Mobile IP
(RFC 3344)
by Charles Perkins

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Why Mobility?

✦ When you move to a new subnet you get a new IP address.

✦ Don’t want to close connections if possible.
  ✦ Not compatible with TCP/UDP as packets are routed by IP address (no other real solutions exist)

✦ Don’t want to miss traffic if possible (other solutions exist). Again packets are routed using the IP of the host.
Two Solutions (bad)

- Change routing such that routing decisions are made based on hosts.
- Dismiss the connections by merely changing the IP address and nothing else. Force the application layer to deal with the problem.
Another Solution?

- Mobile IP!
- But first...
Some Terms

✦ Home Network - Where the mobile node has a long lasting IP address.

✦ Foreign Network - Where the mobile node moves to temporarily

✦ Home Agent - A router/host responsible for intercepting and tunneling packets to the mobile node in the foreign network.

✦ Foreign Agent - A router/host on the foreign network that provides “routing services when registered” (many functions are optional!)
Basic Protocol

- Mobile Node leaves the home network and appears in the foreign network.
- Attempts to get a new IP address (think DHCP). This address is called a care-of-address.
- The foreign agent sends an Agent Advertisement possibly giving the node a default route.
- The mobile host will then register either with the home agent or with the foreign agent (who registers with the home agent)
Basic Protocol cont...

- Upon an affirmative reply, the home agent is prepared to deliver packets to the mobile host in the foreign network.
- Packets sent from the corresponding host are then re-encapsulated at the home network and sent to the mobile host.
- Packets sent from the mobile host to the corresponding host are sourced with the care-of address in the foreign network.
Mobility in Action
Mobility in Action

Mobile Host

Home Network

Home Agent

Corresponding Node

Foreign Agent

Foreign Network
Mobility in Action

Home Network

Foreign Network

Foreign Agent

Mobile Host

Corresponding Node
Mobile IP is 3 Things

- Discovery - Mechanism that allows mobile computers to determine where they are and how they will communicate.
- Registration - Mechanism that tells the mobility agents how to communicate with the mobile host.
- Delivery - Mechanism to deliver messages to the mobile host.
Discovery

- Like ICMP Router Discovery (RFC 1256)
  - The mobile hosts finds itself on the a network.
  - The Foreign Agent sends a periodic Agent Advertisement, which the mobile host heres. Interval can be no longer than 1/3 advertised lifetime of care-of address.
  - The mobile host can either use the advertised care-of address or obtain one externally (DHCP)

- Agent Solicitation
  - Mobile host can send an ICMP Router Solicitation request if it does not hear any Agent Advertisements.
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Registration

- Request forwarding services
- Inform the home agent of the mobile agents care-of address
- Renew expired registered bindings
- De-registering bindings.
Registration continued...

- Done either using the Foreign Agent (which basically just relays the message) or directly with the Home Agent
- Two types of messages sent over UDP (port 434)
  - Registration Request
  - Registration Reply
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```
+-----------------+-----------------+-----------------+-----------------+
|     Type       |S|B|D|M|G|r|T|x|          Lifetime             |
+-----------------+-----------------+-----------------+-----------------+
|                          Home Address                         |
+-----------------+-----------------+-----------------+-----------------+
|                           Home Agent                          |
+-----------------+-----------------+-----------------+-----------------+
|                        Care-of Address                        |
+-----------------+-----------------+-----------------+-----------------+
|                                                               |
+                         Identification                        |
+-----------------+-----------------+-----------------+-----------------+
| Extensions ...                                           |
+-----------------+-----------------+-----------------+-----------------+
```
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Registration continued...

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- Two types of messages sent over UDP (port 43):
  - Registration Request
  - Registration Reply

```
0                   1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
++-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Code      |           Lifetime            |
++-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Home Address                         |
++-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Home Agent                          |
++-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                         Identification                        |
|                                                               |
++-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Extensions ...                                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-++
```

Registration Reply
Registration continued...

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- Two types of messages sent over UDP (port 434)
  - Registration Request
  - Registration Reply
Delivery

- Mobile Nodes
  - May use the Foreign Agent as its next hop router
  - If not, then it must use one of the routers advertised in the ICMP Router Advertisement
  - Must not broadcast ARP (more on this later) to find other nodes

- Home Agents
  - Must support IP-in-IP packet encapsulation
  - May support other encapsulation types not presented
Delivery cont...

- Home Agents
  - Must be able to intercept packets intended for the mobile host! (ARP shows up again)
  - Tunnels packets to the care-of location of the mobile host
  - Maintain soft state. More on this later.

- Foreign Agents
  - Decapsulate packets and compare inner address to visitor list
  - Must not use broadcast ARP to get the MAC address of the mobile node.
Soft Tunnel State

- ICMP Error messages only are required to return 8 bytes of the returned datagram
  - This may not contain the source (it is encapsulated remember)
- Home Agent keeps track of which datagrams were to delivered over tunnels
  - The Home Agent will relay the ICMP error message to the corresponding host. Problems?
- Don’t want to relay network unreachable message, since this will reveal to the correspondent the tunnel existence
  - Relay host unreachable message.
  - RFC includes rules for this sort of thing
- Home Agent should keep track of other state - Path MTU, TTL etc...
ARP

✦ Home Agent should perform Proxy ARP and Gratuitous ARP when the node moves away
✦ Mobile node must not send any broadcast ARP
  ✦ Foreign hosts/routers may create invalid cache entries
  ✦ Can reply to Foreign Agents
  ✦ If it uses a collocated care-of address, then can reply using unicast ARP
✦ Mobile host and Home Agent both use gratuitous ARP to update local entries BEFORE the mobile host de-registers.
Route Optimization

- Current State results in Triangle routes
  - Why is this bad?
- Some suggestions?
  - Direct routing - This is IP!
  - Modify the corresponding host
  - Problem mostly deals with Security. Something we are ignoring during this presentation
  - Must sacrifice invisibility of the tunnel
Smooth Handoffs

- What if you move from one foreign network to another?
- Mobile node instructs new Foreign Agent to create binding at the previous Foreign Agent
- If the old Foreign Agent doesn’t have a binding
  - Simple idea - Just decapsulate and send out
  - Wrong! It will result in loops
  - Use “special tunnel” instead
Smooth Handoffs cont...
Smooth Handoffs cont...
Smooth Handoffs cont...

- Home Network
  - Home Agent
  - Corresponding Node
- Foreign Network
  - Foreign Agent

The diagram illustrates the smooth handoffs in a network setting, showing the interaction between the home network and the foreign network through the home agent and a corresponding node.
Smooth Handoffs cont...
Ingress Filters?

✦ Nobody wants to harbor criminals!
  ✦ Malicious (or misconfigured) users will attempt to send datagrams using bad IP address
  ✦ Firewalls will perform ingress filtering to make sure that the outgoing source address matches the subnet
✦ This is a problem for honest Mobile IP hosts
  ✦ We use our home address, not the care-of address
Solutions

- Tunnel everything back through the home agent
  - Yuck! Very Inefficient.
- Configure the routers to allow your packets...
  - Do networks need more administrative tasks?
  - Another protocol then?
Future Talks

- IPv6 and Mobile IP?
- How is security implemented?
- Are there approaches that attempt to solve this problem at a different layer (say in the application layer)?