“Wireless” vs. “Mobile”

- Host mobility need not imply wireless communication

- Wireless vs. mobile

  - ✗ ✗ Stationary computer
  - ✗ ✓ Notebook on a hotel Ethernet
  - ✓ ✗ Wireless LANs in historic buildings
  - ✓ ✓ Personal Digital Assistant (PDA)

**Focus here: host mobility**
### Impact of Wireless on the Layer Model

<table>
<thead>
<tr>
<th>Layer</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>service location, new/adaptive applications, multimedia</td>
</tr>
<tr>
<td>Transport</td>
<td>congestion/flow control, quality of service</td>
</tr>
<tr>
<td>Network</td>
<td>addressing, routing, device location, hand-over</td>
</tr>
<tr>
<td>Data link</td>
<td>authentication, media access/control, multiplexing, encryption</td>
</tr>
<tr>
<td>Physical</td>
<td>modulation, interference, attenuation, frequency</td>
</tr>
</tbody>
</table>

### What’s The Issue?

- **Routing**
  - Based on IP destination address
    - Network prefix (e.g. 129.13.42) determines physical subnet
  - Topologically correct address
    - Change of physical subnet $\Rightarrow$ change of IP address

- **Specific routes to end-systems?**
  - Add specific route to all routing table entries
  - Not scalable: # mobile hosts, change frequency, security

- **Changing the IP-address?**
  - Acquire and use new IP address for host
  - Nearly impossible to find a mobile system
    - DNS updates take too long
  - TCP connections break, security

**Solution: Mobile IP**
Outline

- Requirements
- Terminology
- Basic Operation
- Advanced/Optimizations
  - Direct routing
  - Reverse tunneling
  - Micro-mobility support

Requirements

- Deploy-ability
  - Do not require changes to software of non-mobile hosts
    - Mobile hosts should be able to communicate with fixed hosts
  - Do not require changes to majority of Internet routers
- Transparency
  - Continuation of communication should be possible
  - Support of the same layer 2 protocols as IP
- Efficiency and scalability
  - Low communication overhead
    - Mobile host typically uses a low bandwidth radio link
  - Global scale: large number of mobile systems world-wide
- Security

Analogy: Postal Forwarding
**Terminology**

- **Mobile Host**
- **Internet**
- **Router**
- **End-system**
- **Foreign Agent (FA)**
- **Home Agent (HA)**
- **Mobile Node (MN)**
- **Correspondent Node (CN)**
- **Home Network**
- **Foreign Network**

**Data Transfer to the Mobile Host**

1. Sender sends to the IP address of MN, HA intercepts packet (proxy ARP)
2. HA tunnels packet to COA, here FA, by encapsulation
3. FA forwards the packet to the MN
Data Transfer From The Mobile Host

1. Sender sends to the IP address of the receiver as usual, FA works as default router.

Agent Discovery

1. HA and FA periodically send advertisement messages into their physical subnets.
2. MN listens, and detects if it is in the home or a foreign network.
3. MN reads a COA from the FA advertisement messages.
### Registration

1. MN signals COA to the HA via the FA
2. HA acknowledges via FA to MN
Actions secured by IP-level authentication

### Problem: Triangular Routing

High latency and load!
Direct Routing

1. HA informs sender about MN location
2. Sender directly tunnels to COA

Reverse Tunneling

1. MN sends to FA
2. FA tunnels packets to HA
3. HA forwards the packet to the receiver
**IP Micro-mobility Support**

- **Micro-mobility support:**
  - Efficient *local* handover inside a foreign domain without involving home agent
    - Mobility support in limited geographical area
  - Reduces control traffic on backbone, load on home agent

- **Example proposals:**
  - Cellular IP
  - HAWAII
  - Hierarchical Mobile IP (HMIP)

- **Important criteria:**
  - Security, Efficiency, Scalability, Transparency, Manageability

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**Problems with Mobile IP**

- **Security**
  - Authentication with FA problematic
    - FA typically belongs to another organization
  - No standardized protocol for key management, distribution

- **Firewalls**
  - Typically firewalls prevent use of mobile IP
    - Special set-ups are needed (e.g., reverse tunneling)

- **QoS**
  - Many new reservations in case of RSVP
  - Tunneling makes it hard to give special treatment to a “flow” of packets

- **Security, firewalls, QoS etc. are topics of research and discussions**