Effect of Competing TCP Traffic on Interactive Real-Time Communication

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Outline

Introduction

- Mobile mixed use devices, so called smartphones, have become very common
- Using Voice over IP (VoIP) in contrast to traditional dedicated voice calls attracts
- How well interactive VoIP works in presence of competing TCP traffic?
  - Especially interesting is Web traffic like workload with transients and parallel TCP connections
  - Test the effect of proposed TCP initial window change

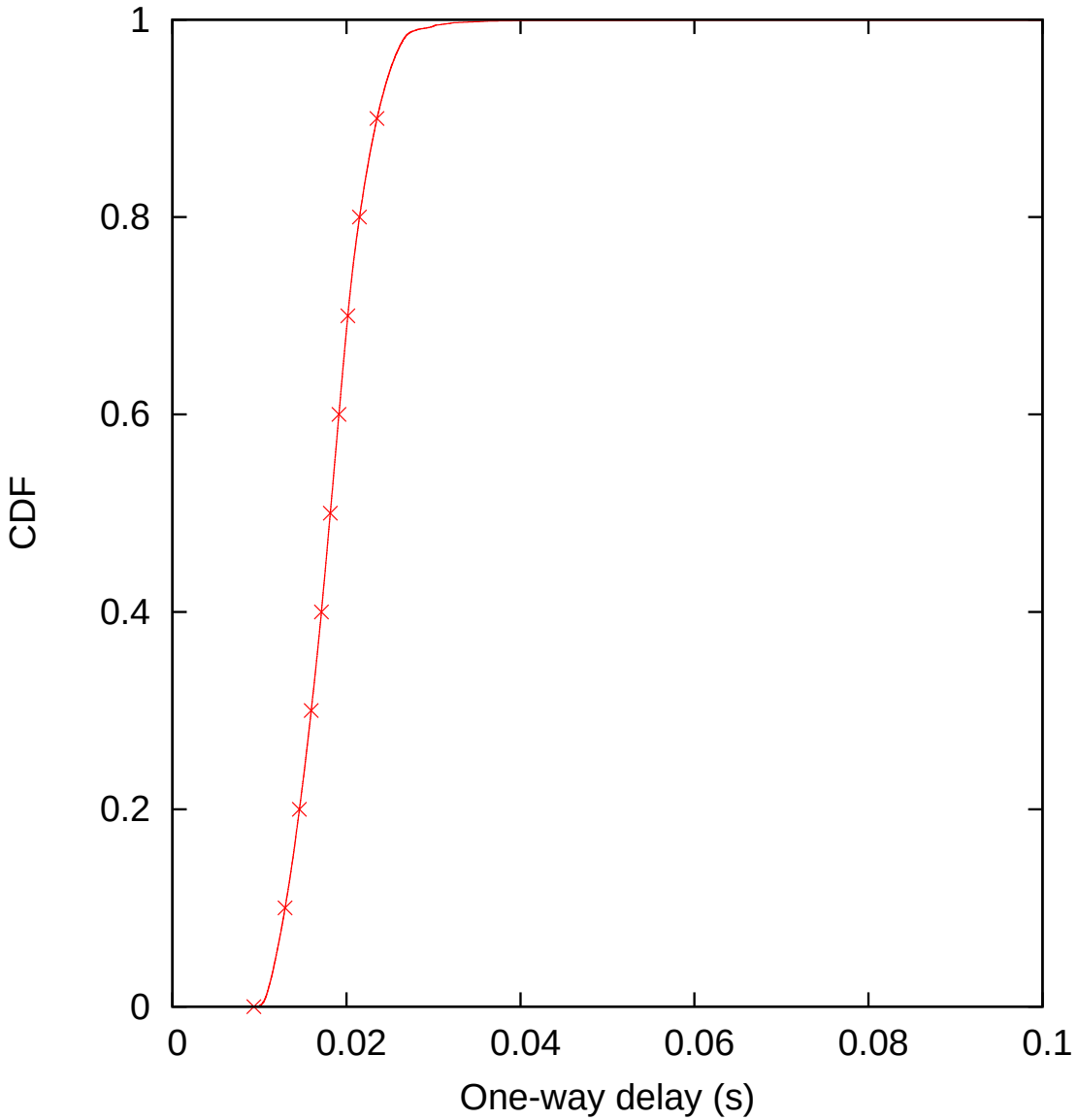
Test Arrangements

- Workloads
  - Emulated interactive audio (CBR, 16kbps payload) alone
  - Emulated interactive audio + bulk TCP connection
  - Emulated interactive audio + emulated Web traffic
    - Parallel flows used, worst-case assumption
- Real HSPA (3.5G) network, fixed server connected over the Internet
- A few test iterations with wireless issues causing duplicates, reordering, many consecutive losses, and very long delay spikes were rerun
- With interactive audio content, limited jitter buffer

TCP Initial Window (IW)

- IW specifies the largest burst of segments that can be sent at once when a TCP connection becomes established
- Current standard IW is 3 MSS segments (from 2002)
- IETF proposal to increase TCP IW from 3 to 10 (draft-ietf-tcpm-initcwnd, published soon as Experimental RFC)
- IW is sent as back-to-back packets, not ACK clocked
  - Limited congestion control for IW (if SYN loss occurs)
  - More challenging for active queue management (AQM) to respond compared with later TCP phases
- Traces suggest larger than IW3 is already being used (e.g., Google, Microsoft)

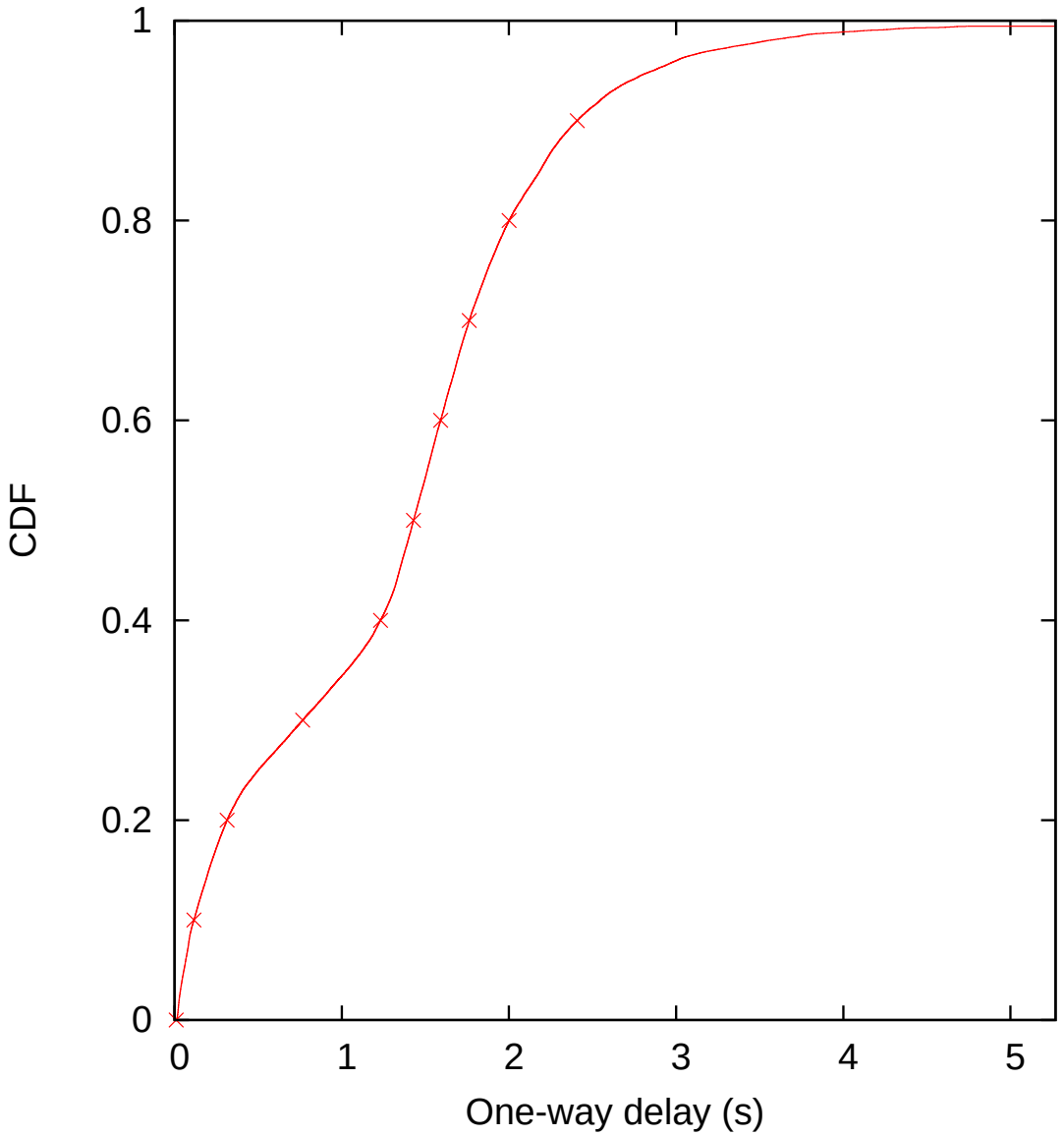
Baseline Results with Audio Only



Observations

- One-way delay is good enough for interactive audio conversation
- Median 18.0 msec
- Maximum 70.4 msec
- Very few samples $>$ 40 msec

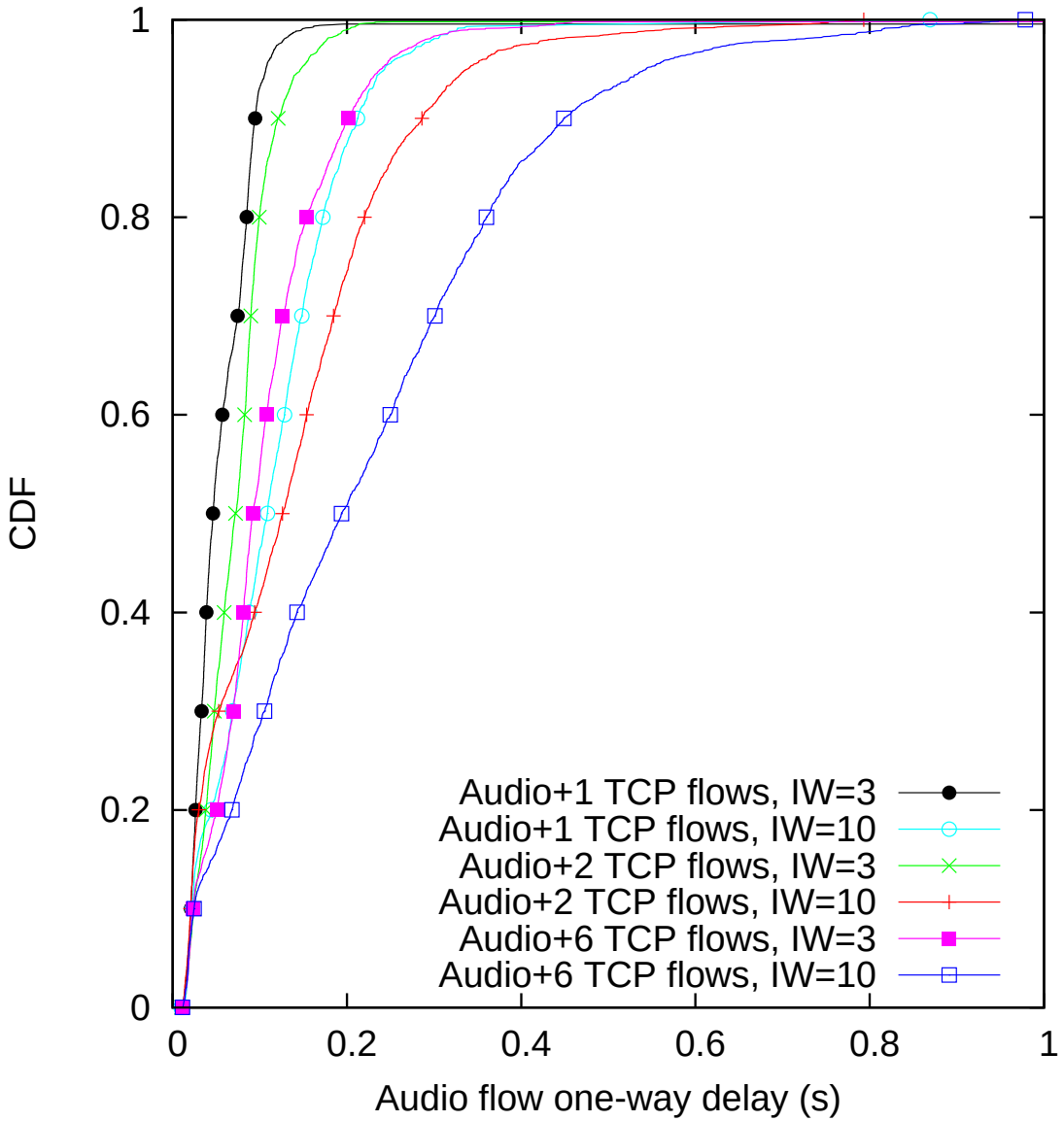
Results with Audio + Bulk Data TCP Transfer



Observations

- Deep buffering causes delay increase
- Interactivity is ruined by the excessive delay
- A few samples in the high end might be due to wireless link problems (but hard to know which)

Results with Audio + Emulated Web Traffic



Notes

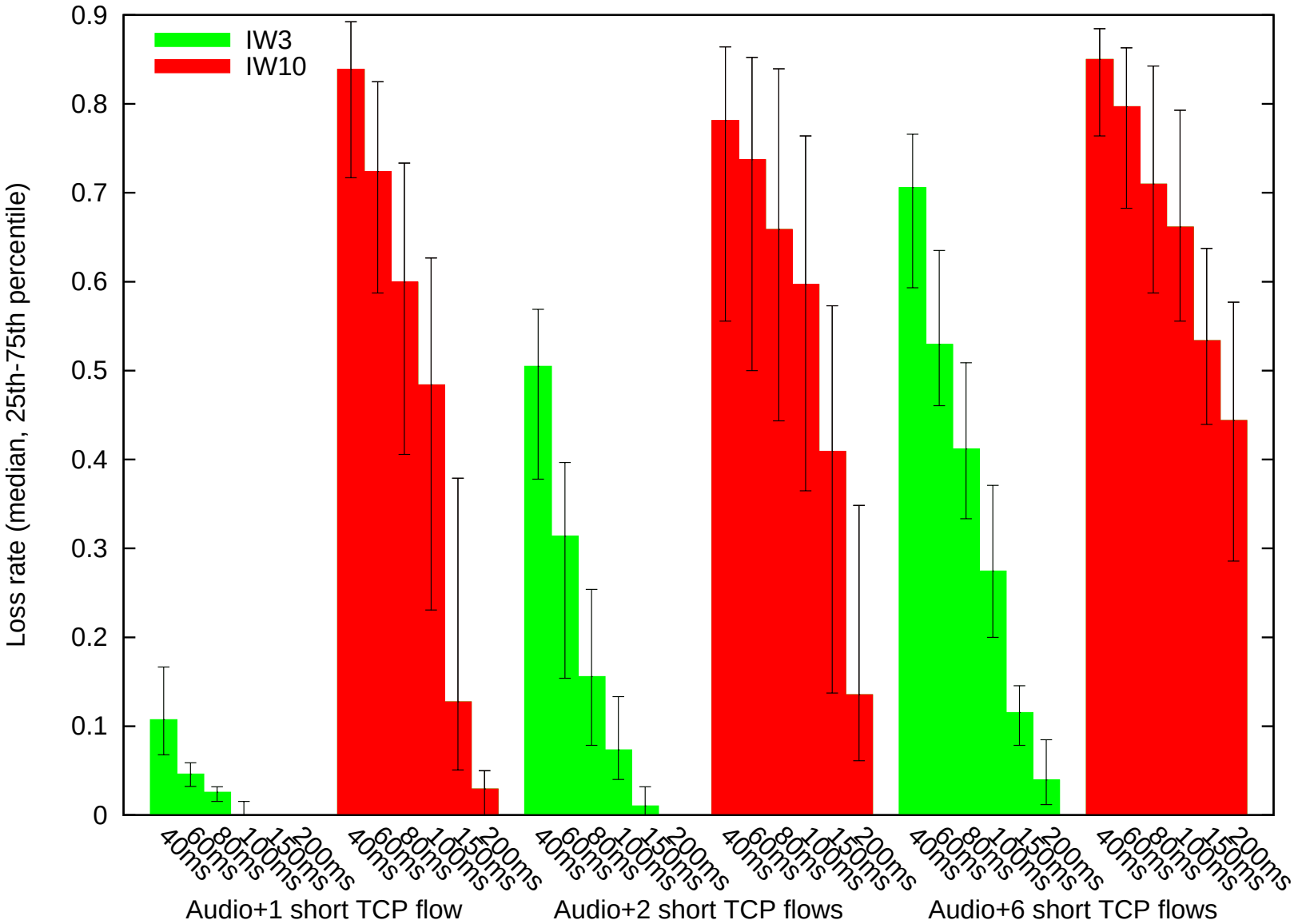
- Only samples overlapping with TCP included
- 1 or 2 TCP flows with IW3 quite ok, 6 flows not so
- Clearly larger delay with IW10 than IW3

Jitter Filter and Loss Period Level

- Jitter filter "drops" late arriving audio packet
  - Mimics time-bound playback of media
  - Base delay based on previous 2s prior to TCP flows arrival
  - Not lost physically, only delayed too much to be useful
- Loss period level
  - Loss period level is based on loss periods [RFC3357] the codec encounters due to consecutive packets being "dropped"

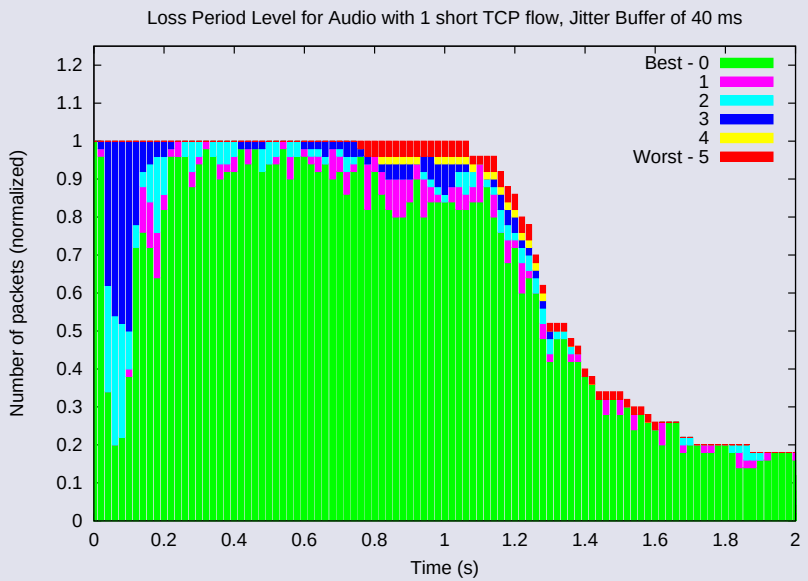
Value	Loss Period Level Description
0	no loss
1	20 ms gap in the stream, no adjacent packet lost
2	40-60 ms of the stream was lost
3	80-100 ms of the stream was lost
4	120-180 ms of the stream was lost
5	200+ ms of the stream was lost

Loss Rate after Applying Jitter Filter

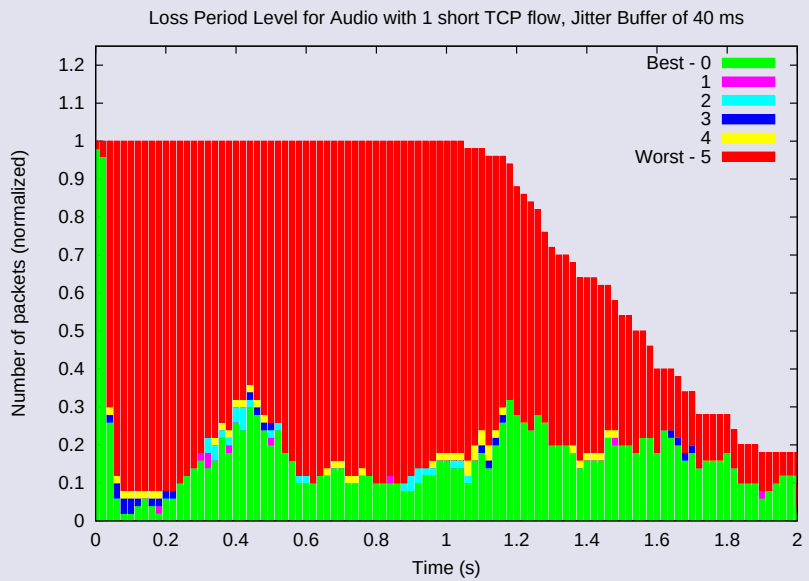


Loss Period Level, Audio + Web Traffic, 40 ms Jitter Buf

IW3



IW10



- IP Packet Delay Variation confirmed that worst delays spikes occurred during initial window

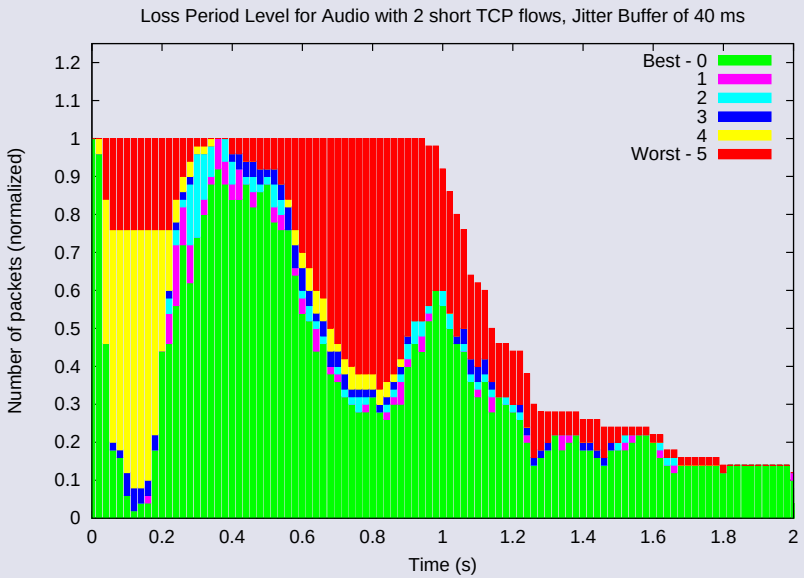
Conclusions

- Packets of the media flow are heavily delayed when competing TCP is present
- Using parallel TCP flows with IW3 causes significant delay for the media flow
- Worst effects occur during TCP initial window transmissions
  - IW10 is much worse than IW3 for the competing media flow

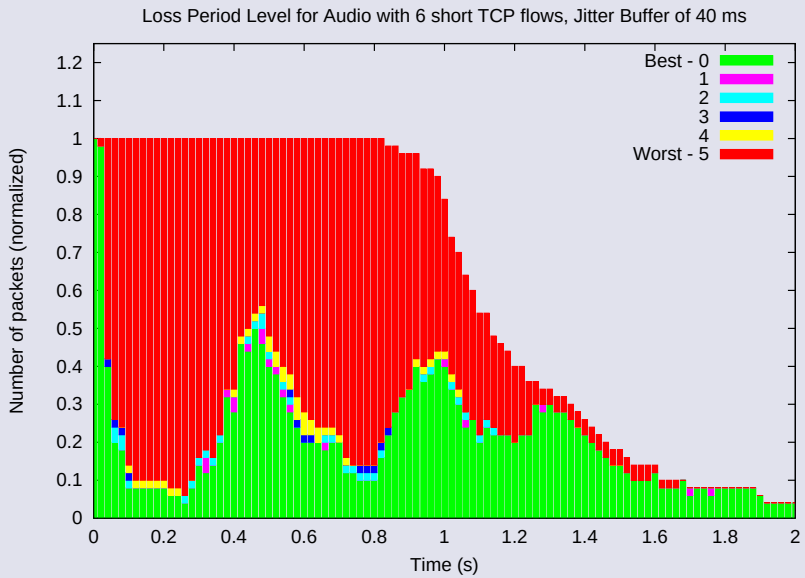
Backup Slides

Backup Slides - Paper Figures

Audio+2 TCP flows, IW3

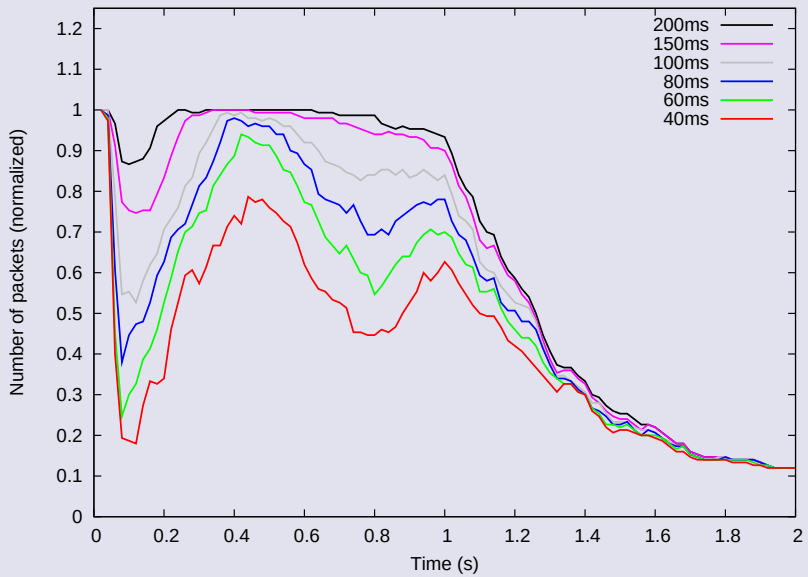


Audio+6 TCP flows, IW3

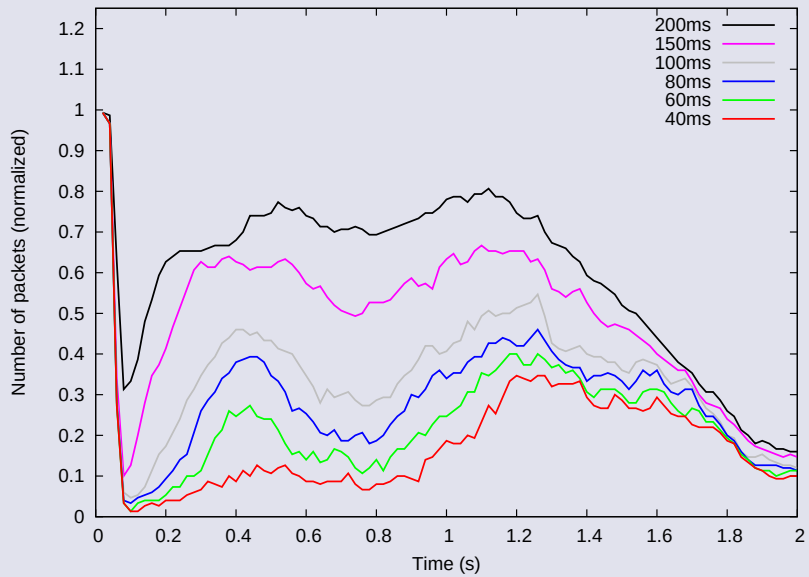


Backup Slides - Paper Figures

IW3

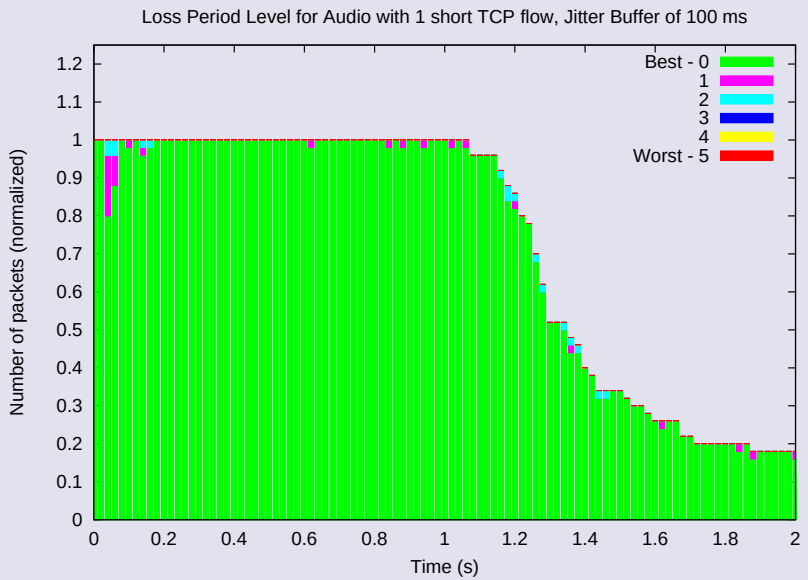


IW10

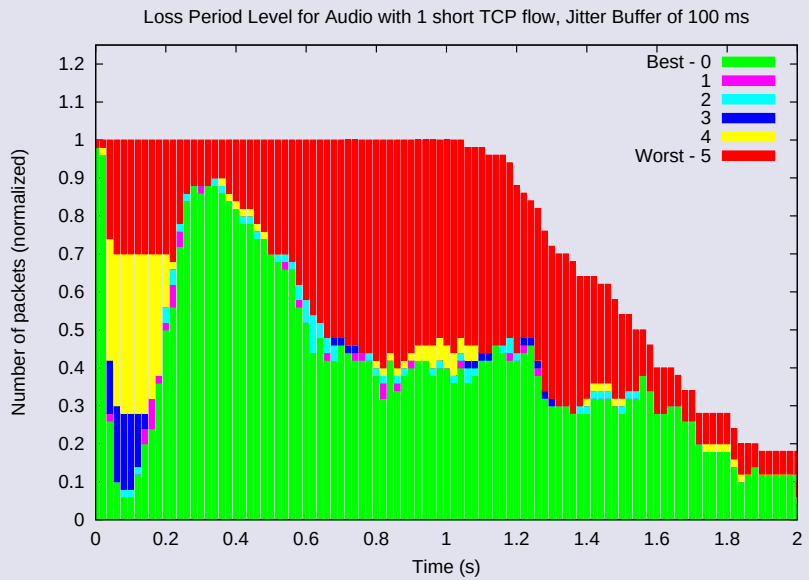


Loss Period Level, Audio + Web Traffic, 100 ms Jitter Buf

IW3



IW10



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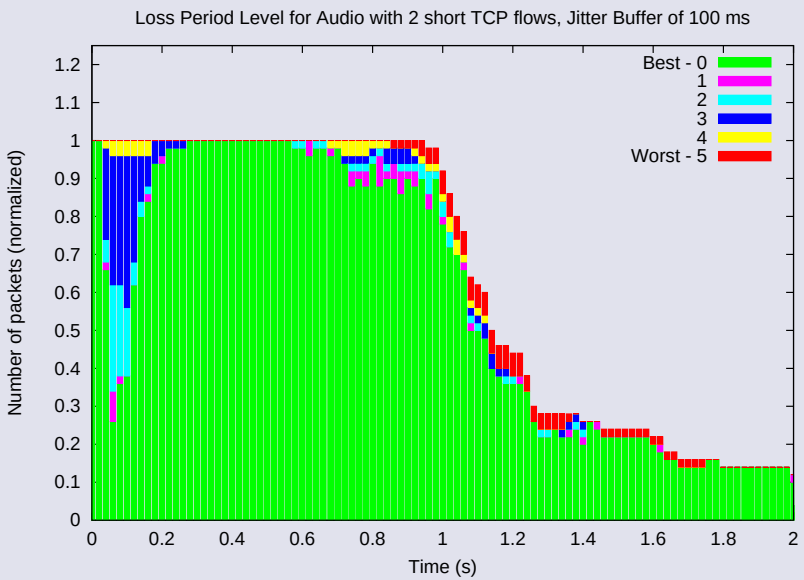
Audio+2 TCP flows, IW3



Audio+6 TCP flows, IW3