Topics Covered: Mobility and Mobile IP

Reading assignment:

- Chapter 4.9 from
  Addison-Wesley, July 2002.

- Tanenbaum Chapter 4.2 (recommended)
What is mobility?

- spectrum of mobility, from the *network* perspective:

  - no mobility
  - mobile user, using same access point
  - mobile user, connecting/disconnecting from network using DHCP
  - mobile user, passing through multiple access points while maintaining ongoing connections (like cell phone)

Can a mobile client keep its address as it moves between networks?

- DHCP vs. Mobile IP
- Level of transparency desired by certain applications

- What supporting wired infrastructure is available?
  - We assume a fixed wired infrastructure to which the mobile client can connect
  - *Ad hoc Networking* provides the capability for two clients near each other to establish a network connection in the absence of a network-layer infrastructure
**Mobility: Vocabulary**

- **home network**: permanent "home" of mobile (e.g., 128.119.40/24)
- **home agent**: entity that will perform mobility functions on behalf of mobile, when mobile is remote
- **Permanent address**: address in home network, can always be used to reach mobile (e.g., 128.119.40.186)

**Mobility: more vocabulary**

- **Permanent address**: remains constant (e.g., 128.119.40.186)
- **Care-of-address**: address in visited network (e.g., 79.129.13.2)
- **foreign (visited) network**: network in which mobile currently resides (e.g., 79.129.13/24)
- **foreign agent**: entity in visited network that performs mobility functions on behalf of mobile
- **correspondent**: wants to communicate with mobile
How do you contact a mobile friend:

Consider friend frequently changing addresses, how do you find her?
- search all phone books?
- call her parents?
- expect her to let you know where he/she is?

I wonder where Alice moved to?

Mobility: approaches

- **Let routing infrastructure handle it:** routers advertise permanent address of mobile-nodes-in-residence via usual routing table exchange.
  - routing tables indicate where each mobile located
  - no changes to end-systems
- **Let end-systems handle it:** push mobility support from core to network edge
  - **indirect routing:** communication from correspondent to mobile goes through home agent, then forwarded to remote
  - **direct routing:** correspondent gets foreign address of mobile, sends directly to mobile
Mobility: approaches

- *Let routing handle it:* routers advertise permanent address of mobile nodes in residence via usual routing table exchange
  - routing tables indicate where each mobile located
  - no changes to end-systems
- *let end-systems handle it:* (Internet architecture)
  - **indirect routing:** communication from correspondent to mobile goes through home agent, then forwarded to remote
  - **direct routing:** correspondent gets foreign address of mobile, sends directly to mobile

Mobility: addressing

- Mobile client uses two addresses:
  - **permanent address:** used by correspondent (hence mobile location is *transparent* to correspondent)
  - **care-of-address:** used by home agent to forward datagrams to mobile
- Foreign agent maintains a COA for the mobile client; informs the home agent that the mobile node is resident in its (foreign) network
- The home agent in mobile node’s home network can keep track of foreign network in which the mobile client resides
**Mobility: registration**

1. Mobile contacts foreign agent on entering visited network
2. Foreign agent contacts home agent home: “this mobile is resident in my network”

**End result:**
- Foreign agent knows about mobile
- Home agent knows location of mobile

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**1) Mobility via Indirect Routing**

1. Correspondent addresses packets using home address of mobile
2. Home agent intercepts packets, forwards to foreign agent
3. Foreign agent receives packets, forwards to mobile
4. Mobile replies directly to correspondent

*e.g. used in mobile IP*
Indirect Routing: comments

- foreign agent functions may be done by mobile itself
- triangle routing: datagram addressed to mobile node
  must be first routed thru the home network and then to the foreign network.

- Specially inefficient when correspondent, mobile
  are in same network

Forwarding datagrams to remote mobile

Encapsulation and Decapsulation

Packet sent by home agent to foreign
agent: a packet within a packet

- dest: 79.129.13.2
- dest: 128.119.40.186

Packet sent by correspondent
- dest: 128.119.40.186

Foreign-agent-to-mobile packet
- dest: 128.119.40.186
### Indirect Routing: moving between networks

- Suppose mobile user moves to another network
  - Registers with new foreign agent
  - New foreign agent registers with home agent
  - Home agent update care-of-address for mobile
  - Packets continue to be forwarded to mobile (but with new care-of-address)

- Possible that a few datagram messages get lost during this transition?
  - **YES.** Higher-level mechanism can handle retransmission.
  - Mobility, changing foreign networks transparent: ongoing connections can be maintained!

### 2) Mobility via Direct Routing

1. Correspondent requests, receives foreign address of mobile
2. Correspondent forwards request to foreign agent
3. Foreign agent receives packets, forwards to mobile
4. Mobile replies directly to correspondent

*E.g. used in GSM cellphone networks*
**Mobility via Direct Routing: comments**

- overcome triangle routing problem
- non-transparent to correspondent: correspondent must get care-of-address from home agent
  - What happens if mobile changes networks?
    - Notify the correspondent of new COA
    - Let old foreign agent re-encapsulate and forward packet to new foreign agent

**Mobile IP**

- RFC 3220
- has many features we’ve seen:
  - home agents, foreign agents, foreign-agent registration, care-of-addresses, encapsulation (packet-within-a-packet)
- three components to current standard:
  - agent discovery
  - registration with home agent
  - indirect routing of datagrams
Mobile IP - Home-Based Approaches

- The principle of Mobile IP.

Mobile IP: agent discovery

Two approaches:
- **agent advertisement**: foreign/home agents advertise service by broadcasting ICMP messages (typefield = 9)

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<th>16</th>
<th>24</th>
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<td>reserved</td>
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</table>
```

- H,F bits: home and/or foreign agent
- R bit: registration required

0 or more care-of-addresses
Mobile IP: agent discovery

- **agent discovery**: a mobile node wanting to learn about agents can broadcast a solicitation message ICMP (typefield = 10)

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- H,F bits: home and/or foreign agent
- R bit: registration required

≈ 0 or more care-of-addresses

Mobile IP: registration example

<table>
<thead>
<tr>
<th>time</th>
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</thead>
</table>
| home agent
HA: 128.119.40.7 |
| foreign agent
COA: 79.129.13.2 |
| ICMP agent adv.
COA: 79.129.13.2 |
| registration req.
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 4999
Identification: 714
encapsulation format |
| registration reply
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 4999
Identification: 714 |
| visited network: 79.129.13/24 |
| Mobile agent
MA: 128.119.40.186 |
| registration req.
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 9999
Identification: 714
encapsulation format |
| registration reply
HA: 128.119.40.7
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Mobility and Mobile IP