Broadband Internet Performance: A View from the Gateway

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What is the Performance of Network Access Links?

Your fears confirmed: "up to" broadband speeds are bogus
By Nate Anderson | Last updated 16 days ago

Broadband providers in the US have long hawked their wares in "up to" terms. You know—"up to" 10Mbps, where "up to" sits like a tiny pebble beside the huge font size of the raw number.

In reality, no one gets these speeds. That’s not news to the techno-literate, of course, but a new Federal Communications Commission report (PDF) shines a

Ofcom: Broadband ISPs are pulling a fast one
- Average speed 46% below that promised by ISPs
- Mandatory code and clear penalties vital, experts say

Graeme Wearden
The Guardian, Tuesday 27 July 2010
Article history

ACTUAL DOWNLOAD SPEEDS
As noted above, in 2009, average (mean) and median advertised download speeds were 7–8 Mbps, across technologies. However, FCC analysis shows that the median actual speed consumers experienced in the first half of 2009 was roughly 3 Mbps, while the average (mean) actual speed was approximately 4 Mbps. Therefore actual download speeds experienced by U.S. consumers appear to lag advertised speeds by roughly 50%.
Previous Performance Studies

- Study from outside
  - Dischinger et al. (IMC 2008), Netalyzr (IMC 2010)
  - Not continuous, not many per user, no view into home

- Study from inside
  - Grenouille project
  - Hard to account for device diversity
  - Hard to account for home network
The BISMark Project

- Periodic measurements to last mile and end-to-end
- Measure directly at the gateway device
- Adjust for confounding factors
Bismark

- Deploy programmable gateways in homes
- NoxBox deployment: about 35 around Atlanta
- SamKnows deployment: about 11000 around the US
Gateway Vantage Point: Advantages

- Observes all traffic passing through network
- Isolate individual factors affecting network performance
  - Wireless
  - Cross traffic
  - Load on measurement host
  - End-to-end path
  - Configuration
Current Deployment

- 16 boxes deployed
- 10 in ATT, 4 in Comcast, 2 ClearWire
- Most of the deployments within Atlanta
- All measurements done to server at Georgia Tech
### Active Measurements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Prot.</th>
<th>Freq.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Latency</strong></td>
<td>End-to-end</td>
<td>ICMP</td>
<td>5 min</td>
<td>Host</td>
</tr>
<tr>
<td></td>
<td>Last-mile</td>
<td>ICMP</td>
<td>5 min</td>
<td>First IP hop</td>
</tr>
<tr>
<td></td>
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<td>ICMP</td>
<td>30 min</td>
<td>During upload</td>
</tr>
<tr>
<td></td>
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<td>During download</td>
</tr>
<tr>
<td><strong>Packet loss</strong></td>
<td>End-to-end</td>
<td>UDP</td>
<td>15 min</td>
<td>D-ITG</td>
</tr>
<tr>
<td><strong>Jitter</strong></td>
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<td>UDP</td>
<td>15 min</td>
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<td>Single-thread HTTP</td>
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<td>Throughput</td>
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**BISMark:** 17 devices, 3 ISPs
Results

• Throughput
  – Different throughput techniques capture different aspects of throughput
  – Depending on how throughput measurements are conducted, they may vary considerably across users

• Latency
  – Latencies vary within the same ISP
  – Last-mile latencies are significant
  – Modem buffers are too large
  – Modifying data transfer using traffic shaping might mitigate the problem in the short term
Different Techniques, Different Aspects of Throughput

- Throughput measurements yield variable results
- Single-threaded HTTP varies across users/access links (likely due to interleaving)
Different Users, Different Performance

- Same service plan & ISP, different loss profile
- User 1 sees much more loss, but also much lower latency
- User 2 has interleaving turned on
Traffic Shaping Differs Across Users

- Different burst magnitudes
- Different lengths of time
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Latency for Two Users

Baselines Different for 2 ATT customers
Last-Mile Latencies are Significant

- All but 2ms comes from last mile
- ADSL last mile – 8 to 25ms, WiMAX – ~ 75ms!

High correlation (0.95) with end-to-end latency
Effects of Access Link Technology

- High variation in WiMax and Cable
- ADSL latencies are more tightly bound

![Comcast](image1)

![Clear](image2)
Modem Buffers are Too Large

- Buffering in modems can be as high as ten seconds!
- Can be empirically modeled with token-bucket filter
Traffic Shaping Affects Latency, Too

• After different periods of time, latency and loss profiles change dramatically
• **Possible cause:** dynamic buffer sizing

![Graph showing latency and loss rate over time](image)
Keeping Latency Under Control

- Intermittent or shaped traffic can achieve same levels of throughput, without incurring high latency.
Takeaway Lessons

• One measurement does not fit all
  – Different measurements yield different results
  – Different ISPs have different shaping behaviors

• One ISP does not fit all
  – There is no “best” ISP for all users
  – Different users may prefer different ISPs
  – There is a need for a “nutrition label”

• Home network equipment can significantly affect performance