Outline

- MIPv4 Micro-mobility solutions
  - Host-based Routing Protocols
    - Cellular IP
    - HAWAII (Handoff-Aware Wireless Access Internet Infrastructure)
Wireless Access Networks model 2/3

- Packets addressed to a mobile host are routed to its current base station on a hop-by-hop basis where each node only needs to know on which of its outgoing ports to forward packets.
- **Mappings**: map mobile host identifiers (IP addresses) to node ports.
- Mappings are created by packets transmitted by mobile hosts, (packets travel toward the gateway router, routed on a hop-by-hop basis)
- Mappings are not cleared in an explicit way after handoff (timers to clear outdated mappings)
- Cheap passive connectivity: use of paging

Paging 1/2

Idle mobile hosts periodically generate *paging-update packets* sending them to the nearest available base station.

Paging 2/2

For a short time two mappings can coexist (at E for example) guaranteeing that the host always remains reachable during migration.
Use of paging caches to locate MH

When IP packets arrive at the GW, addressed to a MH for which no up-to-date routing information is available, the gateway queues the arrived IP packets and generates a paging packet.

Upon receiving the paging packet, the MH creates a route-update packet. Route-update packets travel to the GW routed on a hop-by-hop basis, and create mappings for the MH in Routing Caches on the way.

Routing

<table>
<thead>
<tr>
<th></th>
<th>Paging Cache (PC)</th>
<th>Routing Cache (RC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>driven by</td>
<td>all mobile-originated packets (data, route-update, paging-update)</td>
<td>mobile-originated data and route-update packets</td>
</tr>
<tr>
<td>scope</td>
<td>both idle and active mobile hosts</td>
<td>active mobile hosts only</td>
</tr>
<tr>
<td>purpose</td>
<td>route paging packets</td>
<td>route mobile-addressed data packets</td>
</tr>
<tr>
<td>time scale</td>
<td>mobility</td>
<td>packet</td>
</tr>
</tbody>
</table>

The MH may keep receiving data packets without sending data for some time. To keep RCs configured and to avoid repeated paging, MHs expecting data (when, for instance, a TCP connection is open) but having no packets to transmit must keep transmitting route-update packets periodically.
HAWAII

- Uses specialized path setup schemes which install host-based forwarding entries in specific routers to handle intra-domain micro-mobility
- Defaults to using mobile IP for inter-domain macro-mobility
- Requires that MH obtains a co-located care of address within a domain, nevertheless MH is required to register with a BS within the domain to be able to better handle handoffs
- MH sends path setup update messages during power up and after handoffs

Network Architecture

- Packets destined to MH reach home domain root router, and are forwarded to MH based on specially established dynamic paths
- When first entering foreign domain, MH assigned a co-located care-of-address (DHCP for example) and register according to Mobile IP protocol
- Packets intercepted by HA, tunneled to foreign domain root router and forwarded to MH based on specially established paths
- Message types
  - Power up (establish host-specific routes)
  - Update (establish and update host-specific routes)
  - Refresh (path state is soft-state, MH sends periodic messages to BS to maintain host-based entries, BS and intermediate routers send aggregate hop-by-hop refresh messages towards domain root router)

Path Setup Message after Power up

- Other routers in the domain that do not maintain host-based entries?
- When receive packets for MH, forward on default route to domain root router
- If in foreign domain, MH performs Mobile IP registration with HA
Path Setup Schemes

- **Forwarding**
  - Packets forwarded from old BS to new BS before being diverted at crossover router
  - Rely on wired network to buffer packets and deliver to new BS

- **Non-forwarding**
  - Packets diverted at crossover router resulting in no forwarding of packets at new BS
  - Takes advantage of some wireless links capabilities where connectivity can be maintained between MH and old BS and new BS during a handoff

**Forwarding Path Setup Schemes: MSF**
- Can create multiple streams of misordered packets at MH
- Message 6 is the ACK back to the MH

**Forwarding Path Setup Schemes: SSF**
- SSF: Single Stream Forwarding
- Similar to Mobile IP RO, but does not require tunneling
- Uses interface-based forwarding (extends routing table entry)
- Route packets based on incoming interface of the packet and MH IP address
- Message 7 is the ACK back to MH

**Non Forwarding Path Setup Schemes: UNF**
- Unicast non-forwarding
- MH is able to listen/transmit to two or more BSs for a short duration (CDMA)
- As a result from Message 1, new BS, looks up the interface towards old BS
- Message 6 is ACK to the MH
Non Forwarding Path Setup Schemes: MNF

- Multicast non-forwarding
- MH is able to listen/transmit to only one BS (TDMA)
- Router 0 bi-casts data packets on interfaces B and C for a short duration until message 6 is received
- Message 7 is ACK to MH