Wireless Internet Routing

Mobile IP and Mobile Routing

What is mobility?

- Spectrum of mobility, from the network perspective:

  - no mobility: mobile wireless user, using same access point
  - high mobility: mobile user, passing through multiple access point while maintaining ongoing connections (like cell phone)
**Mobility: Vocabulary**

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

**Mobility: more vocabulary**

- **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
- **Care-of-address**: address in visited network (e.g., 79.129.13.2)
- **permanent address**: remains constant (e.g., 128.119.40.186)
- **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?

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**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:*
  - *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 mobiles in residence via usual routing table exchange
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- Let end-systems handle it:
  - 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: registration

End result:
- Foreign agent knows about mobile
- Home agent knows location of mobile
**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 intercepts packets, forwards to mobile.
4. Mobile replies directly to correspondent.

**Indirect Routing: comments**

- **Mobile 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 functions may be done by mobile itself**

- **Triangle routing:** correspondent-home-network-mobile
  - Inefficient when correspondent, mobile are in same network
**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)

- Mobility, changing foreign networks transparent: **on-going connections can be maintained!**

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**Mobility via Direct Routing**

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

- Home network
- Correspondent
- Wide area network
- Mobile

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Mobility via Direct Routing: comments

- Overcome triangle routing problem
- Non-transparent to correspondent: correspondent must get care-of-address from home agent
  - What if mobile changes visited network?

Accommodating mobility with direct routing

- Anchor foreign agent: FA in first visited network
- Data always routed first to anchor FA
- When mobile moves: new FA arranges to have data forwarded from old FA (chaining)
Mobile IP

- RFC 3344
  - Updates in RFC 4721. Mobile IPv6: RFC 3775
- Many features we've seen:
  - Home agents, foreign agents, foreign-agent registration, care-of-addresses, encapsulation (packet-within-a-packet)
- Three components to standard:
  - Indirect routing of datagrams
  - Agent discovery
  - Registration with home agent

Mobile IP: indirect routing

Permanent address: 128.119.40.186

Care-of address: 79.129.13.2

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

Packet sent by correspondent

dest: 79.129.13.2
dest: 128.119.40.186

dest: 128.119.40.186
**Mobile IP: agent discovery**

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

- **H,F bits:** home and/or foreign agent

- **R bit:** registration required

- **Mobile IP: registration example**
Locator Identifier Separation

- IP address has two functions:
  - Identifier
  - Locator for routing
- Can we separate these functions? How?

Wireless, mobility: impact on higher layer protocols

- Logically, impact should be minimal ...
  - Best effort service model remains unchanged
  - TCP and UDP can (and do) run over wireless, mobile
- ... but performance-wise:
  - Packet loss/delay due to bit-errors (discarded packets, delays for link-layer retransmissions), and handoff
  - TCP interprets loss as congestion, will decrease congestion window un-necessarily
  - Delay impairments for real-time traffic
  - Limited bandwidth of wireless links