Improving TCP/IP Performance Over Wireless Networks

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ACM MOBICOM 95

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Outline

- Introduction
- Related Work
- Snoop Protocol
- Implement
- Performance
- Summary and Future Work
Introduction

- TCP is a reliable transport protocol
  - Correct packets order (receiver)
  - ACK confirms delivery to receiver
  - Reliability achieved by retransmissions
  - Congestion control results in unnecessary reduction
    - Why is unnecessary?
**Related Work (1/2)**

- TCP has poor end-to-end performance in wireless medium
  - The split connection approach (Indirect-TCP)
    - **Advantage:**
      - separate flow and congestion control of wireless link
    - **Disadvantage:**
      - ACK and semantics are not end-to-end
      - Mobile host have to relink the I-TCP library
      - Each packet needs to go through the TCP protocol four times

![Diagram showing Fixed Host (FH) and Mobile Host (MH)]
Related Work (2/2)

- Link-Level retransmission
  - Advantages:
    - End-to-end semantics is maintained
    - Not need relink I-TCP library
  - Disadvantages:
    - Link-level timeout may interact with TCP timeout
    - It adds to congestion when error-rate becomes significantly
Snoop Protocol

- Environment
  - From fixed host through base station to mobile host
- Snoop is a module in BS
- Main function
  - It works by caching unacknowledged TCP data at the BS and performing local retransmission based on a few policies dealing with acknowledgments and timeouts
    - Snoop_data()
    - Snoop_ack()
The packet from FH to BS has three cases:
- A new packet in a normal TCP sequence:
  - Ex: N-2, N-1, N…….arrives
- An out-of-sequence packet that has been cached earlier
  - When timeout or fast-transmission at the sender
    - The seq. number is greater than last acknowledgement
    - The seq. number is less than last acknowledgement
- An out-of-sequence packet that has not been cached earlier
  - When lost due to congestion on wired network or
  - It has been deliverd out-of-order by the network
Snoop_data()(2/3)

Figure 1. Flowchart for snoop_data().
Snoop_data() (3/3)

FH -- Seq.=12345 --> BS

FH -- Seq.=11000 --> Snoop_cache

BS -- Seq.=11345 --> Seq.=13345
Snoop_ack() (1/3)

- Snoop_ack() monitors and processes ACKs sent by MH to BS
- ACKs’ categories:
  - A new ACK
  - A spurious ACK
    - Happen by the wireless network has different delay
  - A duplicate ACK (DUPACK)

```
ACK=1100
ACK=1200
ACK=1155
Snoop_cache
ACK=1200
```
Duplicate ACK

- A duplicate ACK (DUPACK)
  - The packet is either not in snoop cache or has been marked (as having been retransmitted by the FH)
  - Get first DUPACK arrives for the lost packet
    - Make the number of the DUPACKs as small as possible
    - Set maximum number of DUPACKs
      - How set the number
  - An “expected” DUPACK based on the above maximum
Snoop_ack()(2/3)

Figure 2. Flowchart for snoop_ack().
Snoop_ack()
Implement(1/3)

- Environment
  - Testbed, IBM ThinkPad laptops, i486, BSD/OS2.0, AT&T
    2Mb/s per MH
- Cache
  - Pointer information includes: the packet seq. number, cache size, local transmission number, a flag set
  - Highwater mark strategy (HWM)
- How drive retransmission by timeouts
  - Two timer
Implement (2/3)

- The round trip timer
  - Based on the smooth round-trip time (srtt) of last link
    - srtt = (1-a)*old_srtt + a*curr_rtt (default a=0.25)
    - Timer interrupt threshold set to 40ms
  - If ACK hasn’t been received in twice srtt the packet retransmit
    - After first retransmission caused by DUPACK
  - This avoid unnecessary retransmission
Implement (3/3)

- The persist timer
  - When?
    - If there are unacknowledged packet in the cache
    - Sender or receiver has been no activity for 200ms
  - Do what?
    - retransmission
    - Set the number of expected DUPACKs to zero
    - Set next expected ACK
Performance (1/3)

Figure 4. Throughput received by the mobile host at different bit-error rates (log₂ scale). The vertical error bars show the standard deviations of the receiver throughput.
Figure 5. Sequence numbers for transfer to mobile host over channel with $3.8 \times 10^{-6}$ (1/256 Kbits) BER.
Performance(3/3)

- Solve I-TCP problems
  - Maintain end-to-end semantics between FH and MH
  - No relink the application
  - Degrade the overhead of data
  - No additional congestion control retransmission
Summary and Future Work

- Metricom system
  - It has multiple wireless hops from the BS to MH
  - Bandwidth is about 100Kbits/s

- We improve the performance in unreliable links and multiple errors in a window from FH to MH