BANDWIDTH AND ROUND-TRIP TIME DETECTION BASED CONGESTION CONTROL FOR MULTIPATH TCP OVER HIGHLY LOSSY SATELLITE NETWORKS

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Introduction

Characters of Highly Lossy Satellite Network

- High propagation delay
  -- long round-trip time (RTT)
- Frequent handover
  -- periodical high packet loss rate
- High bandwidth-delay product

Disadvantage of Current MPTCP Congestion Control Algorithms

- All based on the AIMD (additive increase/multiplicative decrease)
- Interpret packet loss as "congestion"
- Very low bandwidth utilization

Congestion Control Algorithms

Bandwidth and Round-trip Time Detection Based Congestion Control (BWRD)

- Probe the round trip time every $\Delta t_{RTT}$ seconds and record the minimum round trip time.
  - RTT detection value at time $T$ is:
    \[ RTT_{min} = \min(RTT_t) \quad \forall t \in [T - \Delta t_{RTT}, T] \] (1)
- Calculate the delivery rate every $\Delta t_{BtIBw}$ seconds
  \[ \text{deliveryRate} = \frac{ACK_{seq} - \text{lastACK}_{seq}}{\Delta t_{BtIBw}} \] (2)
  \[ BtIBw = \max(\text{deliveryRate}, \Delta t_{BtIBw}) \quad \forall t \in [T - \Delta t_{BtIBw}, T] \] (3)

Satellite Links Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Rate (Mbps)</td>
<td>LEO 1.5</td>
</tr>
<tr>
<td>Delay (ms)</td>
<td>50</td>
</tr>
<tr>
<td>Loss Rate (%)</td>
<td>1</td>
</tr>
<tr>
<td>Handover interval(s)</td>
<td>20</td>
</tr>
<tr>
<td>Handover latency(s)</td>
<td>1</td>
</tr>
<tr>
<td>Loss rate (%)</td>
<td>20</td>
</tr>
<tr>
<td>Total simulation time(s)</td>
<td>50</td>
</tr>
</tbody>
</table>

Simulation Results

- LEO Link
- GEO Link
- Total Throughput