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CS551

Handoff Performance in Cellular Networks

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<http://merlot.usc.edu/cs551-f12>

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Key Ideas

- Deals with TCP in mobile environments
- packet loss (corruption)
- handoff (changing from one base station to another)
- Snoop
- base stations cache TCP segments and quickly retransmit
- Handoff
- cache TCP segments at nearby base-stations to allow rapid handoff

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Problem: TCP Loss Handling in Wireless

- TCP assumes loss implies congestion
- TCP's reaction: reduce sending rate
- Wireless adds losses due to corruption, collision, handoff
- desired reaction: retransmit lost packets quickly
- Approach:
 - let base-station help out
 - alternative is to do link-level reliability

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Alternatives

- Split-connection TCP:
 - from BS, use one TCP connection to FH and another to MH
 - but requires changes to FH, BS, MH
 - what does an ACK mean now?
- Make TCP distinguish congestion vs. other kinds of loss
- good idea: done with ECN
- but done after this work and not widely deployed even today
- requires changes to FH and MH
- Link-layer retransmission
 - good idea, but must be careful to avoid interactions between link-layer and TCP (works if on different timescale)

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Constraints

- Incremental deployment
- Solution should not require modifications to fixed hosts
- if possible, avoid modifying mobile hosts
- Preserve TCP end-to-end semantics
- ACK of a packet means it's at the receiver, not the base station

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Snoop Overview

Base Station (BS) *snoops* passing traffic (data/acks); quickly retx's data

FH-to-MH:

- Fixed Host (FH) sends data to MH
- no change to FH code
- MH receives data, sends ACKs as usual

MH-to-FH:

- BS adds SACK support (even if FH doesn't support it)
- BS sends ACKs to FH
- Data is sent from BS to FH

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Diagram

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FH-to-MH Snoop Data Processing

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- Packet in sequence
- Add to cache and pass on
- Out of sequence, cached
- Should not be common
- Greater than last acked: pass on
- Else: generate ACK to fixed host (may be caused by a lost ACK)
- Out of sequence, not cached
- Lost or delayed out-of-order
- Pass on, and keep information

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Handoff Support

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- General approach:
 - extend mobile IP to *multicast* packets to several F'A's (base stations, BSes)
 - MH informs BS when it's changing
 - BSes are pre-loaded w/data, can run snoop and quickly repair losses

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Discussion

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- Impact
- deployable solution for wireless performance enhancement
- Does this violate the end-to-end argument?
- Other examples?
 - fast-retransmit in TCP
 - layer-4 caching? (i.e., caching HTTP without the end points knowing it)
- Nice aspects of Snoop
 - minimal changes to improve performance
 - soft-state design
 - preserves TCP semantics
 - implementation

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Snoop ACK Processing

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- New ACK
- Pass on to FH
- Clean up cache
- Duplicate ACK
- If data not in cache, or sender retransmits, pass on to FH (not in flowchart)
- If in cache, respond immediately
- suppress other dupacks

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Other Issues

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- What about mobile-to-fixed communication?
 - Modify snoop module to generate SACKs
 - TCP over ad-hoc networks?
 - Open area of research

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