

# Mobile IP

## Outline

- Intro to mobile IP

- Operation

- Problems with mobility

# One more IP topic...

- ▶ Already covered lots of things about IP
  - ▶ Forwarding, routing, multicast, etc...
- ▶ **One last IP topic: mobile networking**
- ▶ Important for the future
  - ▶ Examples of mobile networking today?
  - ▶ Examples of mobile networking tomorrow?
- ▶ *Mobile networking* should not be confused with *portable networking*

# Portable Networking Technology

- Portable networking requires connection to same ISP
  - ▶ Cellular systems
    - ▶ Cellular Digital Packet Data (CDPD)
    - ▶ 3G
  - ▶ Bluetooth
    - ▶ Low cost, short range radio links between mobile devices
  - ▶ Wireless Ethernet (802.11)
    - ▶ Widely used wireless MAC layer technology

# Mobility and Standard IP Routing

- ▶ IP assumes end hosts are in fixed physical locations
- ▶ IP addresses enable IP routing algorithms to get packets to the correct network
  - ▶ IP address has network part and host part
  - ▶ Host part should not be in routing tables
- ▶ **What if a user roams between networks?**
  - ▶ Want transparency
  - ▶ Routing information becomes invalid
  - ▶ Why can't mobile users change IP when running an application?

# Mobile IP

- ▶ Developed as a means for transparently dealing with problems of mobile users
- ▶ Enables hosts to stay connected to the Internet regardless of their location and without changing IP addresses
- ▶ Requires no changes to software of non-mobile hosts/routers
- ▶ **Requires addition of some infrastructure**
- ▶ Has no geographical limitations
- ▶ Requires no modifications to IP addresses
- ▶ Supports security
- ▶ IETF standardization process is still underway

# Mobile IP Entities

- ▶ Mobile Node (MN)
  - ▶ The entity that moves from network to network
  - ▶ Assigned a permanent IP called its *home address* to which other hosts send packets regardless of MN's location
- ▶ Home Agent (HA)
  - ▶ Router with additional functionality
  - ▶ Located on home network of MN
  - ▶ Mobility binding of MN's IP with its *Care of Address* (COA)
  - ▶ Forwards packets to appropriate network when MN is away - uses encapsulation

# Mobile IP Entities contd.

- ▶ Foreign Agent (FA)
  - ▶ Another router with enhanced functionality
  - ▶ Used to send/receive data between MN and HA
  - ▶ Advertises itself periodically
- ▶ Care-of-address (COA)
  - ▶ Address which identifies MN's current location
  - ▶ Sent by FA to HA when MN attaches
  - ▶ Usually the IP address of the FA
- ▶ Correspondent Node (CN)
  - ▶ End host to which MN is corresponding (eg. a web server)

# Mobile IP Support Services

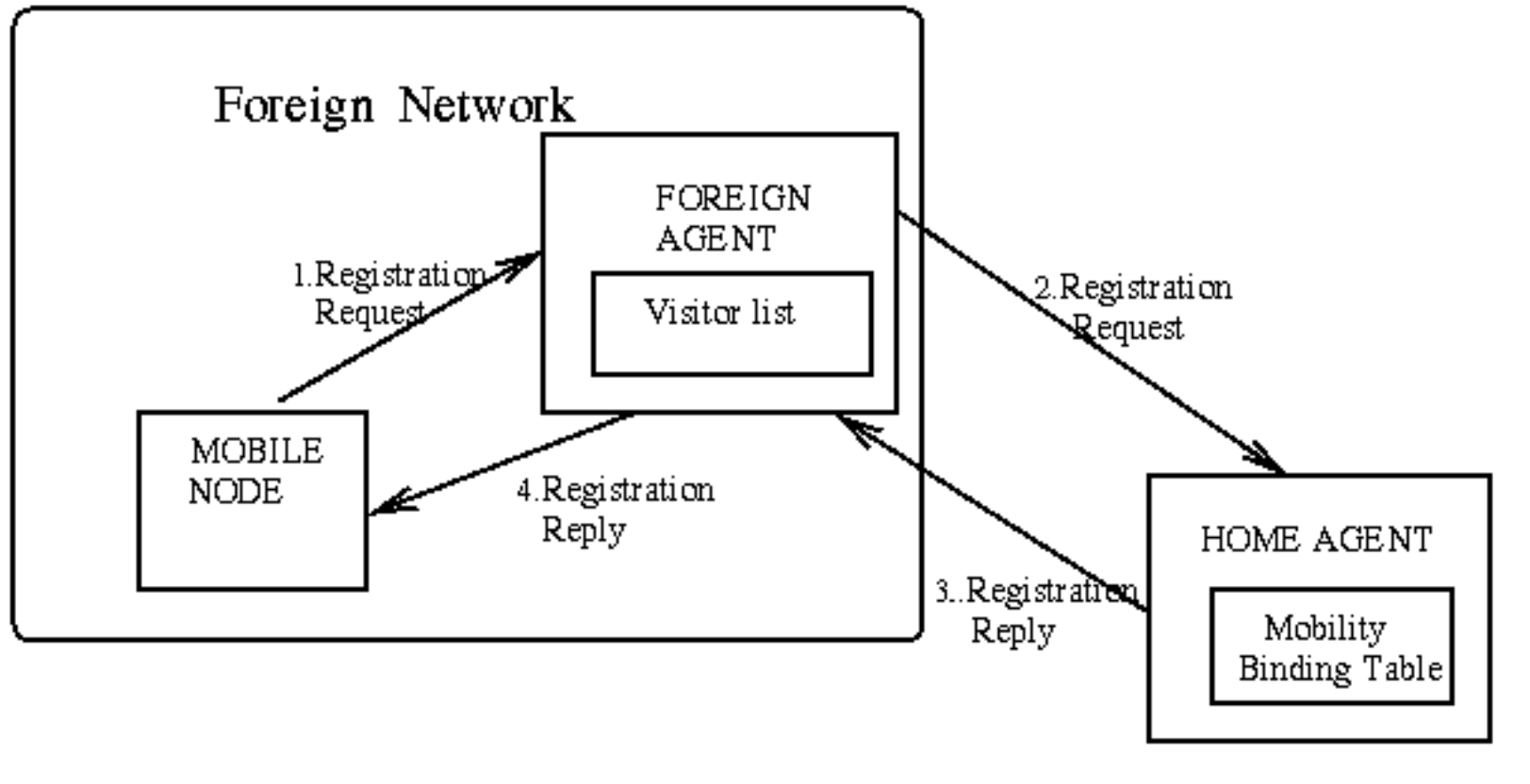
- ▶ Agent Discovery
  - ▶ HA's and FA's broadcast their presence on each network to which they are attached
  - ▶ MN's listen for advertisement and then initiate registration
- ▶ Registration
  - ▶ When MN is away, it registers its COA with its HA, via FA
  - ▶ Registration control messages sent via UDP to well known port
- ▶ Encapsulation/decapsulation - just like standard IP only with COA



# Mobile IP Operation

- ▶ A MN listens for agent advertisement and then initiates registration
  - ▶ If responding agent is the HA, then mobile IP is not necessary
- ▶ After receiving the registration request from a MN, the HA acknowledges and registration is complete
  - ▶ Registration happens as often as MN changes networks
- ▶ HA intercepts all packets destined for MN
  - ▶ This is simple unless sending application is on or near the same network as the MN
  - ▶ HA masquerades as MN
  - ▶ There is a specific lifetime for service before a MN must re-register
  - ▶ There is also a de-registration process with HA if an MN returns home

# Registration Process



# Tables maintained on routers

## ► Mobility Binding Table

- Maintained on HA of MN
- Maps MN's home address with its current COA

Home Address	Care-of Address	Lifetime (in sec)
131.193.171.4	128.172.23.78	200
131.193.171.2	119.123.56.78	150

## ► Visitor List

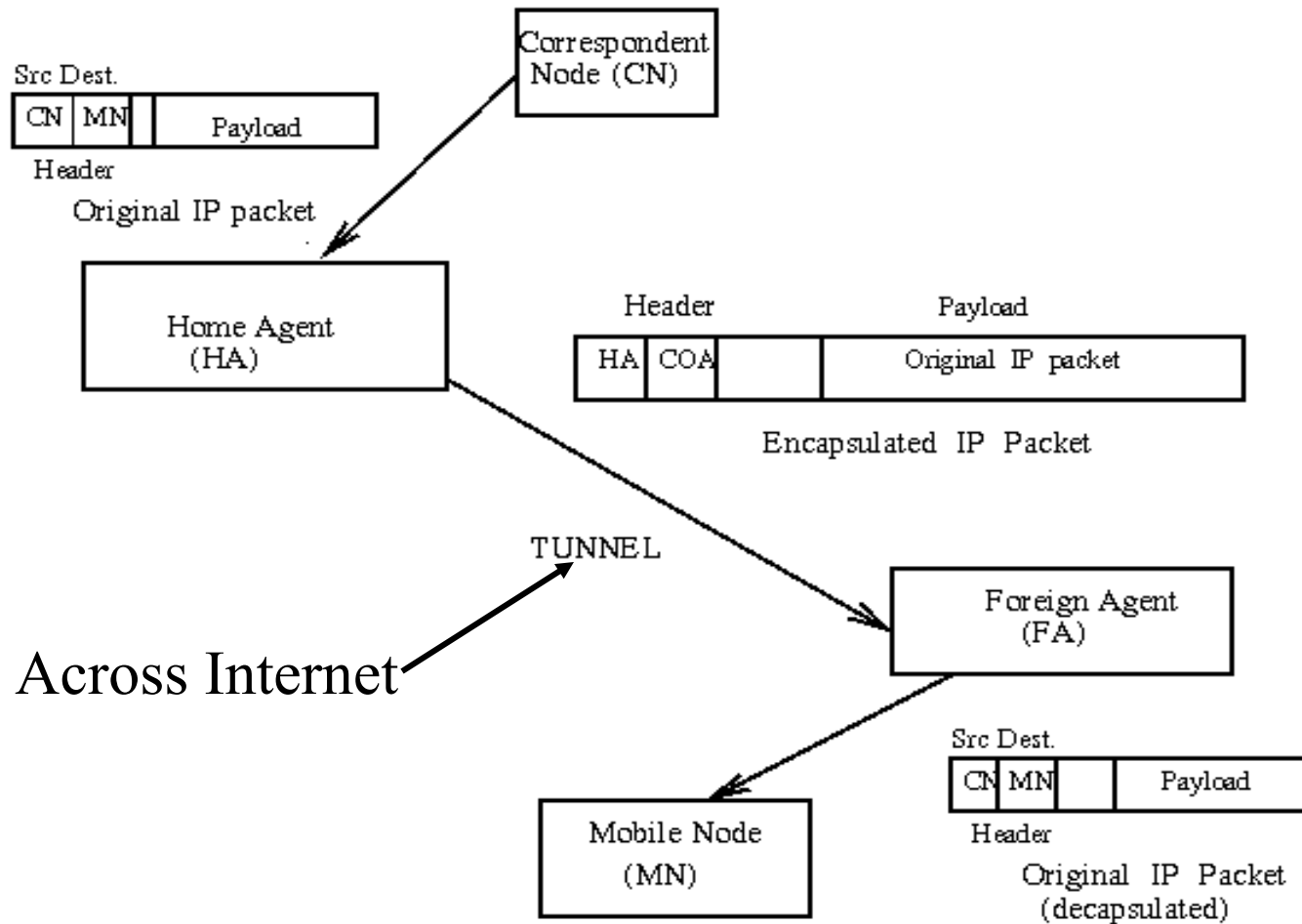
- Maintained on FA serving an MN
- Maps MN's home address to its MAC address and HA address

Home Address	Home Agent Address	Media Address	Lifetime (in s)
131.193.44.14	131.193.44.7	00-60-08-95-66-E1	150
131.193.33.19	131.193.33.1	00-60-08-68-A2-56	200

# Mobile IP Operation contd.

- ▶ HA then encapsulates all packets addressed to MN and forwards them to FA
  - ▶ IP tunneling
- ▶ FA decapsulates all packets addressed to MN and forwards them via hardware address (learned as part of registration process)
- ▶ NOTE that the MN can perform FA functions if it acquires an IP address eg. via DHCP
- ▶ Bidirectional communications require tunneling in each direction

# Mobile IP Tunneling



# Security in Mobile IP

- ▶ Authentication can be performed by all parties
  - ▶ Only authentication between MN and HA is required
  - ▶ Keyed MD5 is the default
- ▶ Replay protection
  - ▶ Timestamps are mandatory
  - ▶ Random numbers on request reply packets are optional
- ▶ HA and FA do not have to share any security information.

# Problems with Mobile IP

- ▶ Suboptimal “triangle” routing

- ▶ What if MN is in same subnetwork as the node to which it is communicating and HA is on the other side of the world?
  - ▶ It would be nice if we could directly route packets
- ▶ Solution: Let the CN know the COA of MN
  - ▶ Then the CN can create its own tunnel to MN
  - ▶ CN must be equipped with software to enable it to learn the COA
  - ▶ Initiated by HA who notifies CN via “binding update”
  - ▶ Binding table can become stale

# Problems with Mobile IP

- ▶ Single HA model is fragile
  - ▶ Possible solution - have multiple HA
- ▶ Frequent reports to HA if MN is moving
  - ▶ Possible solution - support of FA clustering
- ▶ Security
  - ▶ Connection hijacking, snooping...
- ▶ Many open research questions