Predictable Reliability for Media Streaming over unmanaged Internet

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Internet Media Transport

- Inelastic, delay-sensitive and loss-tolerant
- Managed Internet

or

- Error Control and Congestion Control on transport layer
- Variable channel capacity and multiple access
- Dynamic Streaming (e.g. DASH via HTTP/TCP)

Problem Statement

- Transport layer does not consider individual QoS requirements
- TCP-induced packet loss due to loss-based AIMD congestion control
- Managed Internet requires uninterrupted support from the underlying network infrastructure

Is there any option to provide QoS to media streams on unmanaged Internet paths?
Suppose a transport protocol that ...

- ... receives QoS requirements from the multimedia application ...
- ... and meets delay constraints ...
- ... under the current network state (RTT, packet erasure process, packet interval) ...
- ... with minimum coding overhead and controlled residual packet loss rate.
Predictable Reliability

- vs. total and partial reliability
- Spend application’s "time budget" predictably
- Requires block-erasure model, timing model and protocol performance model
- Reliability Control

Predictably Reliable Real-time Transport
Error Control – adaptive Hybrid Block-Erasure Coding

- parameters $k, N_p$
  a) FEC mode
  b) hybrid mode
  c) incremental redundancy

- Proactive repair packets enable control over the residual packet loss rate
- Reactive repair packets provide immediate adaptivity

Optimum adaptivity to transient network conditions
Experimental Setup

- Bottleneck emulation via Dummynet.
  - Bandwidth 50 Mbps, RTT 50 ms, 100 ms, 150 ms
- PRRT source rate (SR) 5 Mbps, 10 Mbps, 20 Mbps
- Greedy TCP (Cubic) background traffic via Iperf, “TCP-induced packet loss”
## Example Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Transport</th>
<th>Residual PLR</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{RTT} = 50 \text{ ms} ), ( \text{SR} = 20 \text{ Mbps} )</td>
<td>PR-SCTP ( D_T = 300 \text{ ms} )</td>
<td>1.3458%</td>
</tr>
<tr>
<td>( \text{RTT} = 100 \text{ ms} ), ( \text{SR} = 10 \text{ Mbps} )</td>
<td>PR-SCTP ( D_T = 500 \text{ ms} )</td>
<td>6.2276%</td>
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<tr>
<td>( \text{RTT} = 150 \text{ ms} ), ( \text{SR} = 5 \text{ Mbps} )</td>
<td>PR-SCTP ( D_T = 700 \text{ ms} )</td>
<td>6.1445%</td>
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</tbody>
</table>

- **Motivation**
  - Predictable Reliability
  - Experimental Results

- **Example Results**
  - Constant maximum transport latency \( D_T \)
  - Controlled residual packet loss rate \( \approx P_T \)
    - Not achievable via partial reliability!
  - Satisfies ITU-T Y.1541 QoS classes 4 & 7, respectively
Media transport ...

- ... under delay constraint
- ... and Predictable Reliability

➡ “Managed transport pipe through the unmanaged Internet”

Predictably Reliable Real-time Transport (PRRT)