Impact of IW10 on Interactive Real-Time Communication

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Introduction

- Any burst of back-to-back packets tends to create transient queue
  - Initial window is significant contributor of back-to-back bursts
  - IW effect tends to intensify when large number of parallel connections is used (e.g., Web traffic)
- In a common case bottleneck resides in the access network
  - Quite often capacity of the access network is not higher than few Mbps

Test Setup

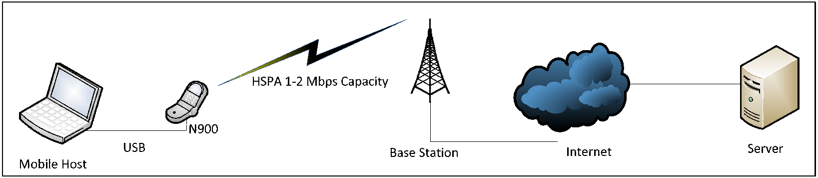

Figure: Test Environment

- 16kbps CBR flow, 20ms sending interval
- 1-6 short TCP flows with total size of 372kB, start 10..12 seconds after CBR
- TCP variant has SACK, delayed ACK and limited transmit enabled.

Jitter Filter

- A "pure loss" when a packet does not reach the receiver.
- A "delayed loss" when a packets is delayed more than a codec jitter buffer can handle.
- The "base delay" is the minimum one-way delay of the CBR packets sent n seconds before the start of the observation period. The default value of n is taken as 2 seconds and it is a configurable parameter.
- "Jitter buffer" is the delay one waits before playing. This is a also a configurable parameter (e.g., 40ms, 60ms, 80ms, 100ms)
- If jitter exceeds the jitter buffer, the packet is considered to be lost ("delayed loss").

Quality Metric

- The metric categorizes the quality of audio based on loss periods (number of consecutive losses, either pure or delayed loss).
- Extract the loss periods and provide the overall distribution of packets in such loss periods (e.g., how many loss periods are $\geq$ 40 ms, $\geq$ 80ms, etc).
- Loss period mapped to non-linear scale (0-5)
  - 0 = packet was not lost
  - 1 = Only single loss (20msec lost), no adjacent packets were lost
  - 2 = This packet is part of 2-3 pkts consecutive loss period (40-60ms lost)
  - 3 = This packet is part of 4-5 pkts consecutive loss period (80-100ms lost)
  - 4 = This packet is part of 6-9 pkts consecutive loss period (120-180ms lost)
  - 5 = This packet is part of 10 or more pkts consecutive loss burst (200ms+ lost)

CBR Quality with 40ms Jitter Buffer, 50 replications

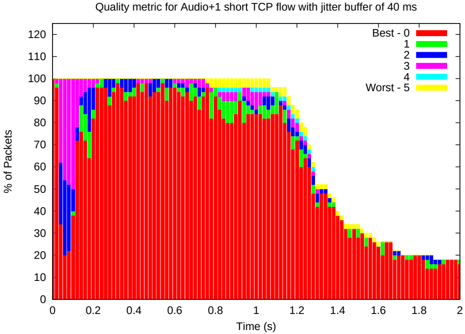

Figure: Audio + 1 short TCP flow, IW3

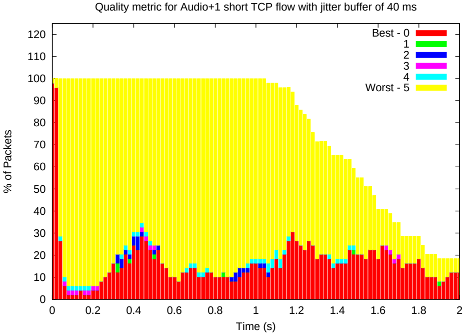

Figure: Audio + 1 short TCP flow, IW10

CBR Quality with 40ms Jitter Buffer, 50 replications

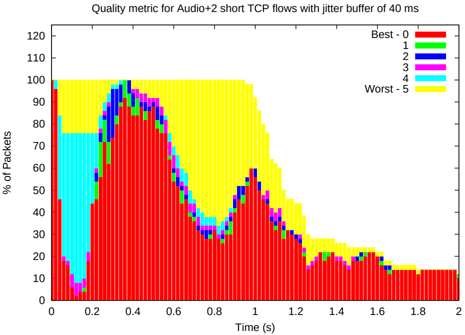

Figure: Audio + 2 short TCP flows, IW3

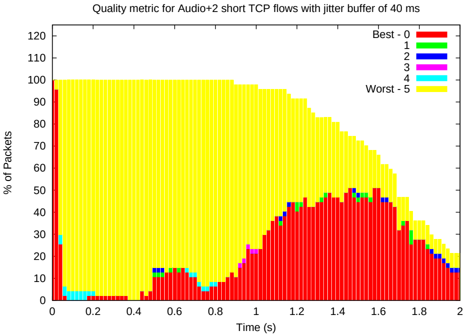

Figure: Audio + 2 short TCP flows, IW10

CBR Quality with 40ms Jitter Buffer, 50 replications

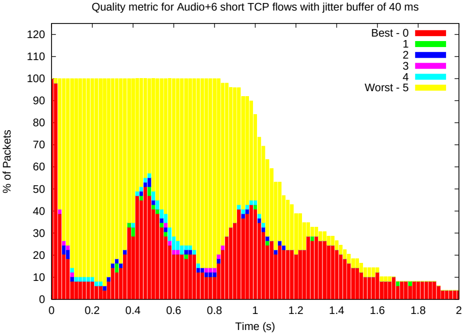

Figure: Audio + 6 short TCP flows, IW3

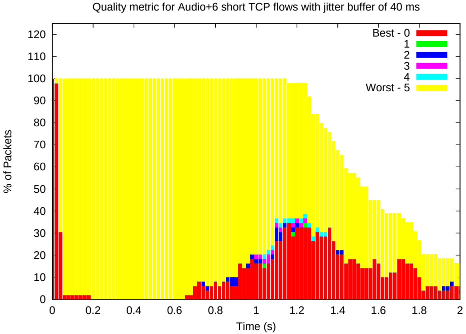

Figure: Audio + 6 short TCP flows, IW10

CBR Quality with 100ms Jitter Buffer, 50 replications

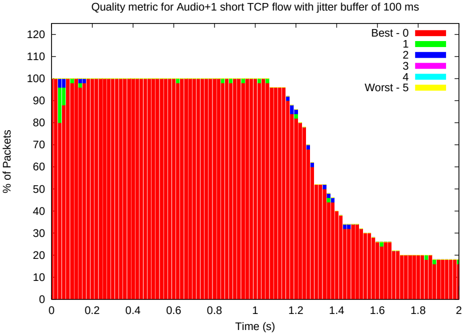

Figure: Audio + 1 short TCP flow, IW3

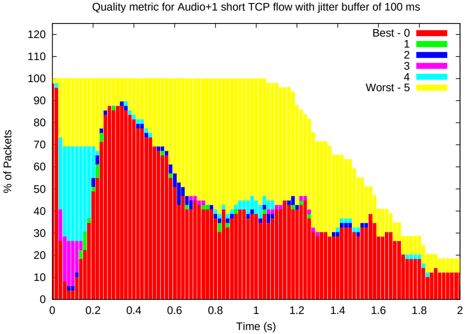

Figure: Audio + 1 short TCP flow, IW10

CBR Quality with 100ms Jitter Buffer, 50 replications

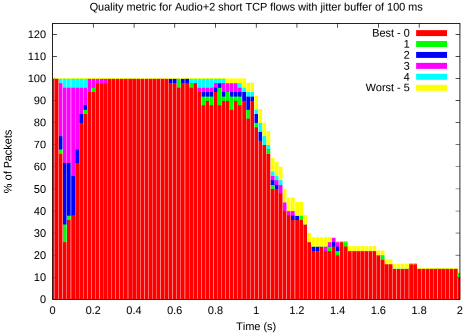

Figure: Audio + 2 short TCP flows, IW3

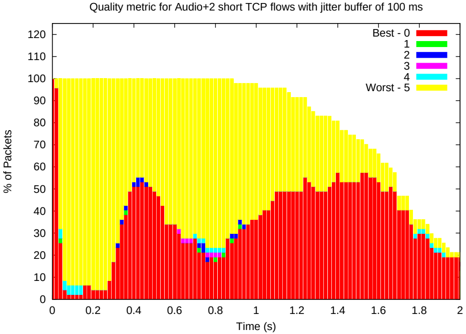

Figure: Audio + 2 short TCP flows, IW10

CBR Quality with 100ms Jitter Buffer, 50 replications

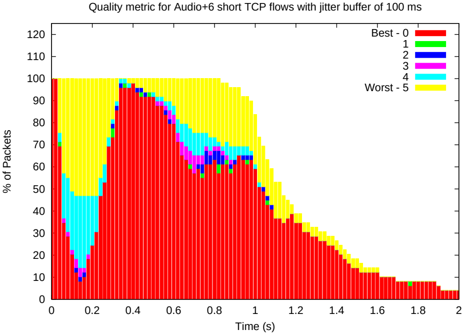

Figure: Audio + 6 short TCP flows, IW3

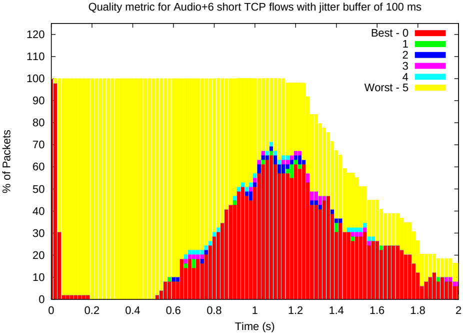

Figure: Audio + 6 short TCP flows, IW10

Good Quality Level with Different Sized Jitter Buffers

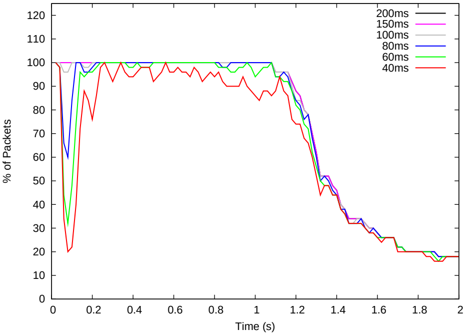

Figure: Audio + 1 short TCP flow, IW3

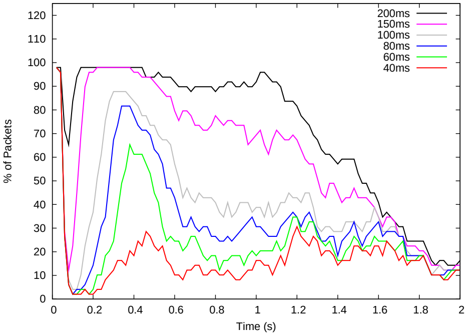

Figure: Audio + 1 short TCP flow, IW10

- Good quality here combines levels 0 (not lost) and 1 (no adjacent loss)

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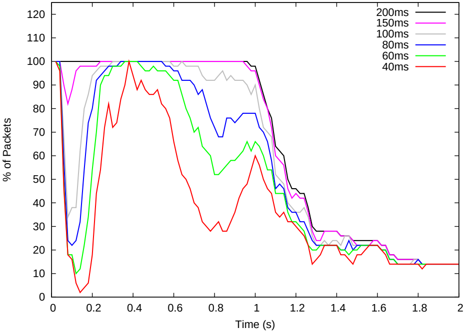
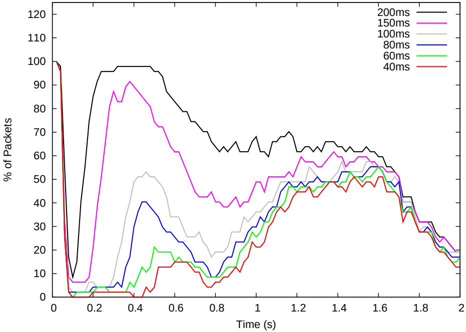


Figure: Audio + 2 short TCP flows, IW3



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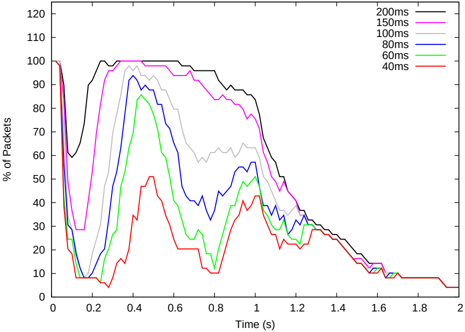

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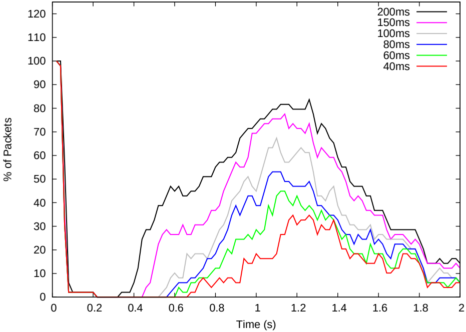

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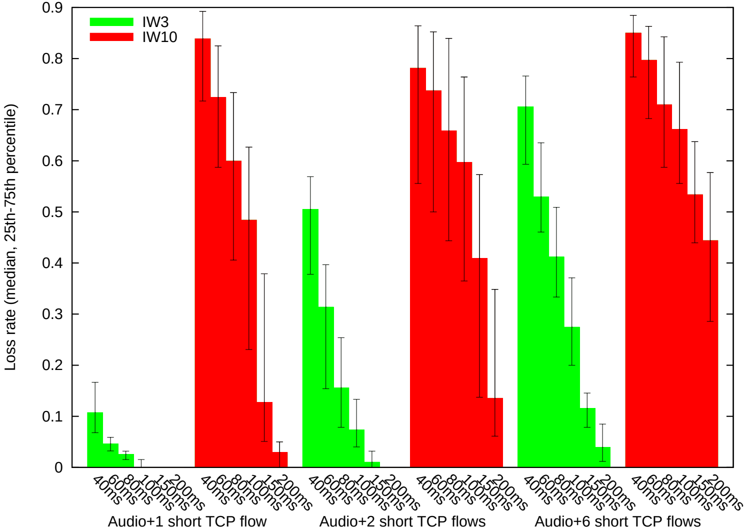
Loss Rate with Different Jitter Buffer Sizes



Discussion – Non-solutions

- AQM is not (easy) solution
  - Off-the-shelf AQM solutions are too slow to react in time to help interactive communications, face deployment challenges if default parametrization is not good enough [Harsh RED: Improving RED for Limited Aggregate Traffic, AINA 2012]
  - An AQM designed specially slow start in mind?
- LEDBAT is not a solution
  - Web browsers and Web pages try to minimize page transfer times
    - Unlikely that LEDBAT (or like) would be enabled "by default"
    - Web transfers are not less than best-effort transfers by any means
  - The sender needs to apply LEDBAT
    - On-demand approach requires end-to-end signalling, challenging to deploy

Conclusions

- IW10 clearly more harmful to interactive flows than IW3 due to jitter triggered packet discarding
- Large number flows also with IW3 is bad

See also: Impact of TCP on Interactive Real-Time Communication, IAB CC workshop [http://www.tschofenig.priv.at/cc-workshop/irtf_iab-ccirtcpaper9.pdf]