Mobile IPv4 Micro-mobility

Host-based Routing
Outline

• MIPv4 Micro-mobility solutions
  ➢ Host-based Routing Protocols
    ✓ Cellular IP
    ✓ HAWAII (Handoff-Aware Wireless Access Internet Infrastructure)
Wireless Access Network and Mobile IP

- Coarse grain mobility
- Fine grain mobility
- Global Internet with Mobile IP
- Wireless access network
- Local handoffs
- Global mobility
- Redirect
- Gateway

MIPv4 Micro-mobility, Host-based Routing

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Wireless Access Networks model 1/3
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• mappings are not cleared in an explicit way after handoff (timers to clear outdated mappings)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
Wireless Access Networks model 3/3

- two parallel structures of mappings
  - Paging caches for idle mobile hosts
    - Timeout in order of seconds or minutes (migration frequency)
  - Routing caches for active mobile hosts (receiving or expecting to receive data)
    - Timeout in order of packet time scale
Idle mobile hosts periodically generate *paging-update packets* sending them to the nearest available base station.
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 1: Comparison of Paging and 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.
Handoff
MH State Diagram

IDLE
- paging packet arrives or connection opened
- send paging-update packets

ACTIVE
- send route-update packets when there is no data to send
- all connections closed, no data expected

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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 1/2
Network Architecture 2/2

• 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

MSF: Multiple Stream Forwarding
Message 1 contains new BS’s address
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