ATCP : TCP for Mobile Ad Hoc Networks

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Outline

- Introduction
- Design of ATCP
- Implementation of ATCP
- Simulation results and analyses
- Conclusion
Introduction

- TCP over Ad Hoc Networks
  - High bit error rate
  - Frequent route change
  - partition

(a) Route change forced by mobility
(b) Partitions are formed and recombined by mobility
Introduction (cont.)

- Implementing a thin layer between IP and TCP.
  - ATCP (Ad hoc TCP)
  - Standard TCP/IP is unmodified
  - ATCP is invisible to TCP
Design goals

- Improve TCP performance for connections setup in ad hoc networks.
- Maintain TCP’s congestion control behavior.
- Appropriate congestion window behavior.
- Maintain end-to-end TCP semantics.
- Be compatible with standard TCP.
This paper utilizes network layer feedback to put the TCP sender into either a persist state, congestion control state, or retransmit state.
State transition diagram for ATCP at the sender
Implementation of ATCP
Data flow through the TCP/ATCP/IP stack
Flowchart for function \texttt{atcp\_timer()}

1. \texttt{ATCP state=normal?}
   - \texttt{Yes}: adjust RTO, RTT
   - \texttt{No}: \texttt{ATCP state = conj. or disc}
     - \texttt{No}: call tcp\_timers()
     - \texttt{Yes}: send timed out packet
       - put TCP to persist mode
       - set ATCP state to loss
Flowchart for function atcp_input()
Flowchart for function atcp_output()
Flowchart for ATCP transition between normal and loss states
Simulation results and analyses
ATCP and TCP performance in the presence of bit error only
TCP trace in the presence of bit error only
ATCP trace in the presence of bit error only
TCP congestion windows in the presence of bit error only
ATCP congestion windows in the presence of bit error only
ATCP and TCP performance in the presence of bit error and congestion
ATCP and TCP performance in the presence of bit error and partition
ATCP and TCP performance in the presence of bit error and larger partition
Route re-computation causes packet reordering
ATCP and TCP performance in the presence of bit error and packet reordering
TCP and ATCP transfer time for 1MB data in the general case
<table>
<thead>
<tr>
<th>Circumstance</th>
<th>ATCP</th>
<th>[7]</th>
<th>[4]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet Loss due to high BER</td>
<td>ATCP Retransmits, TCP does not invoke CC</td>
<td>Not Handled</td>
<td>Not Handled</td>
</tr>
<tr>
<td>Route Changes</td>
<td>ICMP “Destination Unreachable” puts sender in persist until new route found</td>
<td>ELFN freezes sender state</td>
<td>RRN freezes sender state</td>
</tr>
<tr>
<td>Network Partition</td>
<td>As above</td>
<td>As above</td>
<td>As above</td>
</tr>
<tr>
<td>Packet Reordering</td>
<td>ATCP reorders packets so TCP does not generate duplicates</td>
<td>Not handled</td>
<td>Not handled</td>
</tr>
<tr>
<td>Congestion</td>
<td>ECN used to quickly notify sender of congestion. Sender invokes CC.</td>
<td>Not Handled</td>
<td>Not Handled</td>
</tr>
<tr>
<td>CWND</td>
<td>Reset for each new route</td>
<td>Old CWND used</td>
<td>Old CWND used</td>
</tr>
</tbody>
</table>

Conclusion

- The highlights of ATCP are the following:
  - End-to-end TCP semantics are maintained.
  - ATCP is transparent.
  - ATCP does not interfere with TCP’s congestion control behavior when there is network congestion.