CS551
Handoff Performance in Cellular Networks
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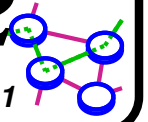
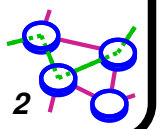
http://merlot.usc.edu/cs551-f12



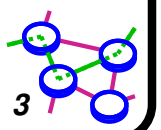
Key Ideas

- 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



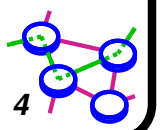
Problem: TCP Loss Handling in Wireless

- 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



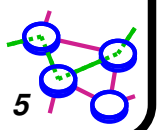
Alternatives

- 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)



Constraints

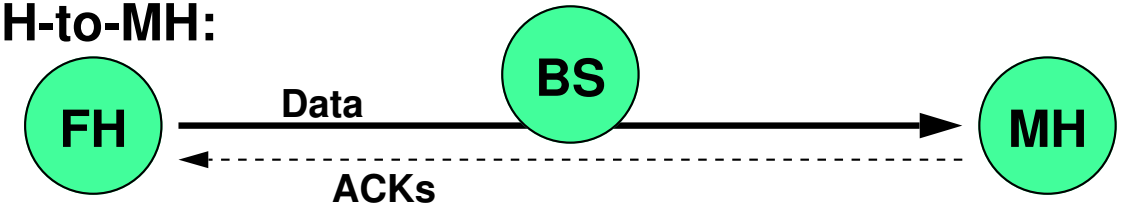
- Incremental deployment
  - Solution should not require modifications to fixed hosts
  - If possible, avoid modifying mobile hosts
- Preserve TCP end-to-end semantics
  - ACK of a packet means it's at the receiver, not the base station



Snoop Overview

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

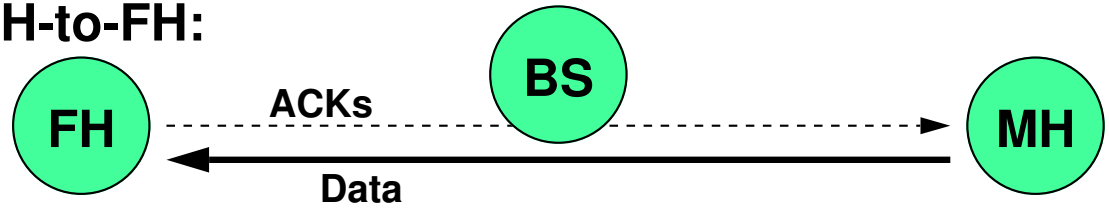
FH-to-MH:



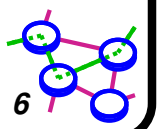
Fixed Host (FH)
sends data to MH
no change to FH code

Mobile Host (MH)
receives data,
sends ACKs as usual

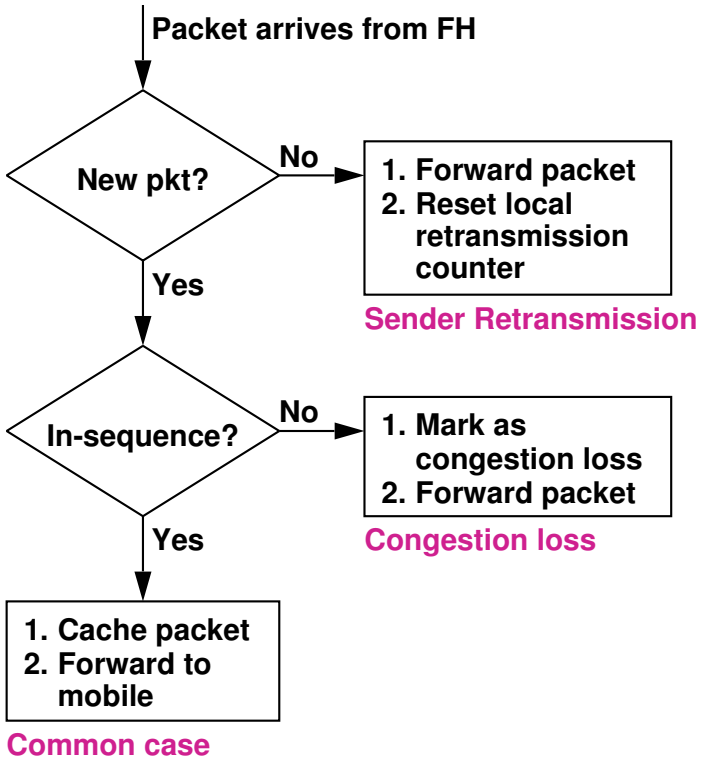
MH-to-FH:



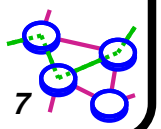
BS adds SACK support
(even if FH doesn't support it)



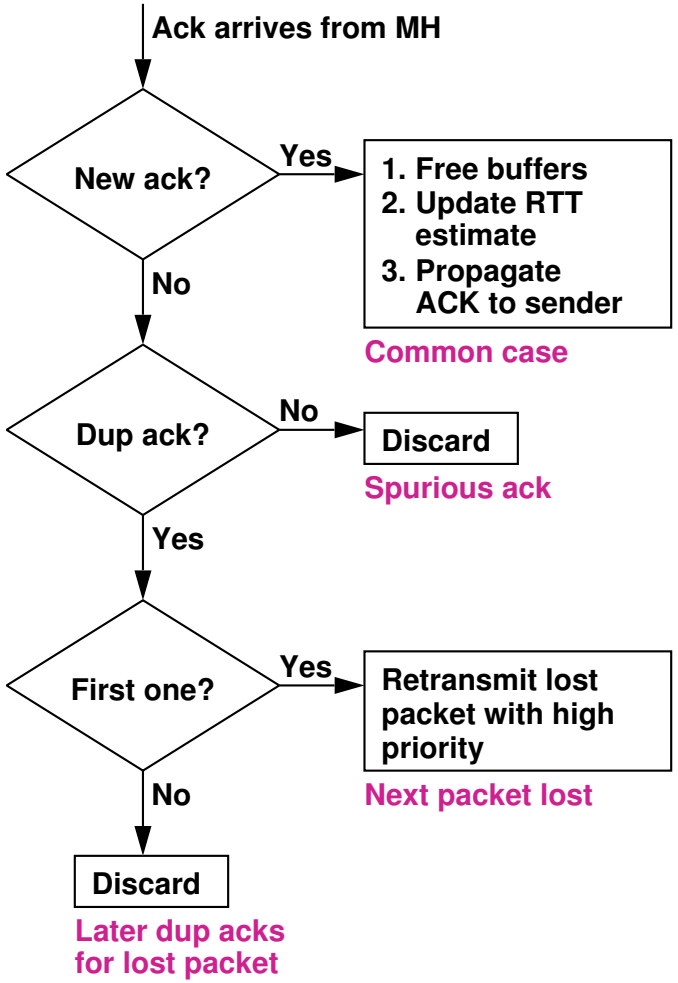
FH-to-MH Snoop Data Processing



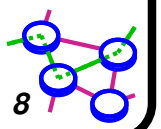
- **Packet in sequence**
  - Add to cache and pass on
- **Out of sequence, cached**
  - Should not be common
  - Greater than last acked: pass on
  - Else: generate ACK to fixed host (may be caused by a lost ACK)
- **Out of sequence, not cached**
  - Lost or delayed out-of-order
  - Pass on, and keep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



Snoop ACK Processing

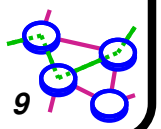


- **New ACK**
  - Pass on to FH
  - Clean up cache
- **Duplicate ACK**
  - If data not in cache, or sender retransmit, pass on to FH (not in flowchart)
  - If in cache, respond immediately
    - suppress other dupacks



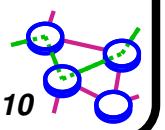
Handoff Support

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



Other Issues

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



Discussion

- 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