ATCP : TCP for Mobile Ad Hoc Networks

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Motivation

- WireLess Network is Different from WireLine Network
- Ad Hoc Network
  - Node Mobility
  - Network Partition
Mobility Example:
Explicit Congestion Notification

By S. Floyd and Team

- Active queue management with RED
- RED can drop a packet or set a bit

ECN-Echo flag 1, CWR flag 1 (SYN)

ECT 1

CE 1

ECN-Echo flag 0, CWR flag 1

ECN-Echo flag 1
Dynamic Source Routing

Route Discover – Route Record

Propagation of Route Reply with Route Record
TORA-Route Creation

QRY packet

UPD pkt – height updates
TCP in Ad Hoc Network

- High Bit Error Rate (BER)
- Route Recomputation
- Network Partition
- Multipath Routing
Goal

- High BER – retransmit lost pkt
- Route Recomputation & Transient Partition - stop transmitting
- Multipath Routing – No congestion control
- Maintain TCP’s congestion control
ATCP Functioning

- States – Normal, congested, loss and disconnected
- Lossy Channel – ATCP loss state and TCP Persist state
- Disconnected – ICMP destination unreachable, TCP in persist state and ATCP in disconnected state
- Congested – ECN flag, ATCP in congested state and do nothing!
State transition diagram

- Receive "Destination Unreachable" ICMP, CWND 1
- Receive ECN
- TCP transmits a pkt
- New Ack
- RTO About to Expire OR 3 dup ACKs
- ATCP Retransmits segments in TCP's buffer
- TCP sender put in persist state
- Receive dup ACK or pkt from receiver
Data flow - TCP/ATCP/IP stack

```
TCP_input()
  ATCP_input()
    ipintr()
      data
---
TCP_output()
  ATCP_output()
    ip_output()
      data
```
Flowchart for function atcp_input()
Flowchart for function atcp_output()
Performance study

- Five Pentium PCs, each with two Ethernet cards
- Emulate wireless in IP, 32 Kbps channel
- Bit error rate $10^{-5}$
- Random hop-by-hop delay
- Network congestion – 5 sec
- Partition – 5 minutes and last for 1 min.
- Packet reordering – 25 seconds
Bit Error - Performance

![Graph showing TCP sequence numbers over time]

- Sequence number vs. Time (seconds)
- TCP sequence numbers in 5 seconds
- ATCP sequence numbers in 2 seconds
Bit Error, Congestion Window

TCP congestion window size

ATCP congestion window size
Congestion and Partition Performance

- **Congestion**
  - Hop by hop delay (ms) vs. Transfer time (second)

- **Partition**
  - Hop by hop delay (ms) vs. Transfer time (second)
Overall Performance
Conclusion

- End-to-End TCP semantics are maintained
- ATCP is transparent
- ATCP does not interfere with TCP’s congestion control behavior
- ATCP improves performance by one-third
- ECN as standard - WIP
References

- RFC 2481
- draft-ietf-manet-tora-spec-02.txt draft-ietf-manet-tora-spec-02.txt