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, connecting/disconnecting from network using DHCP.
  - 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)

**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)

**Visited network:** network in which mobile currently resides (e.g., 79.129.13/24)

**Wide area network**

**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?
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 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.

Not scalable to millions of mobiles.
Mobility: registration

End result:
- Foreign agent knows about mobile
- Home agent knows location of mobile
Mobility via Indirect Routing

Correspondent addresses packets using home address of mobile

Home agent intercepts packets, forwards to foreign agent

Foreign agent receives packets, forwards to mobile

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!**
Mobility via Direct Routing

correspondent requests, receives foreign address of mobile

home network

wide area network

correspondent forwards to foreign agent

foreign agent receives packets, forwards to mobile

visited network

mobile replies directly to correspondent
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

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

Permanent address: 128.119.40.186

dest: 79.129.13.2
dest: 128.119.40.186

Packet sent by correspondent

dest: 128.119.40.186

Care-of address: 79.129.13.2

Foreign-agent-to-mobile packet
dest: 128.119.40.186

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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

0 or more care-of-addresses
Mobile IP: registration example

visited network: 79.129.13/24

home agent
HA: 128.119.40.7

foreign agent
COA: 79.129.13.2

ICMP agent adv.
COA: 79.129.13.2

registration req.
COA: 79.129.13.2
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 9999
Identification: 714
encapsulation format
...

registration reply
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 4999
Identification: 714
encapsulation format
...

registration req.
COA: 79.129.13.2
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 9999
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registration reply
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...

Mobile agent
MA: 128.119.40.186
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