Link Characteristics
Information conveyance

MOBOPTS IETF #65

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Introduction

• Preliminary results from two different sets of simulations utilizing explicit LCI delivery
• Using TCP as the example transport
• Simulation 1
  – LCI delivered as a part of MIP6 signaling and applied to TCP (a Quick-start like variant)
• Simulation 2
  – LCI delivered after the hand-off and used to re-trigger TCP Quick-start
• These are the first experiments...
Quick-Start Challenges

• Deployment to the Internet unlikely to happen soon
  – Deployment to operator networks / private intranets less unlikely
• IP tunnels “hide” QS requests
• Buggy firewalls/NATs can drop packets with unknown IP option
  – As of today, there are lots of them!
Simulation 1

• "TCP Quick-Adjust (QA) by Utilising Access Link Characteristic Information"
• An extension of TCP Quick-Start (QS)
  – Adjusts and sets maxcwnd & cwnd to both directions
• An algorithm of utilizing the explicit link characteristic information (LCI) for TCP

Assumptions:
• The LCI is of the bottleneck link of the whole path.
• The LCI notification is timely.
Simulation Scenario

- An MN moving between WLAN (set to 1Mbps) and GPRS (set to 40.2/13.4kbps).
- FTP data transfer from CN to MN.
- Mobile IPv6 is used for mobility management and LCI transportation.
Evaluation Results
-- WLAN AP and GPRS BS Downlink Queue Length Variation

<table>
<thead>
<tr>
<th></th>
<th>WLAN Throughput</th>
<th>GPRS Throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal TCP SACK</td>
<td>772.8 kbps</td>
<td>33.9 kbps</td>
</tr>
<tr>
<td>TCP Quick-Adjust</td>
<td>772.9 kbps</td>
<td>33.2 kbps</td>
</tr>
</tbody>
</table>
Evaluation Results (Cont.)

-- TCP Trace on WLAN => GPRS Handover

TCP SACK: WLAN->GPRS src TCP

TCP SACK + QA: WLAN->GPRS src TCP

TCP SACK: WLAN->GPRS dst TCP

TCP SACK + QA: WLAN->GPRS dst TCP
Evaluation Results (Cont.)

-- TCP Trace on GPRS => WLAN Handover

TCP SACK: GPRS->WLAN src TCP

TCP SACK: GPRS->WLAN dst TCP

new packets arrived from WLAN

packets drained from GPRS

TCP SACK + QA: GPRS->WLAN src TCP

packet burst

cwnd & maxcwnd increased

fast retransmit triggered

TCP SACK + QA: GPRS->WLAN dst TCP

out-of-order packets that trigger fast retransmit

a duplicate packet caused by fast transmit
Simulation 2: TCP and Vertical Hand-offs

- Somewhat similar network setup as in simulation 1 (WLAN 5Mbps/20ms, EGPRS 200Kbps/600ms)
- TCP congestion window is adjusted rather slowly
  - Slow-start in beginning: double congestion window in one RTT
  - Congestion avoidance: increase congestion window by one in one RTT
  - Packet loss => window is halved
- After hand-off, new path can have different capacity than earlier had
  - Congestion window could be far off from it should be
- As a result:
  - Too large congestion window => many packets are lost
  - Too small congestion window => wireless link is utilized inefficiently
Performance in Connection Start-up

- Connection performance on different TCP file sizes
- Qsthrsh: set TCP congestion window and slow-start threshold based on QS
- Default slow-start threshold leads to packet losses
  - TCP congestion control feed-back is “late” by one RTT
Hand-off Performance

- Break-before-make / Wireless LAN to EGPRS
- With QS, capacity of new path is resolved immediately
- Normal TCP converges slowly to new capacity
Conclusions and Next Steps

• Link characteristics is often essential part of the path characteristics
  – Exact information is hard to get immediately after a ho
  – LCI is more likely a good guess when the change is significant
• Our simulations indicated that LCI delivery can expedite the transport adaptation to new link
• Similar approaches can be used to enhance other transport protocols, such as SCTP, DCCP, RTP/RTCP etc.
• Further work & simulations on delivering notification on ‘significant’ Delay and/or Bandwidth changes (and possibly ho type)
• The gathering and delivery methods of the bottleneck link characteristic information need further investigations
Questions and stuff?