Micro-mobility in IPv6

- Cellular IP: a hierarchy of “anchor points”
- MN attaches to a BS, which attaches to a CIP gw
- Similarly in IPv6 we have “hierarchical mobile IPv6” (HMIPv6)
- A mobile anchor point (MAP) appears between the HA and MN
- Attached to the MAP are several access routers
- The MAP acts like a local HA – within the MAP’s domain, the MN acquires a new IP address called a link COA (LCOA)
- Packets can be forwarded by the access routers from an old LCOA to a new LCOA

(Fig. 1)

Mobile considerations at the transport layer

- Transport layer services:
    - Sockets by application (e.g., 80=http, 22=ssh)
    - Virtual circuit (in-order packet delivery)
    - Flow control and congestion avoidance
- Broadly speaking:
    - Network layer ensures packets get from one host to another
    - Transport layer maintains an end-to-end connection
- Two most common transport layer protocols:
    - User Datagram Protocol (UDP) – provides sockets but no virtual circuit or flow control – simplest transport layer protocol

    - Transmission Control Protocol (TCP) – provides all major transport layer services
- Sockets don't change in mobile, so no changes are made to UDP in mobile applications – we will focus on TCP

Review of TCP flow control

- from the mobile perspective, only the flow control aspects of TCP are important
- Flow control necessary because links on the internet have different bandwidths – must have a way of avoiding buffer overflow

(Fig. 2)

- Example. Downloading a 1-gigabyte file over a two-hop connection: first link 1 Gbps (e.g., backbone), second link 1 Mbps (e.g., DSL) – if the intermediate router's buffer is small, lots of packets get dropped and retransmitted (congestion)
- Idea of flow control is to use the network maximally without causing lots of congestion
- Key concepts:
    - After each packet is sent, the final destination returns an ACK to indicate successful delivery
    - Congestion window: Number of packets that source can transmit while waiting for ACK
    - Slow start (SS): First phase of TCP – size of congestion window starts at 1 and doubles with every successfully acknowledged packet

    - Congestion avoidance (CA): Second phase of TCP – size of congestion window increases by one with every successfully acknowledged packet
    - Congestion threshold: Size of congestion window at the transition between SS and CA
- Example: Congestion threshold=8

(Fig. 3)

- Eventually, the congestion window will grow so large that congestion occurs – when this happens, intermediate routers will drop packets and those packets will not be ACKed
- Source waits for ACKs until a timeout expires, then declares them lost
- If packets are lost, the congestion threshold is set to one half the current congestion window size, and goes back to slow start
- Example

(Fig. 4)

- The assumption in wired TCP is that all packet losses are caused by congestion, and none are caused by noise
- This is not a valid assumption in wireless networks and causes more slow starts than are necessary – thus lower throughput than necessary