Performance of Multimedia Delivery on the Internet Today

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Performance on the Internet Today

Outline

◆ A prototypical videoconferencing system
  » Architecture
  » Quality-of-service requirements
◆ Performance metrics
  » Understanding end-to-end latency
◆ Some typical experimental results
◆ Conclusions?
Performance on the Internet Today

Videoconferencing performance requirements

- No more than 250 ms end-to-end, one-way latency
- Continuous audio
- Minimum of 10 frames per second video throughput
- “Loosely synchronized” playout — ± 80 ms skew

Videoconferencing Performance Requirements

Understanding end-to-end latency

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<th>Time (ms)</th>
<th>Digitize</th>
<th>Compress</th>
<th>Transmit/Synchronize</th>
<th>Decompress</th>
<th>Display</th>
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**Sender’s Pipeline**

**Receiver’s Pipeline**
Understanding End-to-End Latency
Latency as a measure of continuity of playout

![Diagram showing the acquisition and transport pipeline with latency and time measurements.](image)

Understanding End-to-End Latency
Latency as a measure of continuity of playout
Understanding End-to-End Latency

Latency as a measure of continuity of playout

![Diagram showing stages of video processing](image)

Understanding End-to-End Latency

Audio performance

- To provide lip synchronization, audio must be delayed to “wait” for video

![Diagram showing stages of audio processing](image)
Understanding End-to-End Latency

Latency as a measure of lip synchronization

[Graph showing audio and video latency over time]

Understanding End-to-End Latency

Latency as a measure of delay-jitter

- Delay-jitter increases playout latency

[Diagram showing sender and receiver with display initiation points and playout gaps]
Understanding End-to-End Latency
Latency as a measure of delay-jitter

- Recall that actual playout time is not a function of the arrival time, only of the end-to-end delay
  - The key application decision is how long to delay the initial sample prior to playout

\[
\text{sample playout time} = \text{sample generation time} + \text{local clock synchronization correction} + \text{sender packaging delay} + \text{network delay} + \text{jitter-buffer delay}
\]

\[
\text{end-to-end latency}
\]

Understanding End-to-End Latency
Latency as a measure of delay-jitter
Understanding End-to-End Latency

Network v. application latency

Network v. Application Latency
Is application induced latency bad?
Videoconferencing on the Internet Today
ProShare™ performance on the Internet

Throughput (frames/sec)

Packet Loss

Audio Latency (ms)

Video Latency (ms)

Videoconferencing on the Internet Today
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Throughput (frames/sec)

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Audio Latency (ms)

Video Latency (ms)
Videoconferencing on the Internet Today
What’s the problem?

- Where is data being delayed and lost?

- Do we need more bandwidth or just better management of the existing bandwidth?
Where do we go from here?
Two fundamental approaches

- Provide true quality-of-service through reservation of resources in the network
  » Requires coordination amongst all parties
    - admission control
    - policing
    - ...
- Provide “best-effort” service by adapting media streams
  » Monitor & provide feedback on performance
  » Bias transmission and processing of media to ameliorate the effects of congestion