MOBILE COMPUTING

CSE 40814/60814
Spring 2021

Dynamic Host Configuration Protocol

- Application
  - simplification of installation and maintenance of networked computers
  - supplies systems with all necessary information, such as IP address, DNS server address, domain name, subnet mask, default router etc.
  - enables automatic integration of systems into an Intranet or the Internet, can be used to acquire a COA for Mobile IP (see later)

- Client/Server-Model
  - the client sends via a MAC broadcast a request to the DHCP server (might be via a DHCP relay)
DHCP – Protocol Mechanisms

- DHCPDISCOVER
- DHCPOFFER
- DHCPREQUEST
- DHCPACK
- DHCPRELEASE

Mobility

- **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

- **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)
- **Foreign agent

Correspondent: wants to communicate with mobile

Finding Somebody

- 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
  - NOT SCALABLE!
- 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 receives 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 updates care-of-address for mobile
  - packets continue to be forwarded to mobile (but with new care-of-address)
- Mobility, changing foreign networks transparent: ongoing connections can be maintained!
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

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: “anchor 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 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 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: 128.119.40.186

Care-of address:
79.129.13.2

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

Mobile IP: Agent Discovery

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

<table>
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<th>0</th>
<th>8</th>
<th>16</th>
<th>24</th>
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<td>type = 9</td>
<td>code = 0</td>
<td>checksum</td>
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<td>router address</td>
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<td></td>
</tr>
<tr>
<td>type = 16</td>
<td>length</td>
<td>sequence #</td>
<td></td>
</tr>
<tr>
<td>registration lifetime</td>
<td>RBFMGV bits</td>
<td>reserved</td>
<td></td>
</tr>
</tbody>
</table>

0 or more care-of- addresses

H,F bits: home and/or foreign agent

R bit: registration required
Mobile IP: Registration Example

<table>
<thead>
<tr>
<th>home agent</th>
<th>foreign agent</th>
<th>visited network: 79.129.13/24</th>
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<tbody>
<tr>
<td>HA: 128.119.40.7</td>
<td>COA: 79.129.13.2</td>
<td>ICMP agent adv.</td>
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</tr>
<tr>
<td></td>
<td></td>
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<tr>
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<td>HA: 128.119.40.7</td>
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<td></td>
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<td>MA: 128.119.40.186</td>
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Cell Network

- **MSC**
  - connects cells to wide area net
  - manages call setup
  - handles mobility

- **cell**
  - covers geographical region
  - **base station (BS)** analogous to 802.11 AP
  - **mobile users** attach to network through BS
  - **air-interface**: physical and link layer protocol between mobile and BS

wired network

Public telephone network, and Internet
Mobility Management

- Challenge: roaming message destination
  - Location management
  - Roaming management
  - Handoff management

Example: Cellular Networks

HLR: Home Location Register
MSC: Mobile Switching Center
PSTN: Public Switched Telephone Network
VLR: Visitor Location Register
Mobility in Cellular Networks

- **Home network**: network of cellular provider you subscribe to (e.g., AT&T, T-Mobile, Verizon)
  - **home location register (HLR)**: database in home network containing permanent cell phone #, profile information (services, preferences, billing), information about current location (could be in another network)
- **Visited network**: network in which mobile currently resides
  - **visitor location register (VLR)**: database with entry for each user currently in network
  - could be home network

GSM: Indirect Routing

1. **Home MSC** consults **HLR**, gets roaming number of mobile in visited network
2. Home MSC sets up 2nd leg of call to **MSC in visited network**
3. **MSC in visited network** completes call through base station to mobile
4. Call routed to home network

**Diagram**: Illustration of call routing process in GSM networks.
GSM: Handoff with Common MSC

- Handoff goal: route call via new base station (without interruption)
- Reasons for handoff:
  - stronger signal to/from new BSS (continuing connectivity, less battery drain)
  - load balance: free up channel in current BSS
  - GSM doesn’t mandate why to perform handoff (policy), only how (mechanism)
- Handoff initiated by old BSS

GSM: Handoff with Common MSC

1. old BSS informs MSC of impending handoff, provides list of 1+ new BSSs
2. MSC sets up path (allocates resources) to new BSS
3. new BSS allocates radio channel for use by mobile
4. new BSS signals MSC, old BSS: ready
5. old BSS tells mobile: perform handoff to new BSS
6. mobile, new BSS signal to activate new channel
7. mobile signals via new BSS to MSC: handoff complete. MSC reroutes call
8. MSC-old-BSS resources released
GSM: Handoff Between MSCs

- **Anchor MSC**: first MSC visited during call
  - call remains routed through anchor MSC
  - new MSCs add on to end of MSC chain as mobile moves to new MSC
  - IS-41 allows optional path minimization step to shorten multi-MSC chain

(a) before handoff

(b) after handoff