MP-DCCP and congestion control in congestion control

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IETF 110
Multipath solution for UDP – IP traffic

Performs link aggregation by using DCCP as the protocol
  - One DCCP tunnel per path

Use cases: Mobile device multi-connectivity in 3GPP ATSSS, residential multi-connectivity based on Hybrid Access
Congestion control in congestion control

- Tunneling solution results in nested congestion controls
- Multipath brings added complexity
- We use uncoupled congestion control over the two paths
Congestion control in congestion control

- Cheapest path first (strict priority) scheduler
  - Sends data on cheapest path whenever available
  - If the congestion window of the cheapest path is full, it sends on the next available path

- Reordering using an adaptive time limit based on monitored delay difference between the paths
Congestion control in congestion control

- Key challenge: aggregation of capacity over the two paths
- Using the second path before E2E congestion control reacts and slows down the sending rate
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Tunnel throughput over time, stacked with path1 green and path2 red, for four sample configurations

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Rate (Mbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.0</td>
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User-space implementation of multipath framework

- MP-DCCP tunnel framework in user-space offering flexible experimentation
- Program that accepts packets from a Linux TUN-device
- Encapsulate packets with information like path sequence numbers and timestamps
- Scheduling occur over single path sockets
- Solution is only loosely attached to DCCP and allows for other tunnel protocols

- Results from Android experiments with kernel-level implementation presented in tsvwg during IETF 109
Default parameters and CCs used for Mininet experiments

<table>
<thead>
<tr>
<th>Deployment:</th>
<th>Congestion control set</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-to-End:</td>
<td>TCP-Cubic, TCP-BBR</td>
</tr>
<tr>
<td>Tunnel:</td>
<td>TCP-NewReno, TCP-BBR, CCID2, <strong>CCID5</strong>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter:</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Server link RTT:</td>
<td>20 ms</td>
</tr>
<tr>
<td>Path 1 RTT:</td>
<td>20 ms</td>
</tr>
<tr>
<td>Path 2 RTT:</td>
<td>40 ms</td>
</tr>
<tr>
<td>Path 1 &amp; 2 bandwidth:</td>
<td>50 Mbps</td>
</tr>
<tr>
<td>Path 1 &amp; 2 MAC buffer:</td>
<td>500 pkt</td>
</tr>
<tr>
<td>Path 1 &amp; 2 queuing discipline</td>
<td>FIFO</td>
</tr>
</tbody>
</table>

*Implementation of BBRv1 within the modular DCCP CCID framework*
- BBR is performing better as a tunnel protocol, no loss and reacts faster
- BBR over Reno performs poorly here, BBR reacts before second path is used
Having the proxy closer (near) to the UE improves performance as this increases the difference between the tunnel RTT and E2E RTT
Impact of server (E2E RTT) and proxy location, detailed view for BBR over BBR

E2E throughput as a function of deployment scenarios

- BBR, A0, B1000
- Short RTT Distant proxy
- Long RTT Distant proxy
- Short RTT Nearby proxy
- Long RTT Nearby proxy

Tunnel RTT (%) vs. End-to-end RTT (ms)
Summary

- Congestion control in congestion control has important performance impacts on multipath tunneling frameworks
- Complex interaction between many factors
  - Scheduling and reordering mechanism used
  - Choice of congestion controls
  - Placement of proxy functionality
  - Path characteristics
- Overall BBR performs better than Reno as CC for the tunnel
- Having the proxy close to the user is typically beneficial
- This is ongoing work and more results are coming…
Related drafts