Understanding QoS measurements: Experience from the mPlane European Project

Marco Mellia
Politecnico di Torino

ITU Regional Workshop for Europe
New Issues in QoS Measuring and Monitoring
25-26 November 2015
Experience from the mPlane European Project
mPlane project quick facts

- mPlane is an FP7 Integrated Project
- Project acronym: mPlane
- Grant agreement no: 318627
- Staring Date: November 1\textsuperscript{st} 2012
- Total Cost: 11,274,908.00 €
- Duration: 3 years
- Partners: 16
- Coordinator: Prof. Marco Mellia – Politecnico di Torino - IT
Who we are

- 3 operators
- 6 research centers
- 5 universities
- 2 small enterprises
Which problem(s) mPlane aims at solving
“The Internet is the first thing that humanity has built that humanity doesn't understand, the largest experiment in anarchy that we have ever had.”

Eric Schmidt – ex Google Exec. Chairman
A complicated technology...

Internet: different technologies are combined to offer a plethora of services

We sorely miss the technology to understand what is happening in the network and thus to optimize its performance and utilization

Specially when something goes wrong!
A complicated technology...
...that no one controls and understands

- Why WhatsApp is not working?
- Which is the best ISP in my area?
- Where is YouTube traffic coming from?
- ...
- How to measure the QoS?

There are no tools to help me!
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Understanding QoS measurements

Zen and the art of speedtest
QoS == speedtest

- Trivial idea: Measure the application throughput
  - Download a file of size D
  - Measure the time $\Delta T$ to complete the transfer
  - Get throughput as $T'\text{put}=D/\Delta T$

- From theory to practice
  - Which server to use?
  - What TCP version?
  - Which configuration?
  - …
Impact of client RWND

Test 1

C = line capacity

throughput [Mbits/sec]

0 10 20 30 40 50 60 70 80 90

RTT [ms]

0 20 40 60 80 100

RWND/RTT

Plane

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Impact of TCP Congestion Control

“The Internet is the first thing that humanity has built that humanity doesn't understand, the largest experiment in anarchy that we have ever had.”
Troubleshooting and understanding
Network Measurements...

- **Active measurements**
  - Exactly define the workload the network is subject to
  - Measure the desired quantity
    - Examples: traceroute, speedtest, etc.

- **Passive measurements**
  - Do not change the working point of the network
  - More detailed view of the network status
    - Examples: wireshark, tcpdump, etc.
Hybrid Measurements

- Combine active and passive approaches:
  1. Augment active tests with detailed information obtained from passive measurements
  2. Active measurements generate the desired amount of traffic
Passive probe: Tstat

- Captures traffic on the network interface and processes it in **real-time**
- **Rebuilds** TCP/UDP flows
- Computes **100+ statistics**, logged at the end of the flow
- Open-source: [http://tstat.polito.it](http://tstat.polito.it)

<table>
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<tr>
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<th>S2C</th>
<th>Short description</th>
<th>Unit</th>
<th>Long description</th>
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<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>Client/Server IP addr</td>
<td>-</td>
<td>IP addresses of the client/server</td>
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<tr>
<td>2</td>
<td>46</td>
<td>Client/Server TCP port</td>
<td>-</td>
<td>TCP port addresses for the client/server</td>
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<td>3</td>
<td>47</td>
<td>packets</td>
<td>-</td>
<td>total number of packets observed from the client/server</td>
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<td>4</td>
<td>48</td>
<td>RST sent</td>
<td>0/1</td>
<td>0 = no RST segment has been sent by the client/server</td>
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<td>49</td>
<td>ACK sent</td>
<td>-</td>
<td>number of segments with the ACK field set to 1</td>
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<tr>
<td>6</td>
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<td>PURE ACK sent</td>
<td>-</td>
<td>number of segments with ACK field set to 1 and no data</td>
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<td>bytes</td>
<td>number of bytes sent in the payload</td>
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<td>data pkts</td>
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<td>number of segments with payload</td>
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<tr>
<td>9</td>
<td>53</td>
<td>data bytes</td>
<td>bytes</td>
<td>number of bytes transmitted in the payload, including retransmissions</td>
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<td>56</td>
<td>out seq pkts</td>
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<td>number of segments observed out of sequence</td>
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</table>
Hybrid Measurements for Network Troubleshooting

Analysis Layer

Repository Layer

Measurement Layer
Testbed & Dataset

- **30+ Speetest probes distributed within the network**
- **Network configurations**
  1. **ADSL:**
     - U-1Mbps/D-16Mbps
     - U-1Mbps/D-12Mbps
     - U-0.5Mbps/D-8Mbps
  2. **FTTH**
     - U-10Mbps/D-10Mbps
- **10-sec long speedtest every 4min**
  - FTP transfers in both Upload and Download
- **3 months of tests (Feb 1st to Apr 30th 2014)**
- **More than 1.3M speed-test reports**
Congestion in the Virtual Leased Lines

ADSL U1Mbps/D12Mbps

Evident day/night periodicity + Large std(RTT)

Active Test

Passive measurement

Congestion in the Virtual Leased Line
Low SNR on ADSL lines

ADSL U1Mbps/D16Mbps

Active Test

Passive measurement

Large RTX rate +
No day/night pattern

Large Bit Error Rate
Congestion at the Uplink

FTTH U10Mbps/D10Mbps

FTTH (no SNR issues) +
No day/night periodicity +
large RTX segment rate

Active Test

Passive measurement

Small buffer at the uplink
Conclusions

- Even simple speedtest measurements are complicated
- Hybrid measurements to find the possible root cause of an issue
- To accelerate the network troubleshooting procedures

Question: is speedtest an interesting metric?
  - Can I see YouTube with a 100Mb/s line?
Thank you!