Mobile IP

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Motivation for Mobile IP

- Routing
  - Based on IP destination address, network prefix (e.g. 129.13.42) determines physical subnet
  - Change of physical subnet implies change of IP address to have a topological correct address (standard IP) or needs special entries in the routing tables
- Specific routes to end-systems?
  - Change of all routing table entries to forward packets to the right destination
  - Does not scale with the number of mobile hosts and frequent changes in the location, security problems
- Changing the IP-address?
  - Adjust the host IP address depending on the current location
  - Almost impossible to find a mobile system, DNS updates take to long time
  - TCP connections break, security problems

Desirable Features of Mobile IP

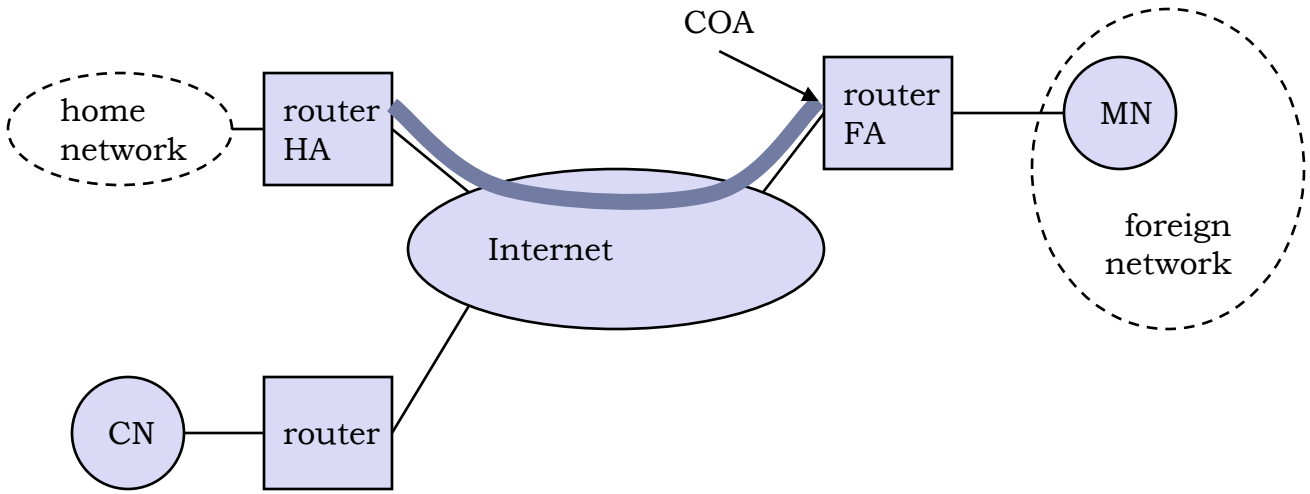
- Transparency
  - Mobile end-systems should keep their IP address
  - Continuation of communication after interruption of link is possible
  - Point of connection to the fixed network can be changed
- Compatibility
  - Support of the same layer 2 protocols as IP
  - No changes to current end-systems and routers required
  - Mobile end-systems can communicate with fixed systems
- Security
  - Authentication of all registration messages
- Efficiency and scalability
  - Only little additional messages to the mobile system required (connection typically via a low bandwidth radio link)
  - World-wide support of a large number of mobile systems in the whole Internet

Mobile IP

- Entities and Terminology
- IP packet delivery
- Agent discovery
- Tunnelling and encapsulation

Entities and Terminology

- Mobile Node (MN)
  - System (node) that can change the point of connection to the network without changing its IP address
  - Assigned a permanent IP called its ***home address*** to which other hosts send packets regardless of MN's location
    - Since this IP doesn't change it can be used by long-lived applications as MN's location changes



Entities and Terminology

- Home Network
  - Provides home address to the mobile device.
  - The home network is the subnet the MN belongs to with respect to its IP address.
  - No mobile IP support is needed within the home network.
- Home Agent (HA)
  - System in the home network of the MN, typically a router
  - Maintains a location directory of the mobile nodes belonging permanently to the home network
  - Tunnel starts at the home agent.

Entities and Terminology

- Foreign Agent (FA)
  - System in the current foreign network of the MN, typically a router
  - Functions as point of attachment for a mobile node when it roams to the foreign network.
  - Packets from the home agent are sent to the foreign node which delivers it to mobile node.
- Care-of Address (COA)
  - Address which identifies MN's current location
  - Actual location of the MN from an IP point of view can be chosen, e.g., via DHCP
  - The packets sent to the mobile node(MN) are delivered to COA using tunneling.
  - COA is the tunnel end point.

Entities and Terminology

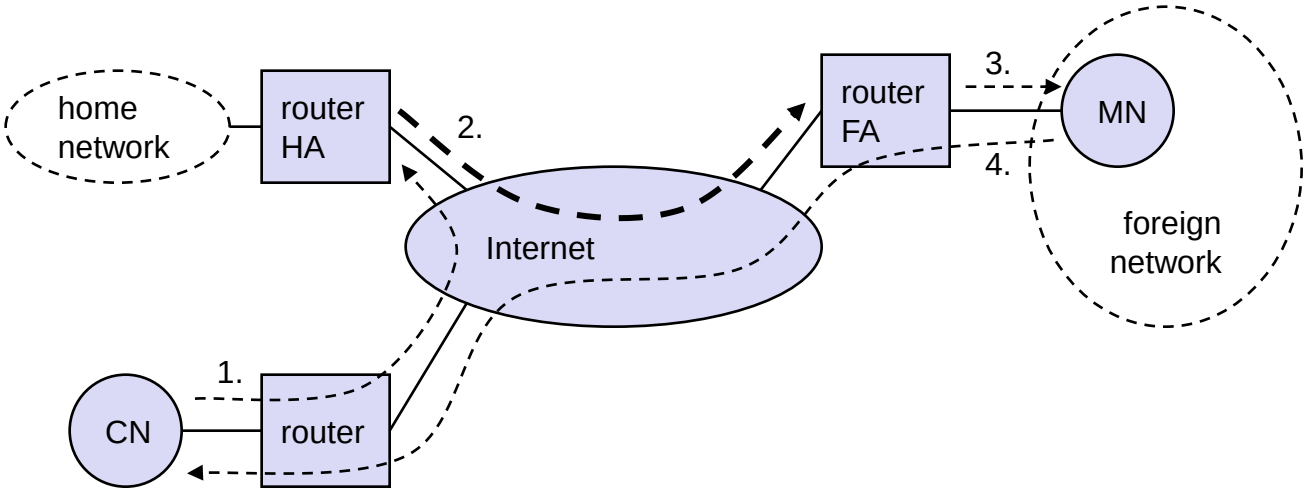
- 2 types of COA
  - Foreign Agent COA
    - Usually the IP address of the FA
    - Many MN using FA can share COA as common COA
    - FA is the tunnel end point, and FA forwards packet to the MN
  - Co-Located COA
    - When the MN temporarily acquires an additional IP address, that acts as the COA.
    - MN is the tunnel end point.
- Correspondent node (CN)
  - At least one partner is needed for communication.
  - The CN can be a fixed or mobile node.

Tunnelling and Encapsulation

- Tunnel
  - Virtual pipe for packets available between a tunnels entry point and an end point
- Tunnelling
  - The process of sending a packet via tunnel and achieved by a mechanism called encapsulation
- Encapsulation
  - Assembling old packet(packet header and data) in data part of new packet
- Decapsulation
  - Disassembling the data part of an encapsulated packet.

IP Packet Delivery

- Mobile IP → Hides the mobility of the MN
- Data Transfer to the Mobile Node
- Data Transfer from the Mobile Node



Data Transfer to the Mobile Node

1. CN transmits to the IP address of MN, HA intercepts packet (proxy ARP)
   - SA →CN IP, DA→ MN IP
   - No knowledge about MN's current location
   - Standard routing mechanisms of the internet
2. HA tunnels packet to COA (FA), by encapsulation
   - New header on top of old IP (encapsulation)
   - SA → HA, DA → COA
   - Tunnel → The path taken by the encapsulated packets.
   - Tunneling.
3. FA forwards the packet to the MN
   - Decapsulation
   - SA →CN IP, DA→ MN IP
   - Mobility not visible by MN

Data Transfer from the Mobile Node

4. CN transmits packet to the IP address of the receiver as usual.
   - SA → MA IP, DA → CN IP
   - FA works as default router and forwards the packet in standard manner (CN → Fixed Node).
   - CN → Mobile node, steps 1 through 3

Agent Discovery

- How to find a foreign agent is the major problem.
- How does the MN discover that it has moved?
- 2 methods:
  - Agent advertisement
  - Agent solicitation

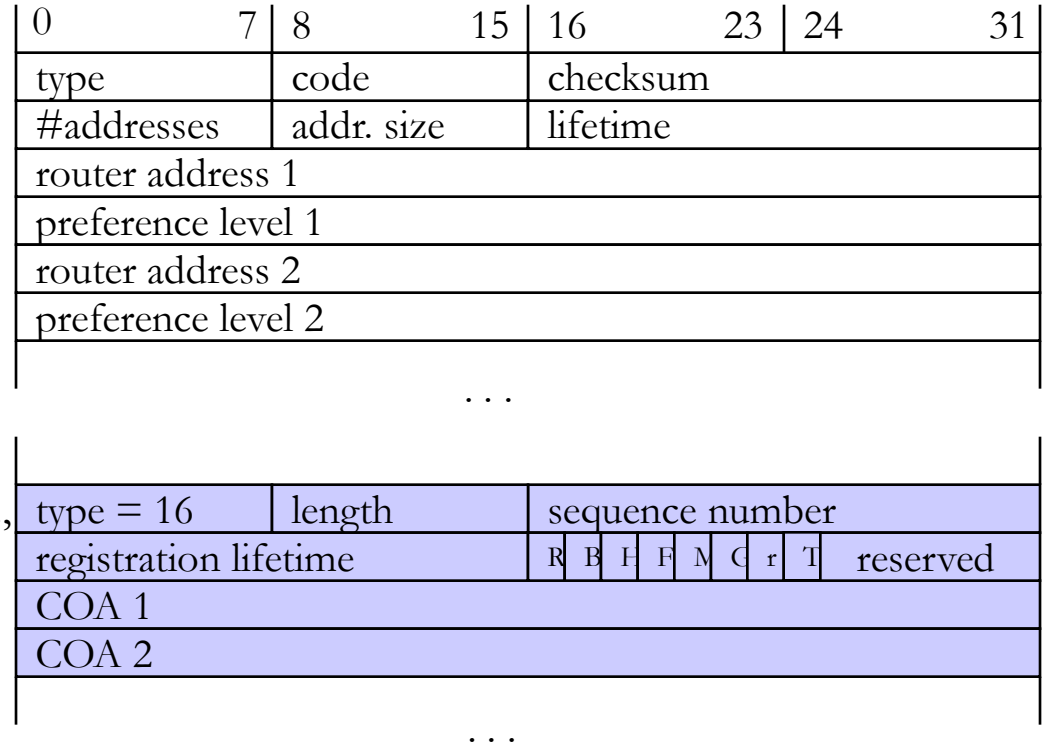
Agent Advertisement

- Home Agents and Foreign Agents periodically send **advertisement messages** into their physical subnets
- Advertisement is similar to Beacon Broadcast
- MN listens to these messages and detects, if it is in the home or a foreign network (standard case for home network)
- MN reads a COA from the FA advertisement messages

Agent Advertisement

RFC 1256 +mobility extension
(upper ICMP, lover mobility)
Type=9
Code 0 (normal)or 16(only mobile)

type = 16
length = 6 + 4 * #COAs
(6 = the number of bytes in the seq. no., Lifetime, Flags, and Reserved + another 4 bytes per each COA)
R: registration required
B: busy, no more registrations
H: home agent
F: foreign agent
M: minimal encapsulation
G: Generic Routing Encapsulation
r: =0, ignored (former Van Jacobson compression)
T: FA supports reverse tunneling
reserved: =0, ignored



Agent Solicitation

- The mobile node must send **agent solicitations** when it enters a foreign network**.**
- When a mobile node enters into a new network it can send out three solicitations, one per second
- If a MN does not get a new address, many packets will be lost
- If a MN does not receive an answer to its solicitations it must decrease the rate of solicitations exponentially to avoid flooding the network
- When the MN discovers a new agent it stops sending agent solicitation.
- A MN understands its FA by receiving an advertisement

Summary

- Motivation for Mobile IP
- Desirable Features of Mobile IP
- Mobile IP
  - Entities and Terminology
  - IP packet delivery
  - Agent discovery

Test your knowledge

- What is a dual stack?
  - The host or router uses both IPv4 and IPv6, but at different times
  - The host or router uses both IPv4 and IPv6 at the same time
  - The host or router uses IPv4 at different times
- What is one major difference between IPv4 and IPv6 configuration?
  - The router doesn't enable the routing of IPv6 packets by default, so you would need to use the global command to enable IPv6 routing
  - You can use the network router subcommand to enable IPv6 routing
  - IP addresses are shortened from 128 bits to 32 bits

Test your knowledge

- When IPv4 addresses are exhausted and you're using IPv4 connections to access the Internet, you
  - won't be able to access IPv6 websites at all
  - may still be able to access some IPv6 websites with some limitations
  - will still be able to access IPv6 website with no problem at all

References

- Jochen H. Schller, "Mobile Communications", Second Edition, Pearson Education, New Delhi, 2007.
- Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt. Ltd, New Delhi – 2012.