bluewin.ch	[2001:4d98:bffd:1b::3]	28.0 ms
5 zhh-005-lo0-0.ip6.ip-plus.net	[2001:918:100:1::1]	27.2 ms
6 zhb-001-loo191.ip6.ip-plus.net	[2001:4d98:a000::46]	28.5 ms
7 ipp-nlai-ch-rap-r-001-gig0-0-0.ce.ip-plus.net	[2001:918:10b:1::67]	29.1 ms
8 2001:918:ff68::2	[2001:918:ff68::2]	28.9 ms
9 ipp-nlai-ch-rap-r-001-gig0-0-0.ce.ip-plus.net	[2001:918:10b:1::67]	29.9 ms
10 2001:918:ff68:1::3	[2001:918:ff68:1::3]	29.3 ms

Measurement to cnlab IPv6 Reference System with UPC Internet 250 (250/15 Mbit/s) Account, Rapperswil



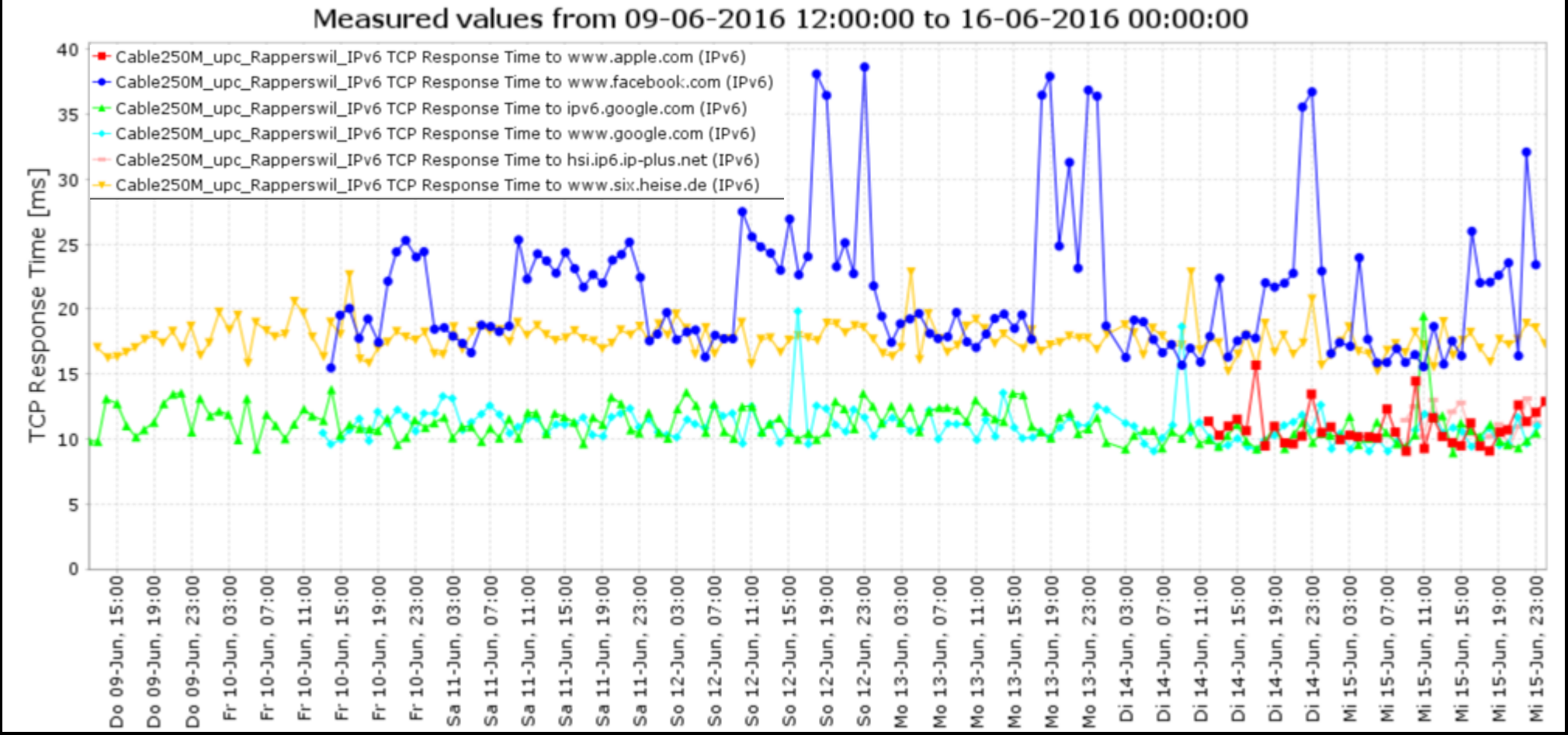
upc
appr. 15% of users
with IPv6 DS-Lite

ch.cnlab.speedtest.library.data.traceroute: hopCount : 12

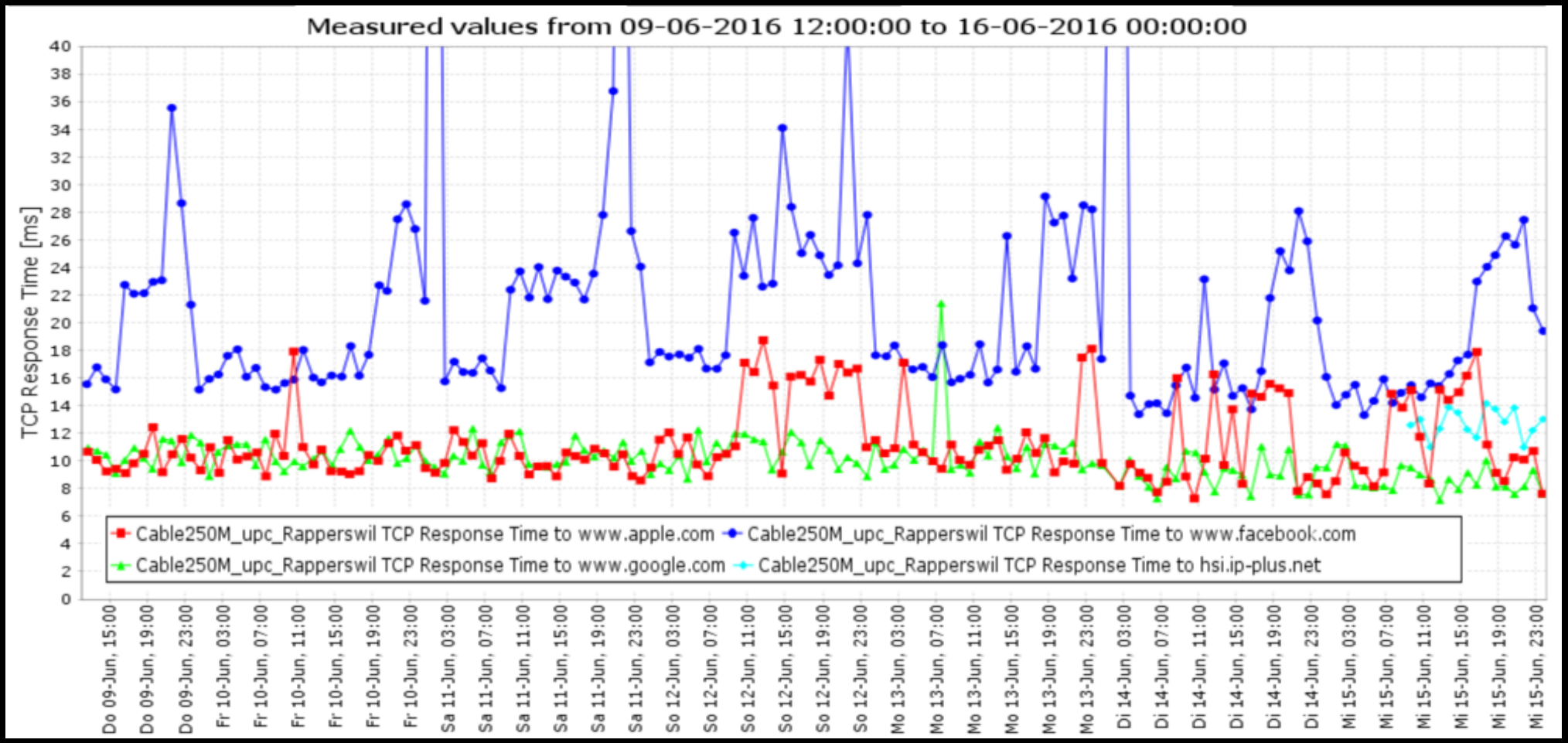
1 2a02:aa12:5401:6380:4632:c8ff:fe1d:cb82 [2a02:aa12:5401:6380:4632:c8ff:fe1d:cb82] 0.5 ms
2 n/a [n/a]
3 2a02:aa00:2:5401::1 [2a02:aa00:2:5401::1] 8.2 ms
4 2001:730:2700::5474:806d 2001:730:2700::5474:806d] 8.4 ms
5 2001:730:2700::5474:800a [2001:730:2700::5474:800a] 7.8 ms
6 tix-035-xe-5-1-1-0.ip6.ip-plus.net [2001:4d98:a000::74] 8.8 ms
7 zhb-025-loo191.ip6.ip-plus.net [2001:4d98:a000::2] 8.5 ms
8 zhb-010-loo6.ip6.ip-plus.net [2001:918:100:10b::1] 9.5 ms
9 zhb-001-loo191.ip6.ip-plus.net [2001:4d98:a000::46] 8.2 ms
10 ipp-nlai-ch-rap-r-001-gig0-0-0.ce.ip-plus.net [2001:918:10b:1::67] 10.7 ms
11 2001:918:ff68::2 [2001:918:ff68::2] 10.0 ms
12 2001:918:ff68:1::3 [2001:918:ff68:1::3] 10.1 ms

3. Cnlab Controlled Accessnet Benchmarking (CAB) and IPv6

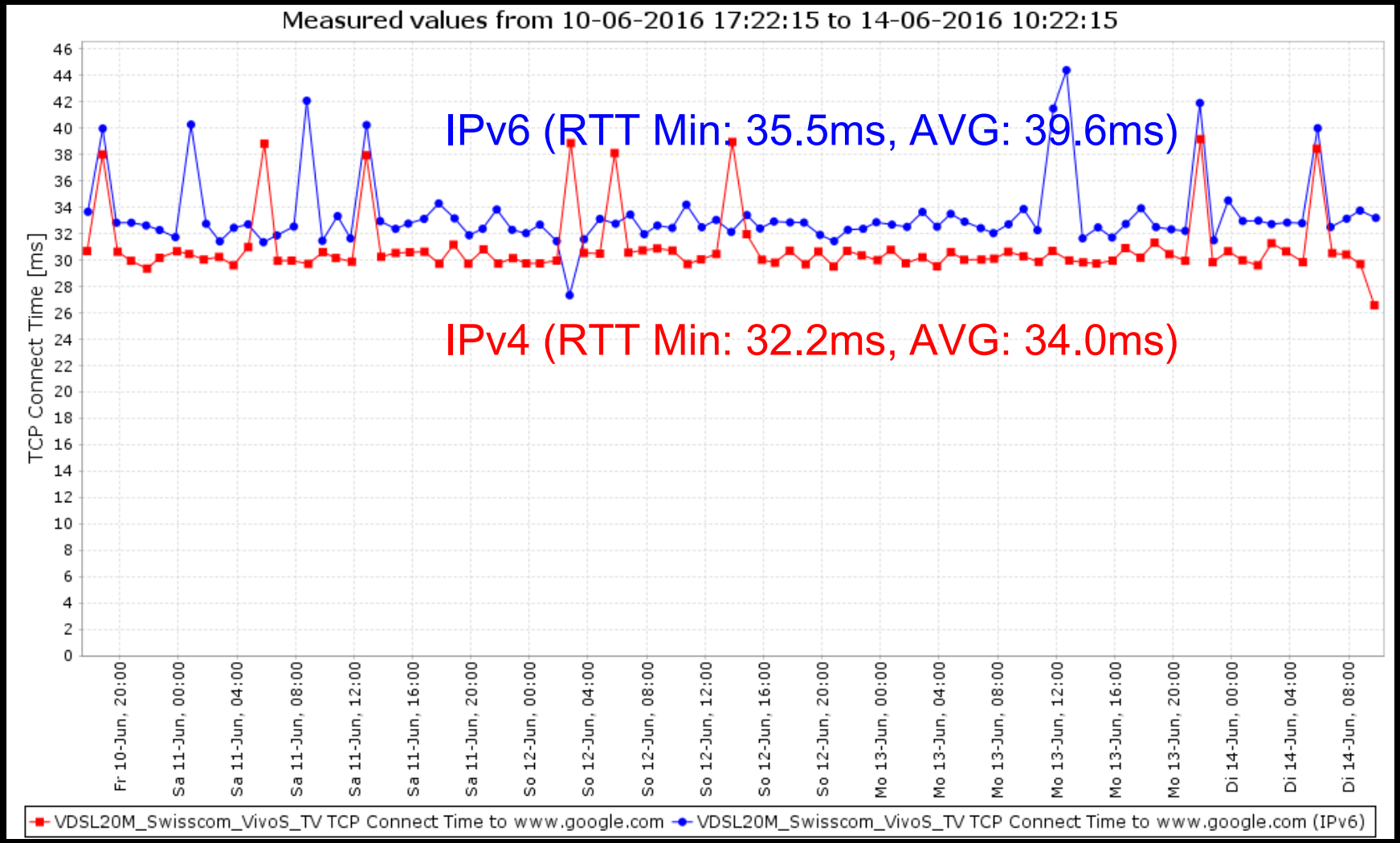
RTT with IPv6: Cable250M_upc to apple, facebook, google, ip-plus, heise



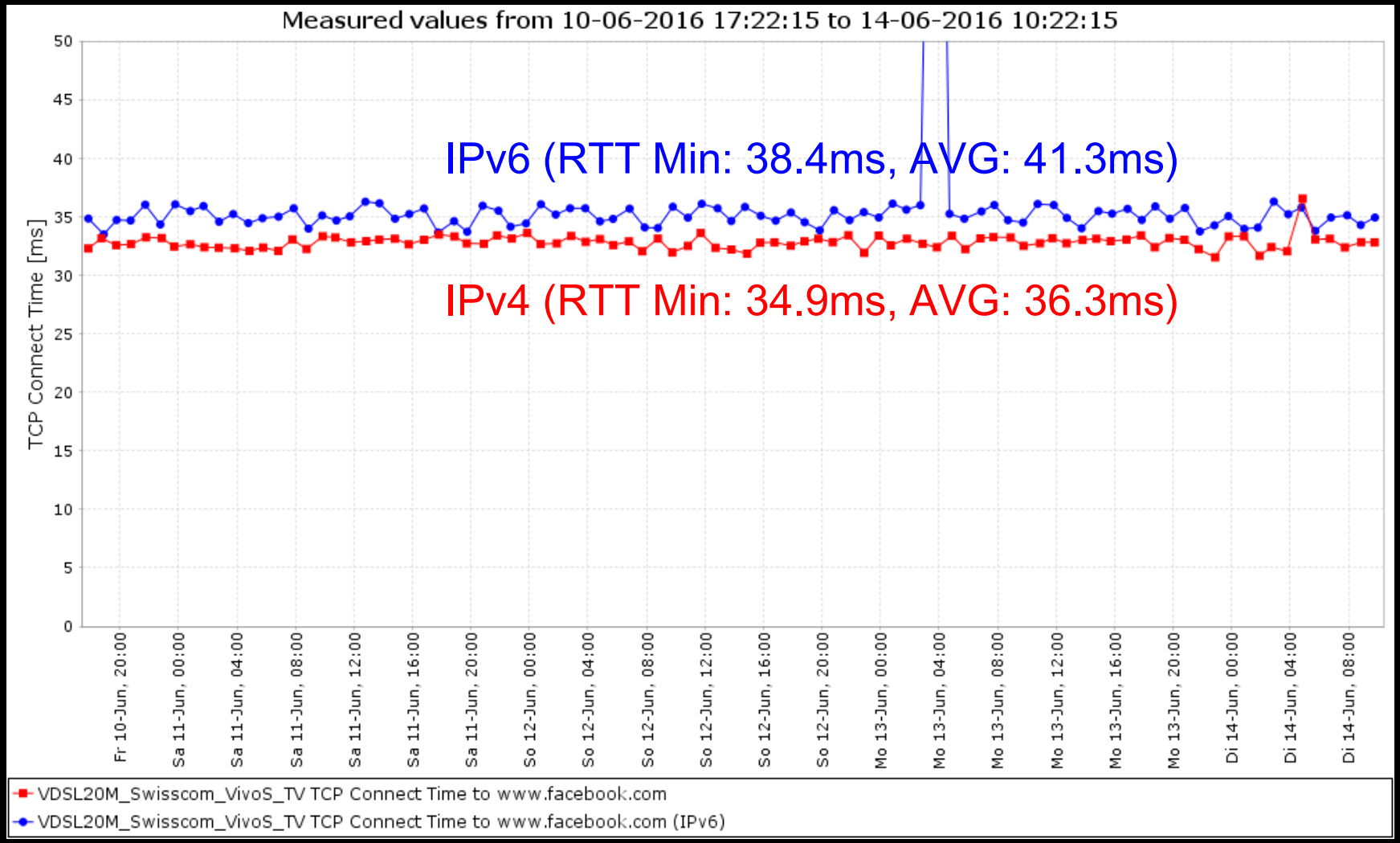
RTT with IPv4: Cable250M_upc to apple, facebook, google, ip-plus



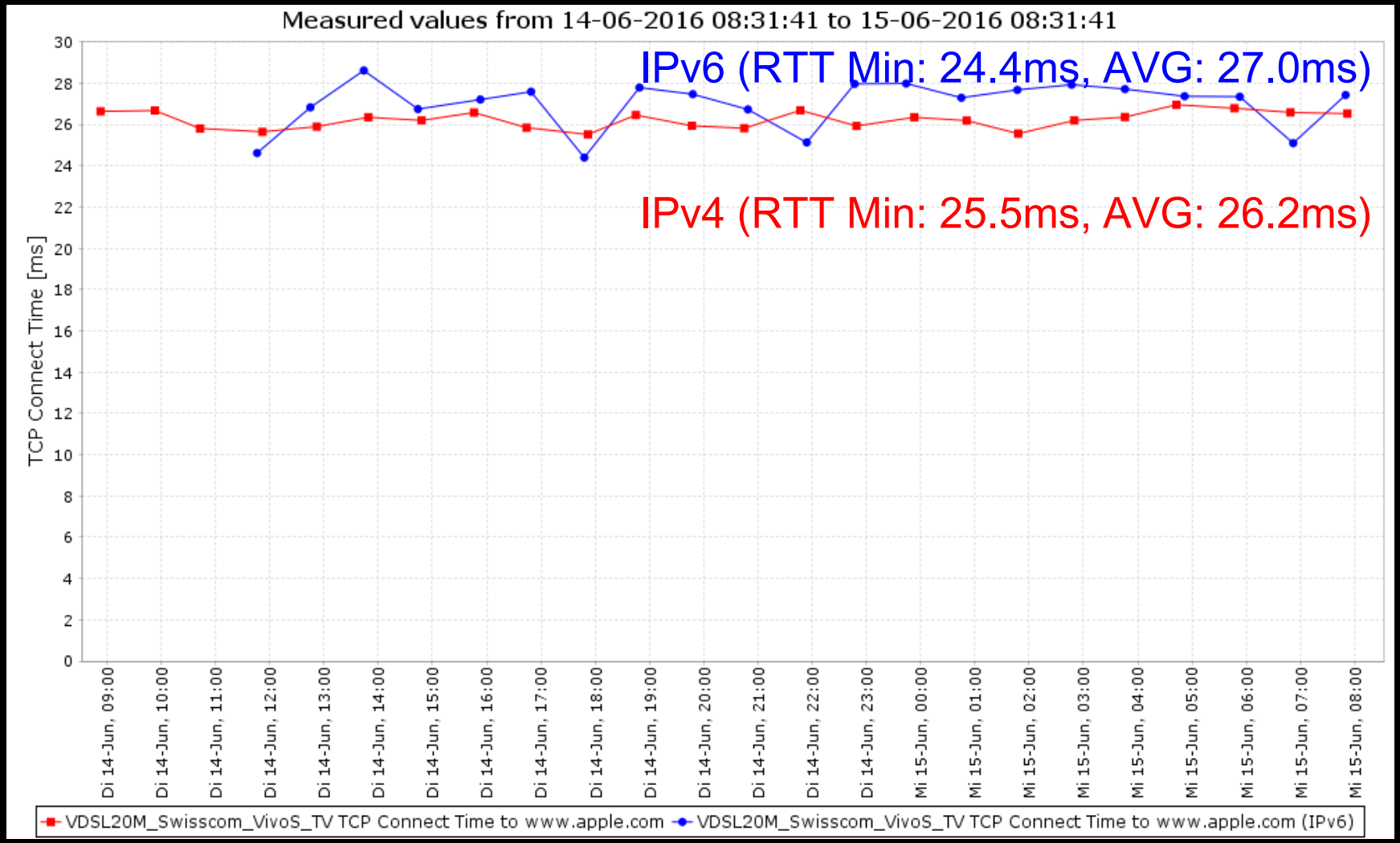
RTT with IPv4 vs. IPv6: DSL20M_Swisscom_VivoS to www.google.com



RTT with IPv4 vs. IPv6: DSL20M_Swisscom_VivoS to www.facebook.com



RTT with IPv4 vs. IPv6: DSL20M_Swisscom_VivoS to www.apple.com



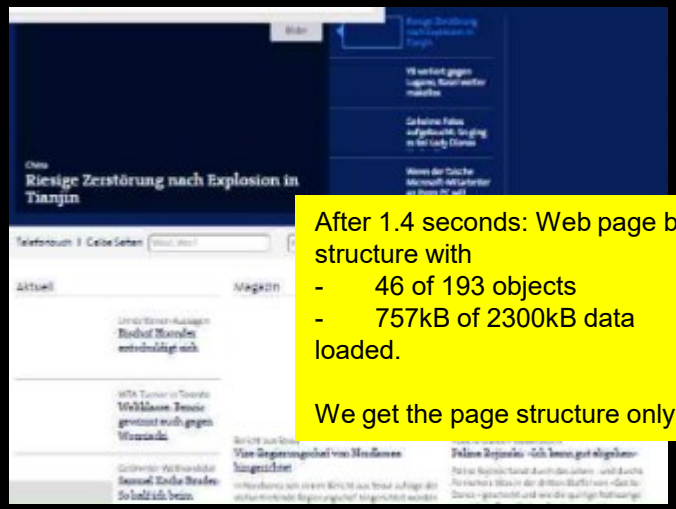
4. Performance Benchmarking and „User Experience“

User Experience and Use Cases

- **Surfing:** Page Load time (PLT): RTT, R_down, Peering, CDN, Web-Page Design, protocol, Browser, Rechner
  - Subsecond response time needed
  - Extra 1sec delay leads to 11% fewer page views and 16% decrease in customer satisfaction
  - Take into account the tends in faster web protocol developments (HTTP2.0).
- **Streaming Services** (e.g. YouTube): R_down and Packet Loss
  - Player adapts video quality to channel quality
  - Interruptions are most disturbing
  - Pause, Forward, Backword control; Zapping
- **VoIP:** RTT, Packet Loss
  - Voice Quality: Subjective quality measures (mean opinion score, MOS)
  - Conversation Qualtiy: conversation problems with RTT > 200 … 800ms
- **Cloud Services:** R_down and R_up
  - Higher upload data rate i.e. symmetrical speed may be needed (cloud storage)
- **Gaming:** RTT
  - Bild Erneuerungsfrequenz / Tick Rate 100Hz (10ms)
  - Lag Compensation zum Ausgleich unterschiedlicher Antwortzeiten der verschiedenen Spieler
  - «Professional Gamer» expect RTT < 60ms

Web Page Load Time (PLT)

for a Webpage with 193 Objects with a total of 2.3MB Data



After 1.4 seconds: Web page basic structure with
- 46 of 193 objects
- 757kB of 2300kB data loaded.

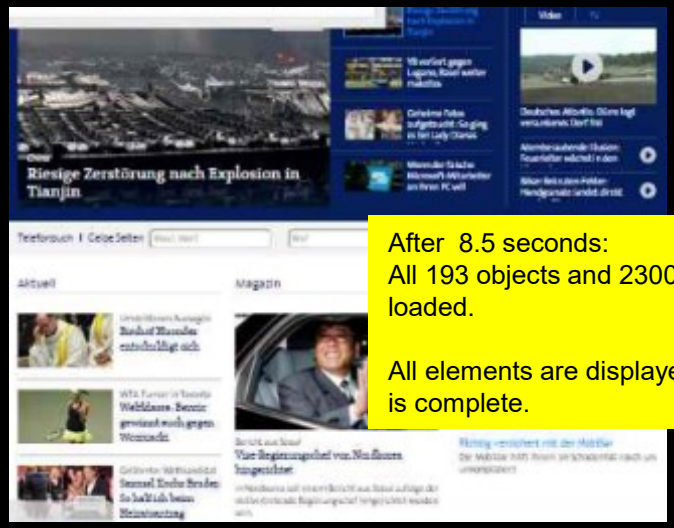
We get the page structure only.

After 4.2 seconds:
- 80 of 193 objects
- 1100kB of 2300kB data loaded.

We see some images but there is still much missing.

After 7.6 seconds:
- 175 of 193 objects
- 2200kB of 2300kB data loaded.

The page is usable..

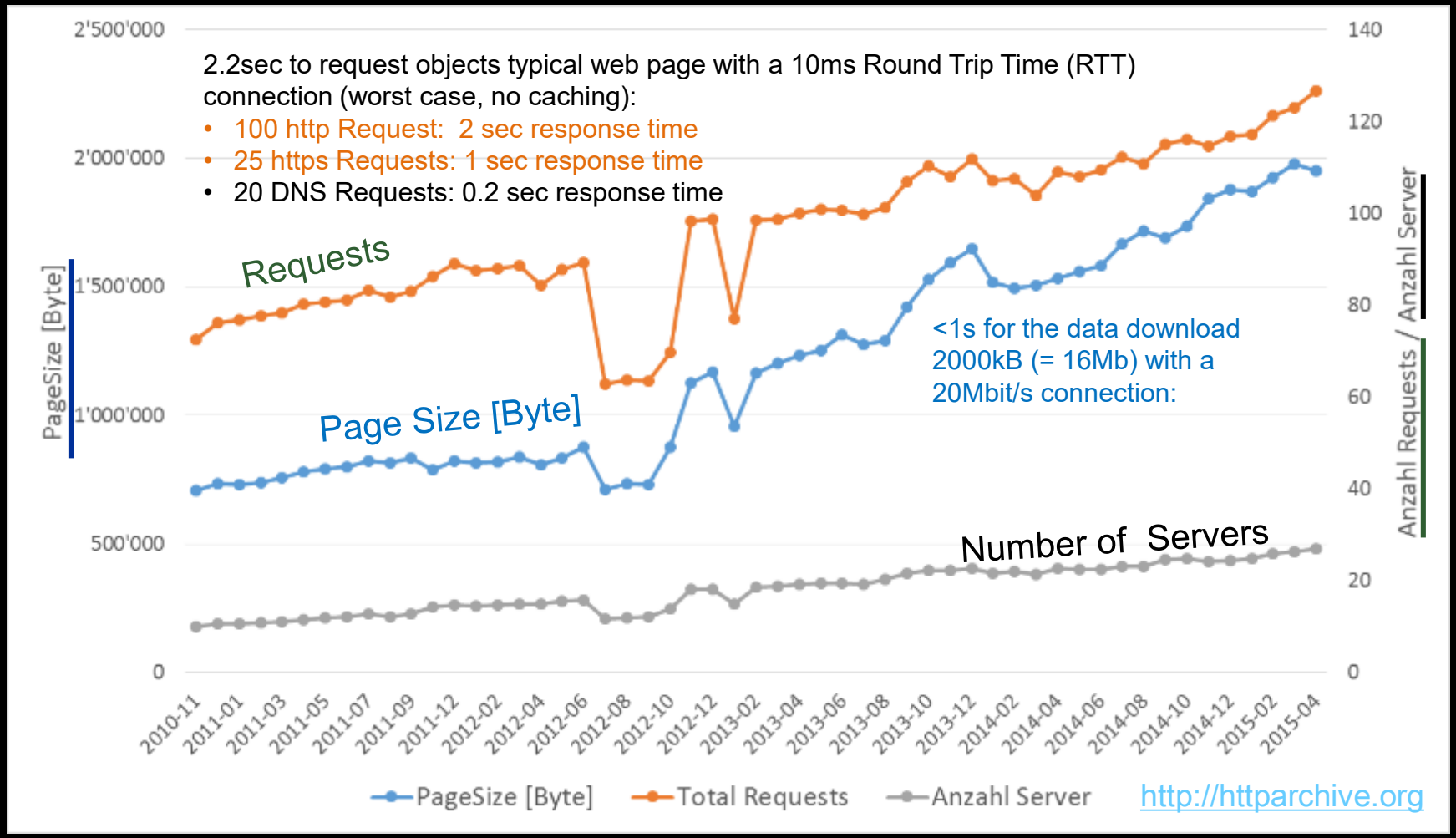


After 8.5 seconds:
All 193 objects and 2300kB data loaded.

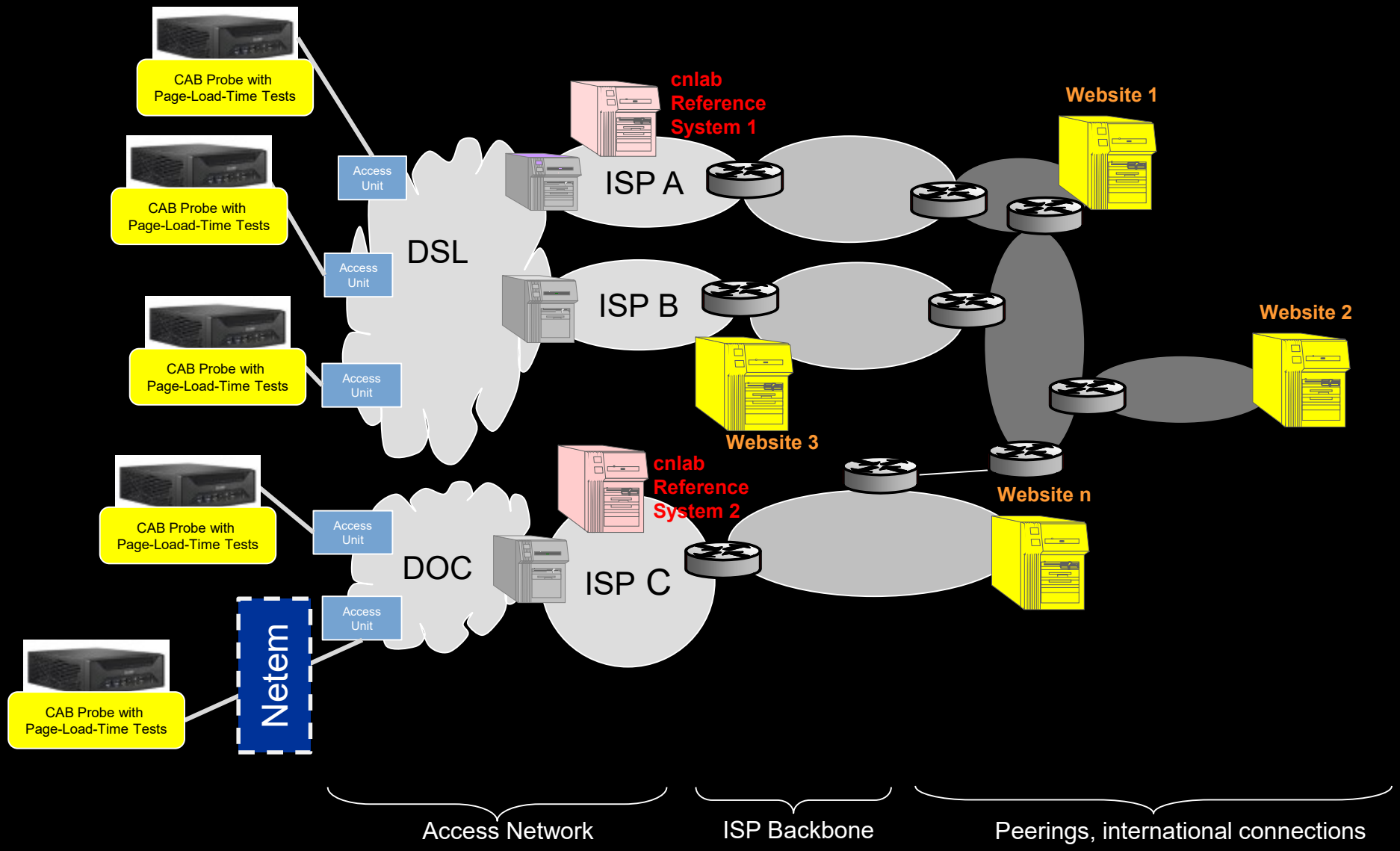
All elements are displayed., page is complete.

Evolution of Web Page Structure

Number of http/https Requests (Objects), Page Size [kB] and Number of Servers

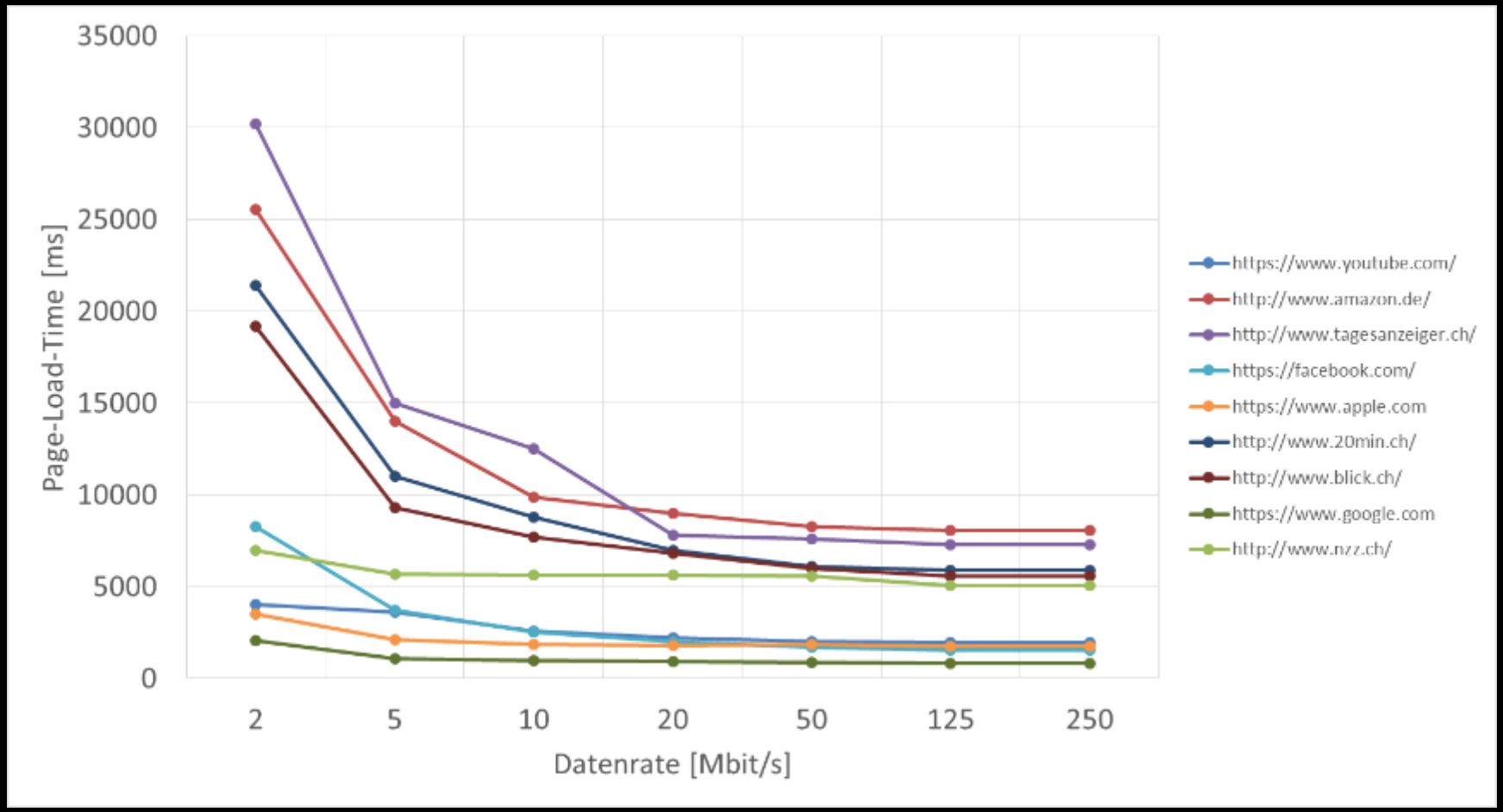


Setup Page-Load-Time Measurements



Media Sites Page Load Time (PLT) and Download Data Rate

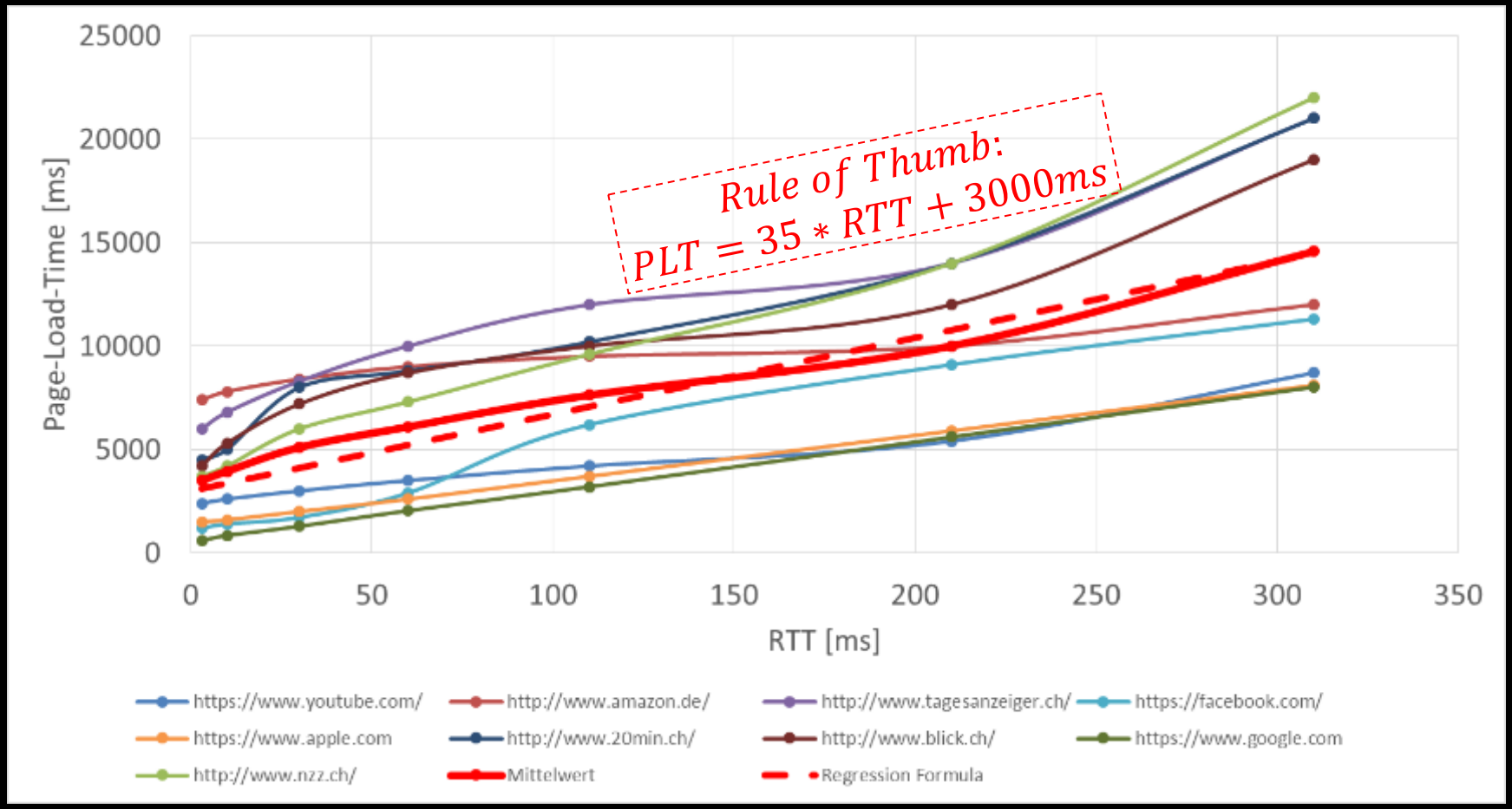
(Netemulator Measurements at 250Mbit/s Account)



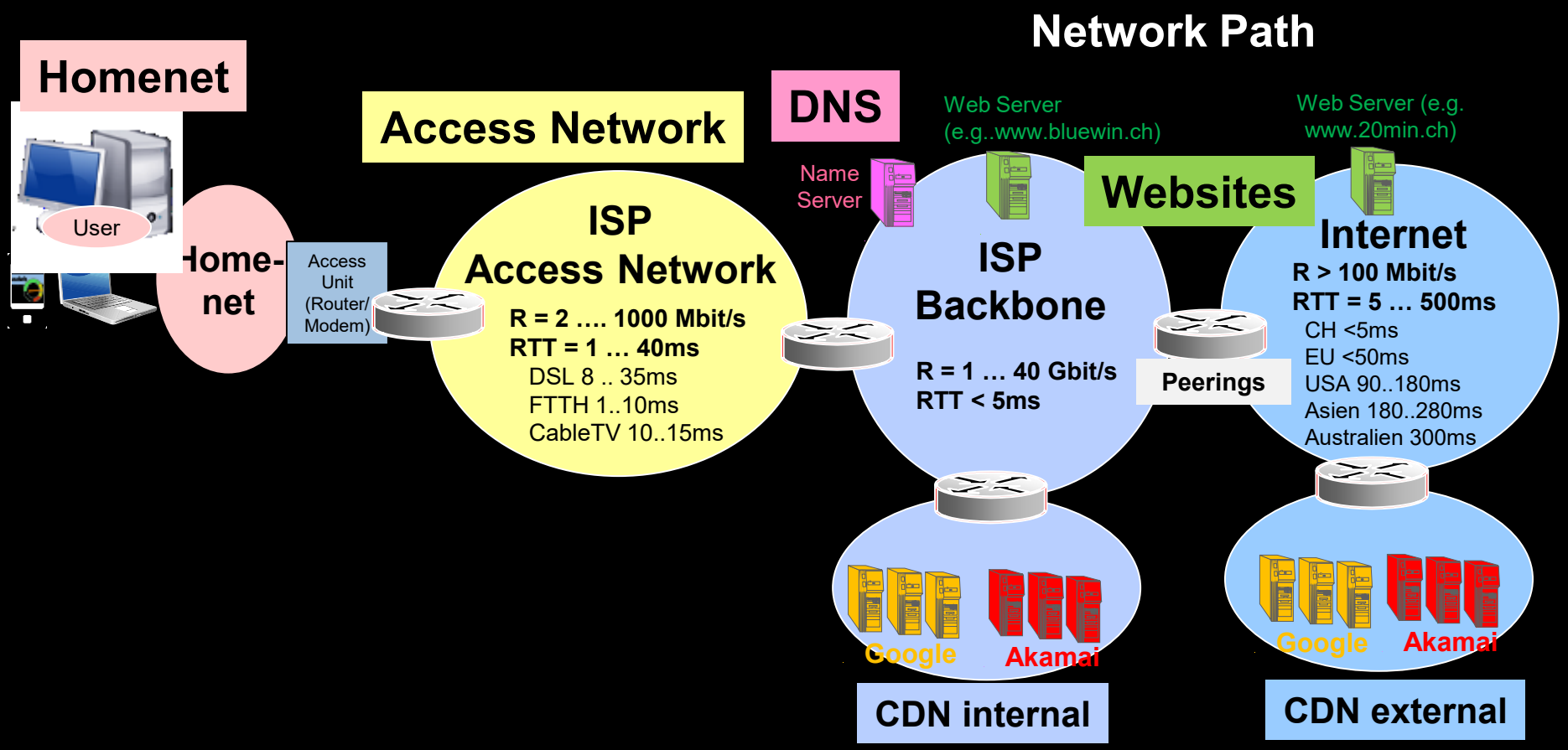
Higher speeds than 20Mbit/s bing only minor improvements of PLT.

Media Sites Page Load Time (PLT) and RTT

(Netemulator Measurements at 250Mbit/s Account)

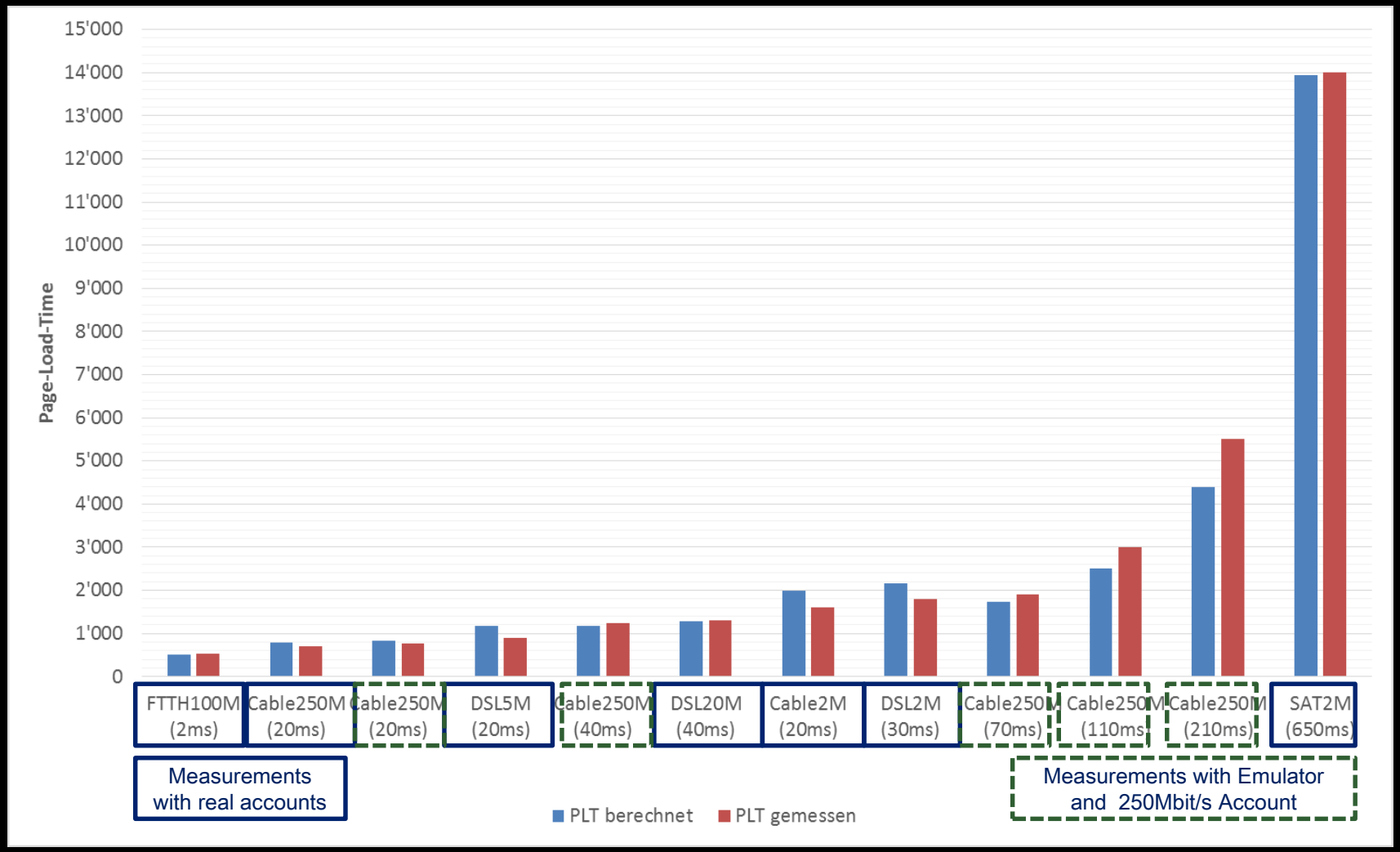


How and Where to Improve your RTT and PLT

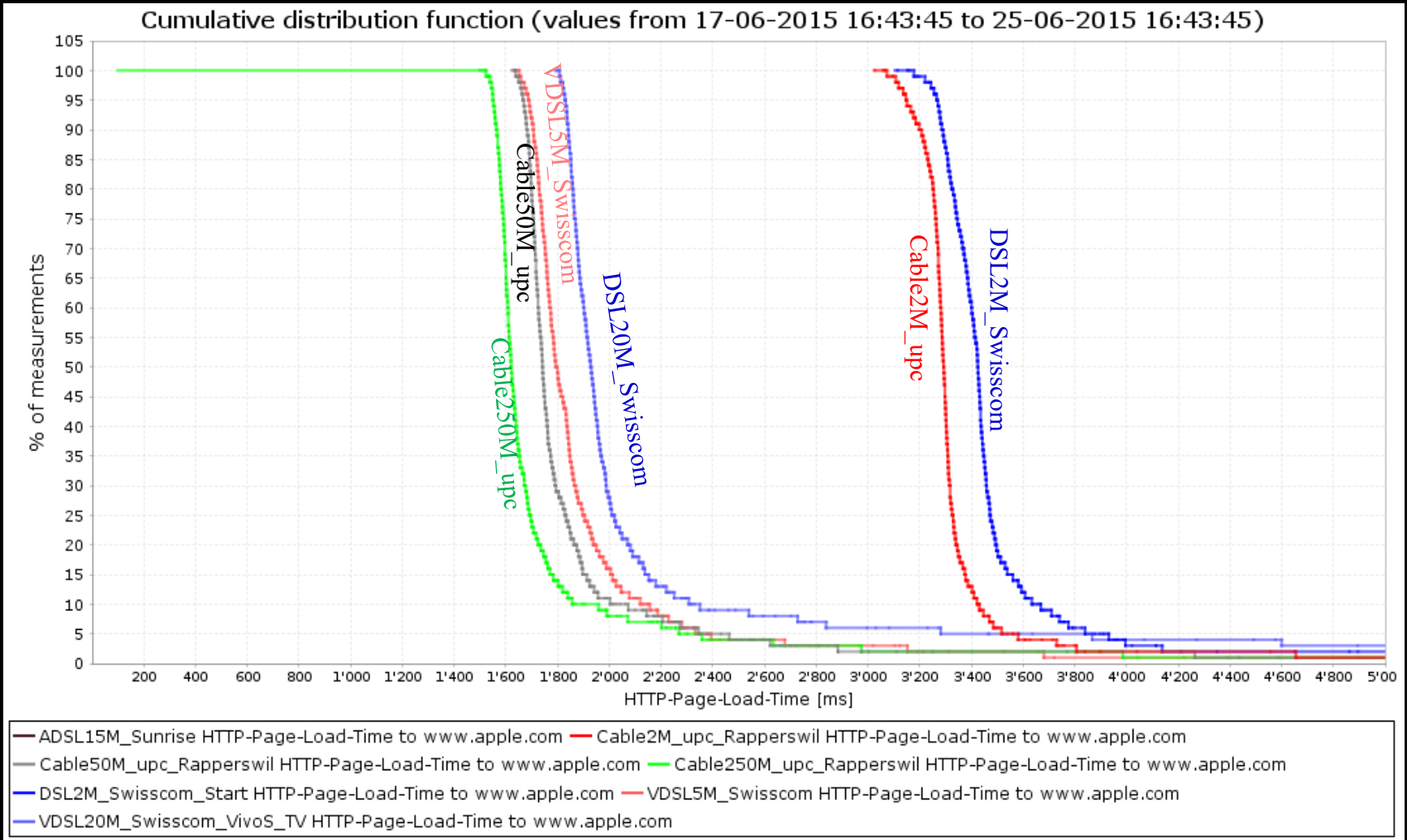


Page Load Time for https://www.google.ch with Different Accounts (and RTT)

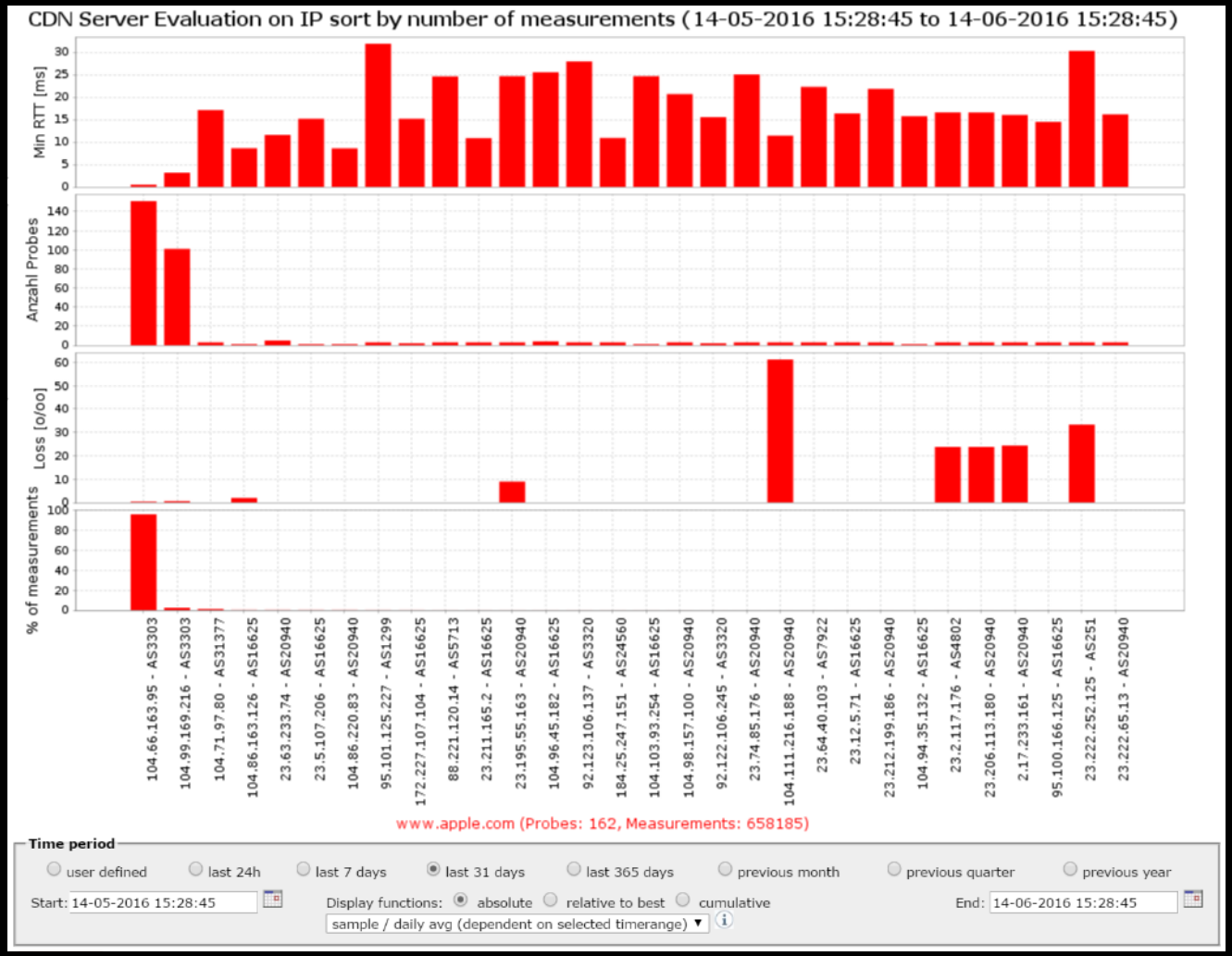
(Google opens 4 TLS/SSL connections sequentially)



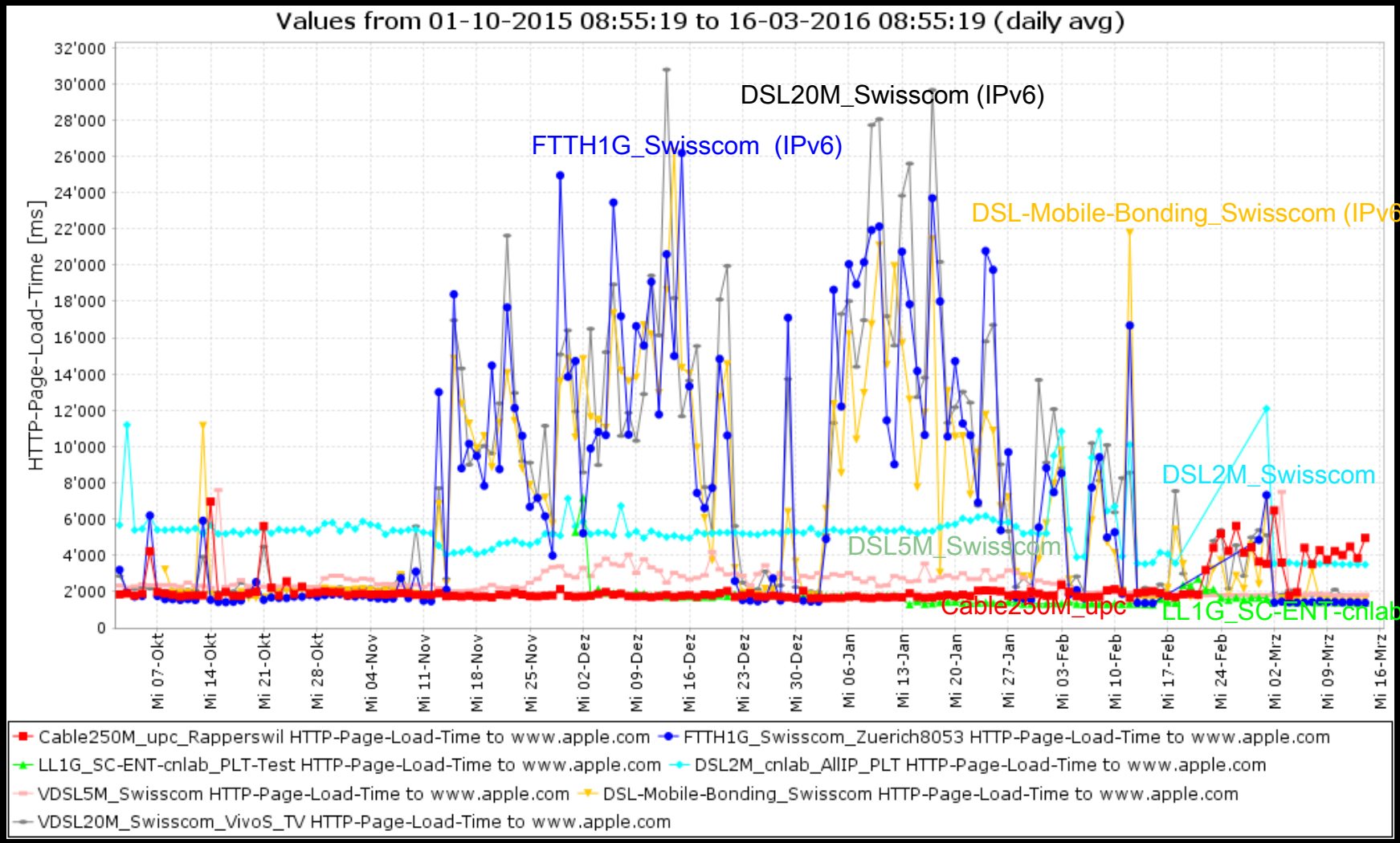
Page Load Time for https://www.apple.com (670kB, 39 Elements) with Different Accounts



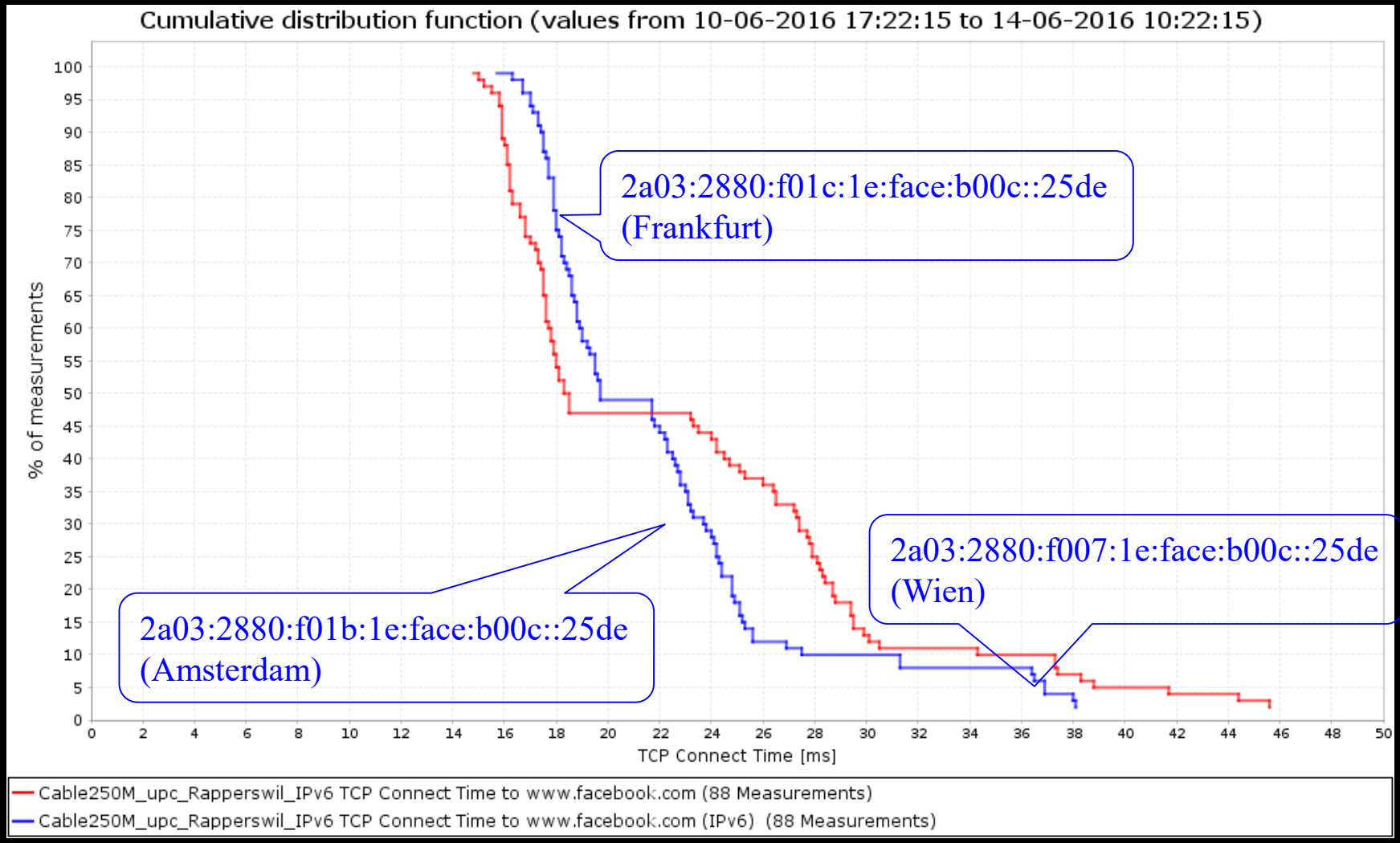
www.apple.com CDN Server Mapping for different Users from Swisscom



www.apple.com CDN Server Mapping for IPv6 and IPv4 Users from Swisscom



www.facebook.com CDN Server Mapping for IPv6 and IPv4 for a UPC User



5. Conclusion

- End user Speedtests (PAB)
  - Be careful when comparing Speedtest results
  - Speedtest providers only begin to offer IPv6 tests
- Speedtests based on probes
  - Similar Round Trip Time results for IPv6 and IPv4
  - routing differences between IPv6 and IPv4
- Web surfing experience (Page Load Time)
  - More than 20 Mbit/s brings only minor improvements
  - Focus on RTT and Web engineering to improve PLT
  - CDN is key to significantly improved PLT
- IPv6 will rather lead to application than to performance problems