Week 4: Bandwidth

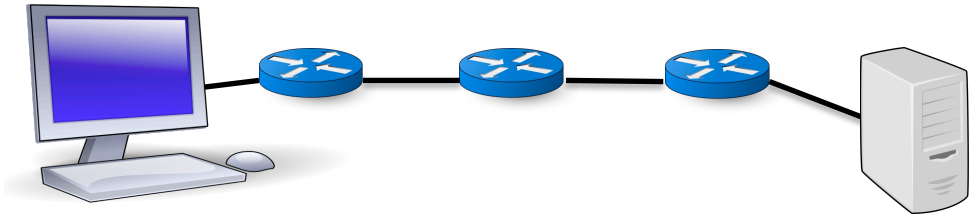
1. Introduction
2. Definitions of bandwidth metrics
3. End-to-end measurement approaches
4. **Flooding**
   A. Method
   B. **Example tools**
5. Advanced probing
6. Conclusion

Flooding tools and services for measuring available bandwidth

- iperf/iperf3
  - Control of client and server
  - Configurable tests
- Services for measuring broadband Internet: Speedtest
  - Fixed set of servers
  - Fixed tests

iperf3: Vantage points

- Installation at client and server
  - Public servers exist



source:
iperf client
`iperf -c server`

destination:
iperf server
`iperf -s`

iperf3: Test configuration

- Protocol
  - TCP (default)
    - ✓ Configuration of window size (`-w`), congestion control (`-C`)
    - ✓ Multi-threaded TCP (`-P`): parallel streams
  - UDP (`-u`)
- Rates, timing
  - Bandwidth (`-b`)
  - Time to transmit (`-t`)
  - Bytes to transmit (`-n`)

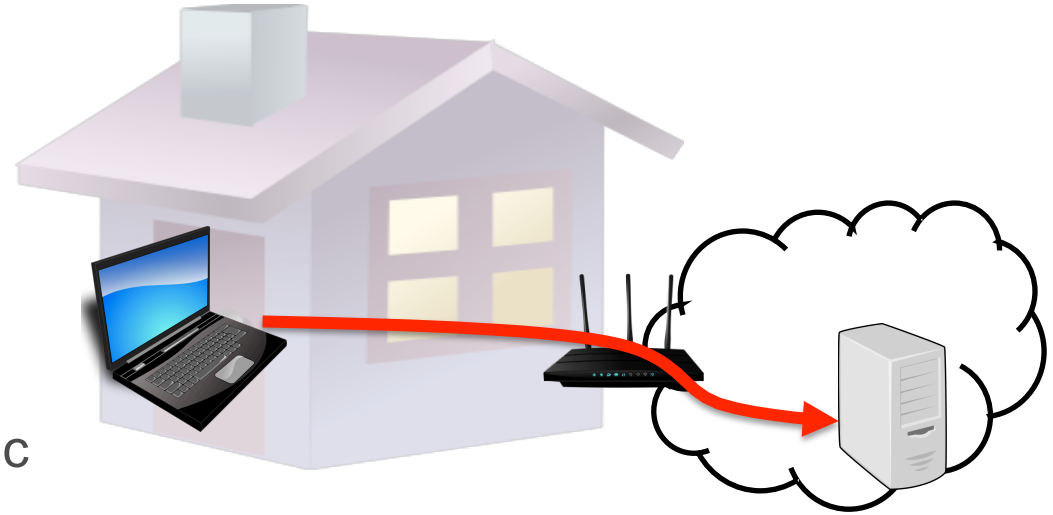
iperf3: Output

```
$ iperf3 -u -t 10 -b 100Mbit --get-server-output -c 192.168.1.174
Connecting to host 192.168.1.174, port 5201
[  4] local 192.168.1.231 port 51069 connected to 192.168.1.174 port 5201
[ ID] Interval           Transfer     Bandwidth       Total Datagrams
[  4]   0.00-1.00   sec  10.8 MBytes  90.2 Mbits/sec  1379
                ⋮
[  4]   9.00-10.00  sec  12.0 MBytes   100 Mbits/sec  1532
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  4]   0.00-10.00  sec   118 MBytes  99.0 Mbits/sec  0.839 ms  2034/15114 (13%)
[  4] Sent 15114 datagrams

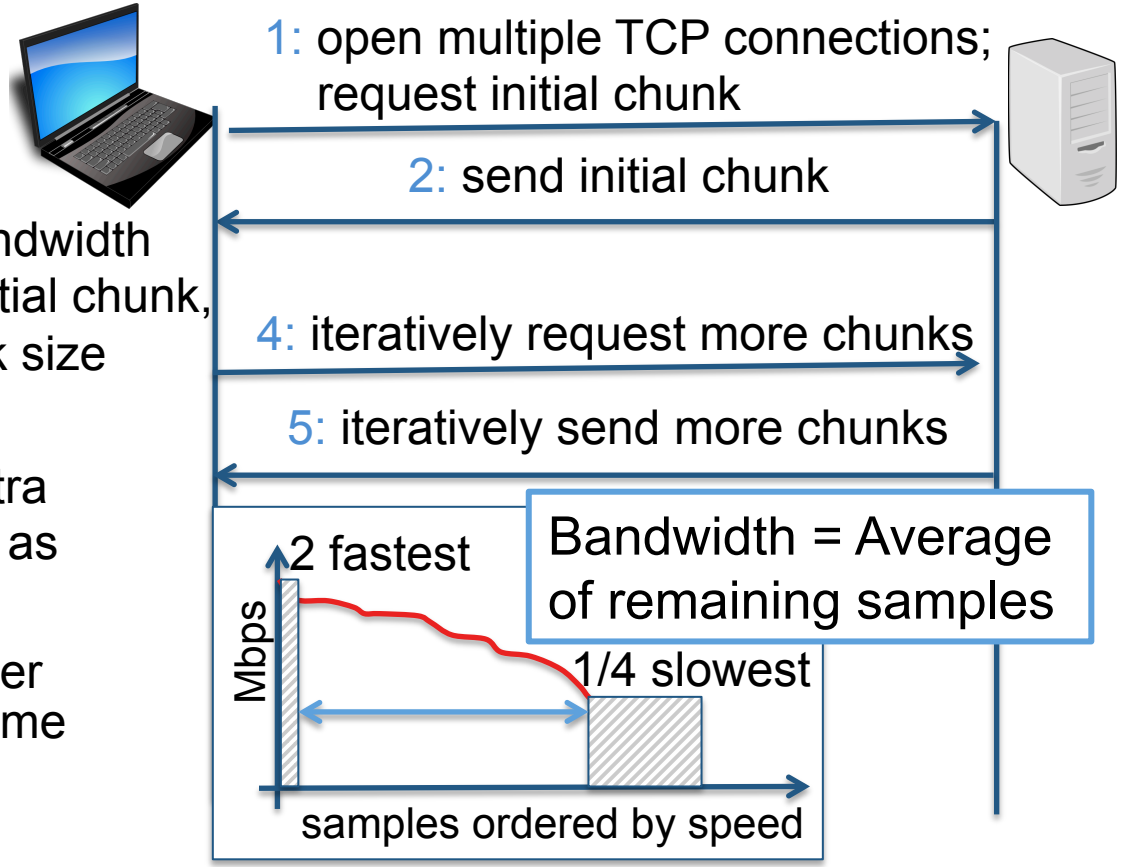
Server output:
Accepted connection from 192.168.1.231, port 58542
[  5] local 192.168.1.174 port 5201 connected to 192.168.1.231 port 51069
[  5]   0.00-1.00   sec  7.05 MBytes  59.2 Mbits/sec  1.190 ms  226/1129 (20%)
                ⋮
[  5]   9.00-10.00  sec  11.4 MBytes  95.9 Mbits/sec  2.670 ms  74/1537 (4.8%)
```

Measuring residential broadband: Speedtest

- Well-placed servers
  - In major ISPs
- Client
  - User devices
    - ✓ Affected by WiFi, home traffic



Example: Speedtest's download test



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Example: Speedtest's download test





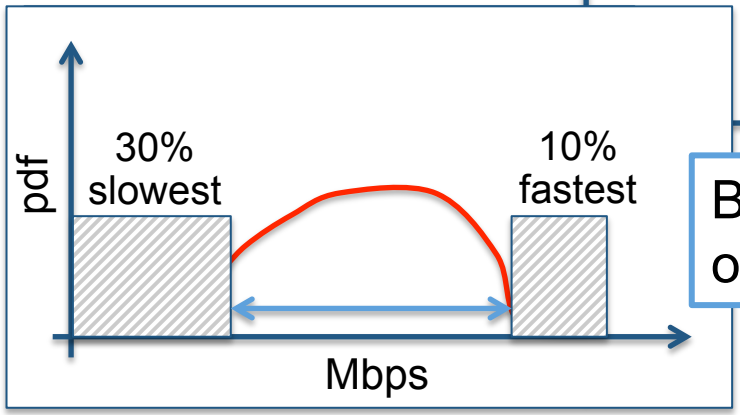
1: request small file

2: small file download

3: estimate bandwidth, select file for real test

4: request test file

5: download test file (up to 8 HTTP connections)



Bandwidth = Average of remaining samples