A Path-Aware Scheduling Scheme for MPTCP

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Latency-Sensitive applications

• Latency-Sensitive applications require the data delivered in the path with the lowest latency

• RTT is commonly used as a condition for data scheduling amongst multiple paths

• However, the delays of the forward path and the reverse path may be different in
  ➢ wireless environment
  ➢ scenario when congestion causes the different queue delays

• Better to consider OWL for data scheduling
Example: Scheduling based on RTT

Data will be scheduled in Path 2 based on RTT.
Example: Scheduling based on OWL

Data will be scheduled in Path 1 based on OWL.
Example: Scheduling based on OWL

Considering the interactive latency, data will be scheduled in Path 1, while ACK will scheduled in Path 3.
A Path-Aware Scheduling Scheme

Design principles:
• employ redundant transmission when path characteristics are unknown;
• always send data in the path with the lowest OWL;
• periodically update the OWLs of all paths and schedule data again.
Initialization

- transmit data redundantly until obtain the effective OWLs of all paths;
- / transmit data redundantly for a period of time (e.g. 1s ).
Packet Scheduling

- Always send data in the path with the lowest OWL, for example, If $d\text{OWL} < 0$, send data in Path 1; Else send data in Path 2.

OWL (1) = $T_{\text{recv}} (1) - T_{\text{send}} (1) + dT$
OWL (2) = $T_{\text{recv}} (2) - T_{\text{send}} (2) + dT$

where

$T_{\text{send}} (i)$ is the sending time of the data;
$T_{\text{recv}} (i)$ is the receiving time of the data;
$dT$ is the the time difference caused by the absolute clock time.

$d\text{OWL} = \text{OWL} (1) - \text{OWL} (2)$
- no time synchronization issue
Periodically Redundant Transmission

Every 10 seconds, redundant transmission is activated, which
• obtain the OWLs of all paths in the same time;
• without introducing extra packets;
• guarantee the lowest delivery time no matter which path the data goes through.
Immediately Activate the Redundant Transmission

The OWL of the selected path is not the lowest any more

- When the OWL of the selected path has increased so much that it may not be the lowest any more, the redundant transmission is activated immediately.
Implementation Consideration

- A new MPTCP option (MP_OWL Option) is defined to carry the timestamp of data receiving at the receiver.

MP_OWL option (Kind = 30)

Subtype of MP_OWL option (Subtype = 0x8)

Value | Symbol | Name
---|---|---
0x8 | MP_OWL | One-Way Latency
OWL Calculation

• Negotiation needed ensuring MP_OWL option is supported

• The steps of OWL calculation:

  ➢ the sender sends each data and remember $T_{send}$ of the data;
  ➢ the receiver responses an ACK with $T_{recv}$ of the data;
  ➢ the sender fetches $T_{recv}$ from the ACK and subtracts $T_{send}$ of the data to get the OWL ($OWL = T_{recv} - T_{send}$).
Thank you

Questions/Comments

Any interest in continuing this work?