

Mobile IP

Part I: IPv4

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These slides are available on-line at:

<http://www.cse.wustl.edu/~jain/cse574-06/>

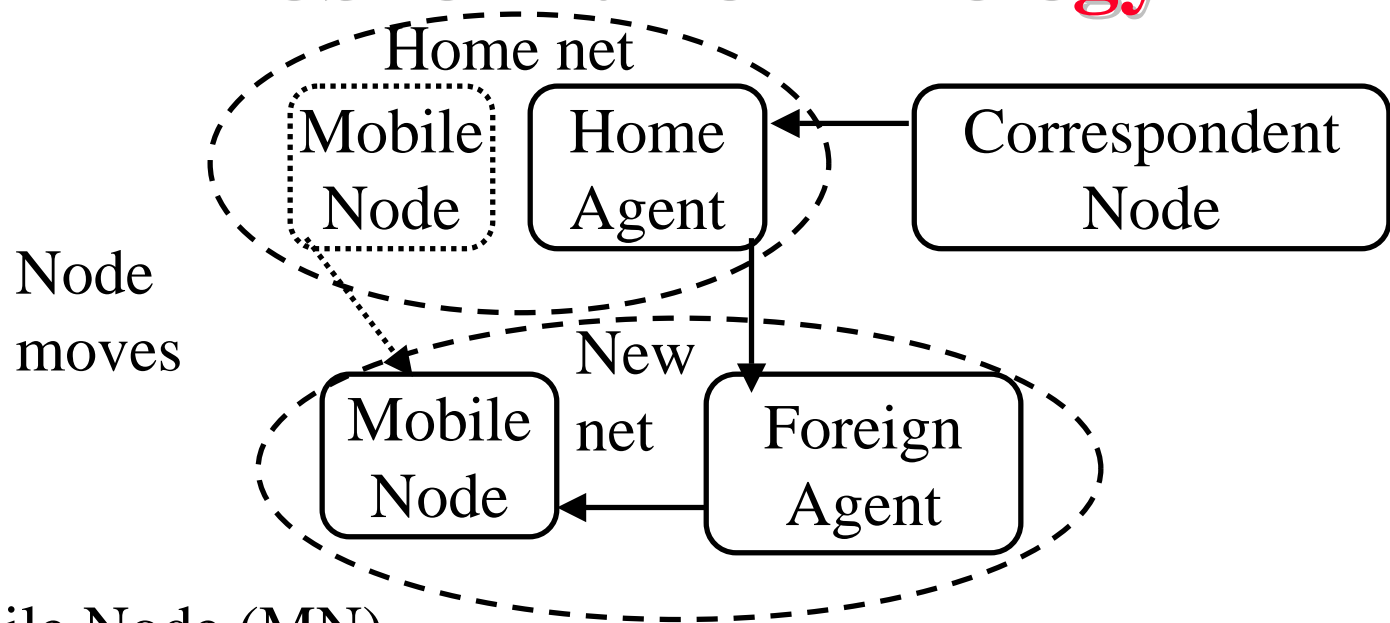


- ❑ Mobile IP: Terminology
- ❑ Processes: Registration, Advertisements, ..
- ❑ Security Issues
- ❑ Reverse Tunneling
- ❑ Home Networks with Dynamic IP Address
- ❑ Dynamic Home Agent Assignment
- ❑ Network Mobility (NEMO)
- ❑ Mobile IP and VPN

Mobile IP: Features

- ❑ You can take your notebook to any location
- ❑ Your TCP connection can continue. TCP connections are from one IP address to another IP address
⇒ TCP is unaware of the mobility
- ❑ Continuous access to your home resources
- ❑ Access to local resources: Printers
- ❑ Finds nearby IP routers and connects *automatically*
- ❑ Your IP messages are delivered to your new location
- ❑ Only "Mobility Aware" routers and mobile units need new s/w
- ❑ Other routers and hosts can use current IP
- ❑ No new IP address formats.
- ❑ Secure: Allows authentication

Mobile IP: Terminology



- ❑ Mobile Node (MN)
- ❑ Home Agent (HA), Foreign Agent (FA)
- ❑ Care-of-address (COA): Address of the end-of-tunnel towards the mobile node
- ❑ Correspondent Node (CN)
- ❑ Home Address: Mobile's permanent IP address

Terminology

- ❑ **Home Address:** Long-term IP address of the mobile on the home network
- ❑ **IP Access Address:** Local IP address of the mobile on the foreign network
- ❑ **Care-of-Address:** Address to which the packets are sent by the home agent. Destination of the IP tunnel between home agent and the mobile. Generally COA=IP Access Address
- ❑ **Mobility Agent:** Home agent or foreign agent
- ❑ **Agent Advertisement:** Periodic advertisement from mobility agents
- ❑ **Correspondent Node:** The node communicating with mobile
- ❑ **Foreign Network:** Any network other than the home network
- ❑ **Gratuitous ARP:** Sent by home agent to update other node's ARP cache

Terminology (Cont)

- ❑ **Mobility Binding:** Binding between home address and COA
- ❑ **Tunnel:** Path followed by an encapsulated packet
- ❑ **Mobile Router:** A router with changing point of attachment
- ❑ **Mobile Host:** A end host (not a router)
- ❑ **Mobile Node:** Mobile Host or Mobile Router
- ❑ **Mobile Network:** An entire network that changes its point of attachment
- ❑ **Mobile Network Node:** A node in a mobile network. May itself be mobile (visiting) or fixed (permanent) member of the network.
- ❑ **Roaming:** Getting connectivity from a foreign network based on a formal agreement between foreign and home network service providers

Terminology (Cont)

- ❑ **Handover**: Changing the point of attachment
- ❑ **L2 Handover**: Moving from one access point to another access point in the same IP network (same network prefix)
- ❑ **L3 Handover**: Moving from one IP network to another. Moving from one access router to another access router
- ❑ **Horizontal Handover**: Moving between same technology. WLAN to WLAN or 3G to 3G
- ❑ **Vertical Handover**: Moving between different technologies. WLAN to 3G.
- ❑ **Push Handover**: Previous access router initiates handover
- ❑ **Pull Handover**: New access router initiates handover

Terminology (Cont)

- ❑ **Make-Before-Break:** Make a new connection before disconnecting previous. Will communicate with both for some time.
- ❑ **Break-before-Make:** Disconnect previous and then connect with next.
- ❑ **Handover Delay:** Time between break and make.
- ❑ **Smooth Handover:** Minimize packet loss. Handover delay not critical.
- ❑ **Fast Handover:** Minimize handover delay. Packet loss not critical.
- ❑ **Seamless Handover:** No change in quality, security, or capability of service.

Terminology (Cont)

- ❑ **Diversity**: Ability to receive two signals at the same time.
- ❑ **Micro Diversity**: Two signals between the same subscriber and base station
- ❑ **Macro Diversity**: Two signals from different base stations
- ❑ **IP Diversity**: Packets from two IP networks
- ❑ **Micro Mobility**: Mobility within a single network. No effect outside the network. a.k.a. Local Mobility.
- ❑ **Macro Mobility**: Mobility between networks. Requires Mobile IP type solution. a.k.a. Global Mobility.

Mobile IP: Processes

- ❑ **Agent Discovery:** To find agents
 - ❑ Home agents and foreign agents advertise periodically on network layer and optionally on datalink
 - ❑ They also respond to solicitation from mobile node
 - ❑ Mobile can send solicitation to Mobile agent multicast group 224.0.0.11
 - ❑ Mobile selects an agent and gets/uses care-of-address
- ❑ **Registration**
 - ❑ Mobile registers its care-of-address with home agent. Either directly or through foreign agent
 - ❑ Home agent sends a reply to the CoA
 - ❑ Each "Mobility binding" has a negotiated lifetime limit
 - ❑ To continue, reregister within lifetime

Processes (Cont)

- **Return to Home:**
 - Mobile node deregisters with home agent
sets care-of-address to its permanent IP address
 - Lifetime = 0 \Rightarrow Deregistration
- Deregistration with foreign agents is not required.
Expires automatically
- Simultaneous registrations with more than one COA
allowed (for handoff)

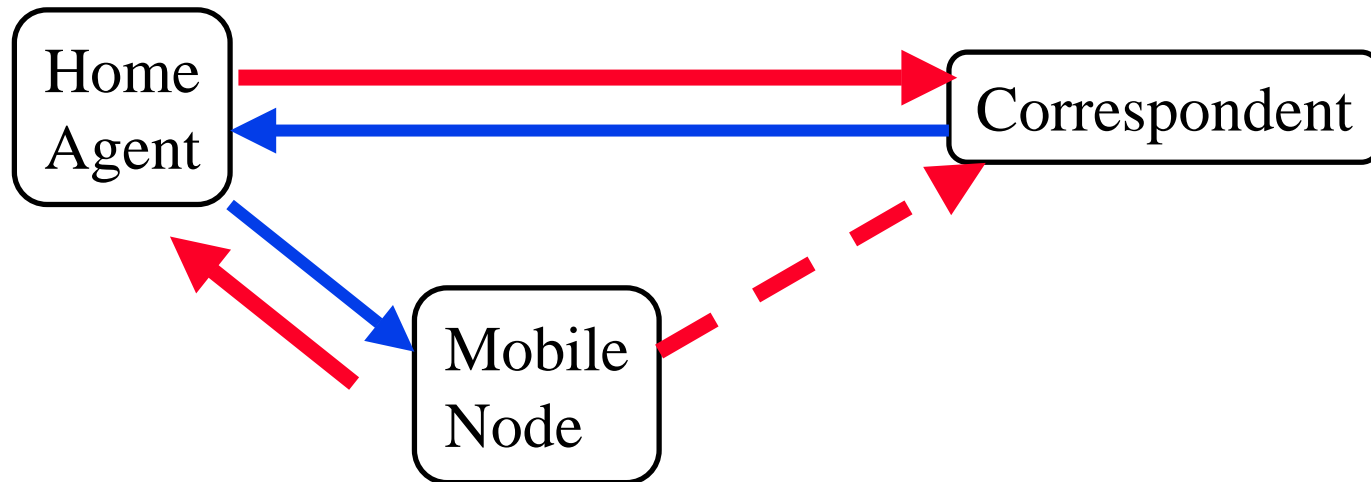
Encapsulation/Tunneling

- ❑ Home agent intercepts mobile node's datagrams and forwards them to care-of-address
- ❑ Care of Address can be the Foreign Agent or it can be co-located in the mobile host
- ❑ Home agent tells local nodes and routers to send mobile node's datagrams to it
- ❑ De-encapsulation: Datagram is extracted and sent to mobile node



Reverse Tunneling

- ❑ Normally, MN sends the packets directly to the correspondent with SA=Home Address, DA=Correspondent
- ❑ Problem: Such packets may be dropped by visited network's firewalls since the source address is not on foreign network
- ❑ Solution: Reverse traffic is also sent via home agent [RFC 3024]

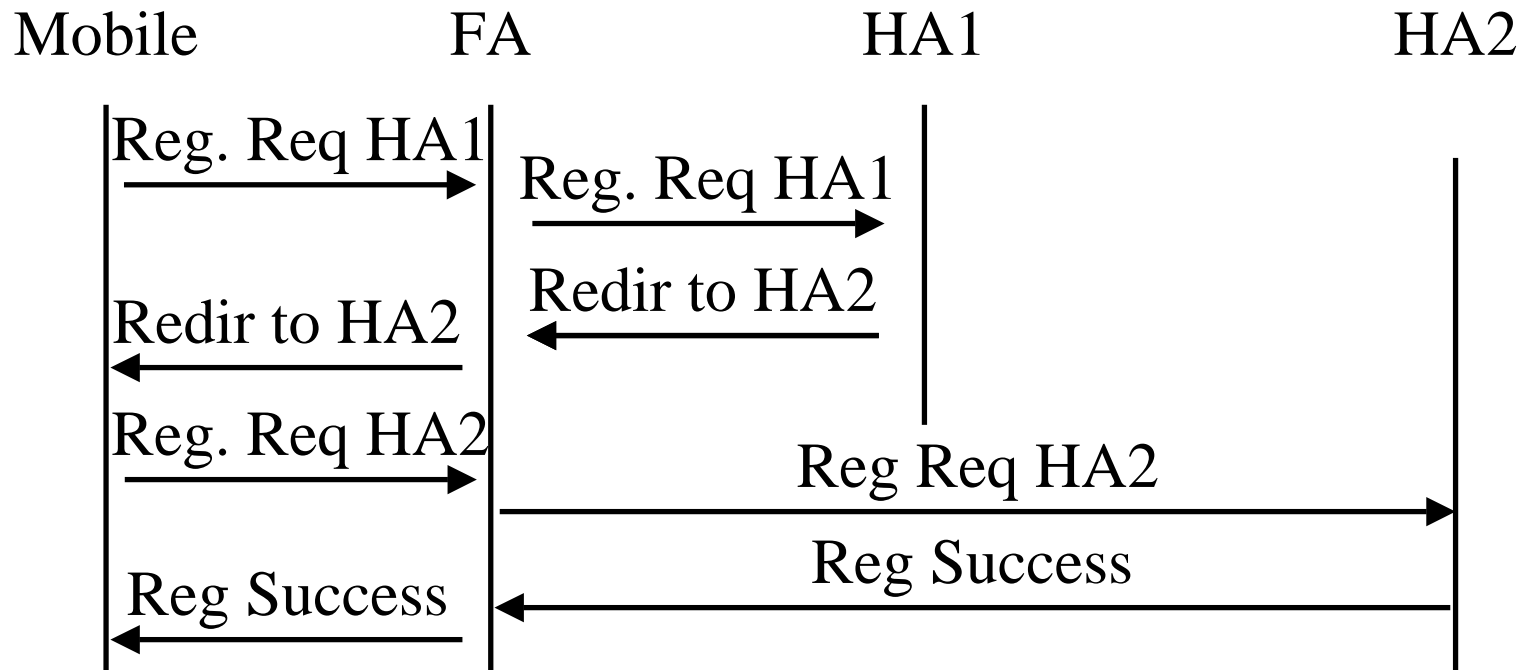


Home Networks with Dynamic IP Address

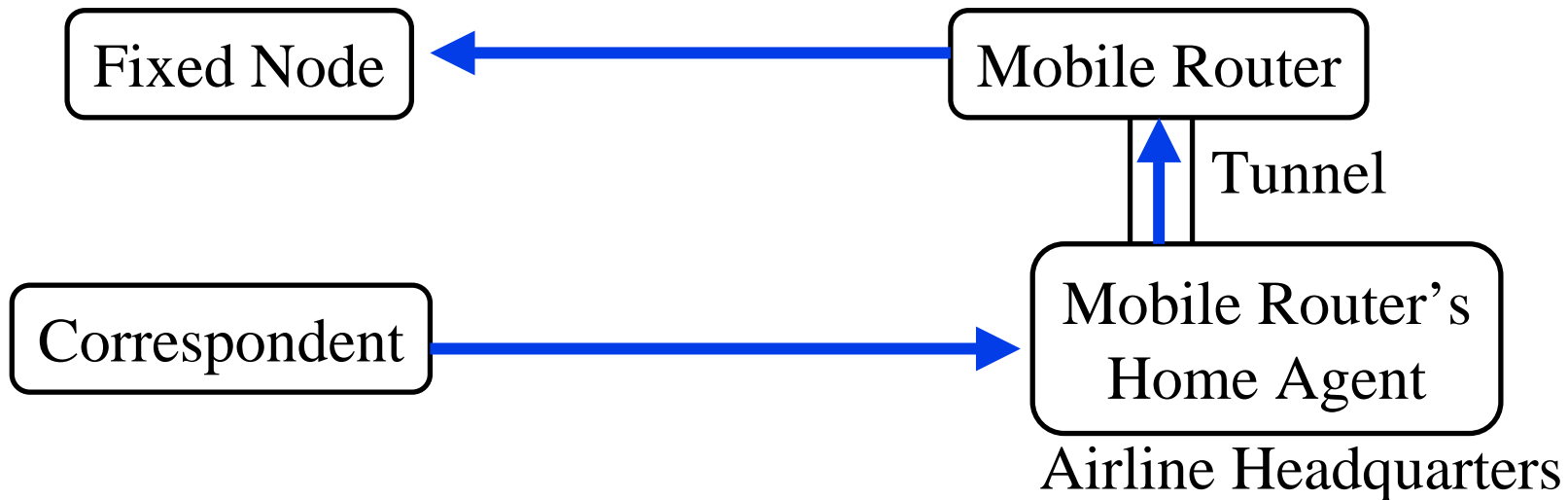
- ❑ Problem: DHCP based hosts do not have the initial IP address, DNS address on the home network
- ❑ Cisco's Solution: The registration request to home agent includes a request for configuration
- ❑ The registration reply includes IP address, DHCP server's address, DNS address
- ❑ RFC 4332, Cisco's Mobile IPv4 Host Configuration Extensions

Dynamic Home Agent Assignment

- ❑ Dynamic HA extension allows home agents to be assigned dynamically. Based on load balancing or other considerations.
- ❑ Example: Using CoA at foreign agent [RFC 4433]



Network Mobility (NEMO)



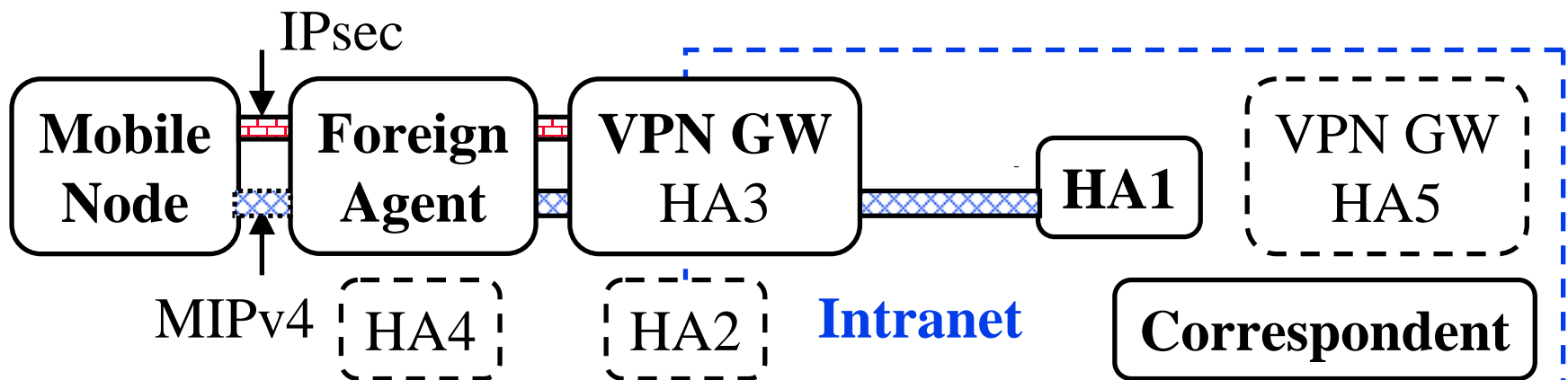
- ❑ Mobile router registers “network prefixes” with home agent
- ❑ All addresses with those prefixes are forwarded by home agent to Mobile router in a tunnel
- ❑ The reverse traffic is also tunneled.
- ❑ The mobile network may have visiting mobile routers or visiting mobile nodes.
- ❑ RFC 3963, Jan 2005

Security Issues

- ❑ Need to Authenticate: MN – FA, FA-HA, MN-HA
- ❑ Message Authentication Code: Use keyed-MD5
- ❑ Key Management: Need network key distribution
- ❑ Confidentiality: Use encryption IPsec ESP
- ❑ Replay Protection: Changing Identification field. Use time stamps as ID or Nonces
- ❑ Location Privacy: Reverse traffic is tunneled via HA
- ❑ Ingress Filtering: Firewalls drop outgoing packets with topologically incorrect source address
⇒ Use reverse tunneling with COA as SA

Mobile IP and VPN

- ❑ Mobile IP \Rightarrow MIPv4 tunnel between Care-of-Address and Home Agent. COA at Foreign agent or co-located in Mobile.
- ❑ VPN \Rightarrow IPsec Tunnel between Mobile and VPN Gateway
- ❑ Depending upon the location of home agent:
 - ❑ IPsec inside MIPv4 tunnel or MIPv4 inside IPsec tunnel
- ❑ RFC 4093 lists five possible locations for Home Agent
- ❑ Work in progress to modify Mobile IP for VPN



Mobile IP and VPN (Cont)

1. Home Agent inside Intranet: MIP inside IPsec.

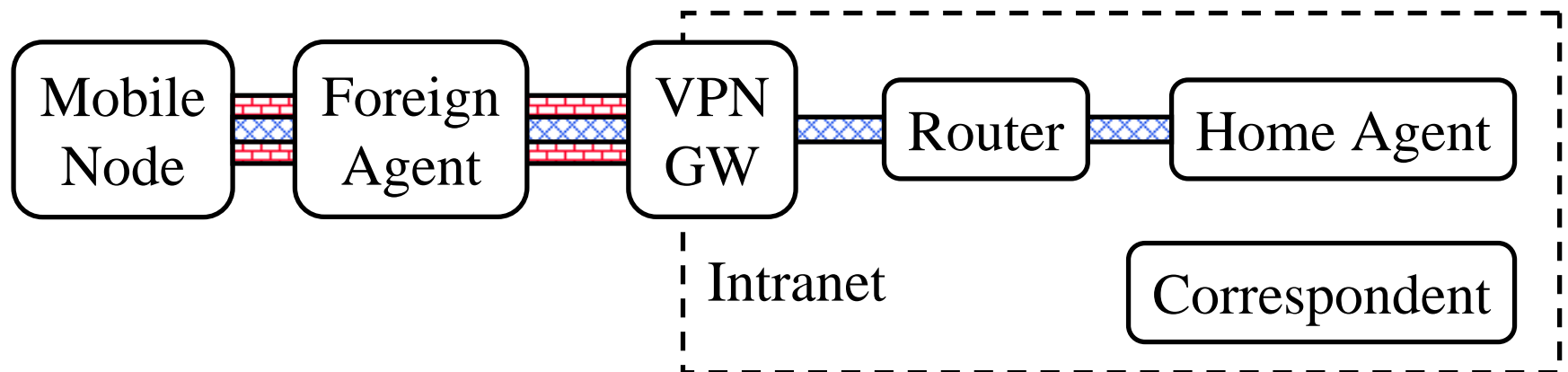
Foreign agent cannot be COA.

Co-located COA only.

Every COA change \Rightarrow New VPN tunnel

This is the most common configuration

\Rightarrow Requires modifications to MIPv4



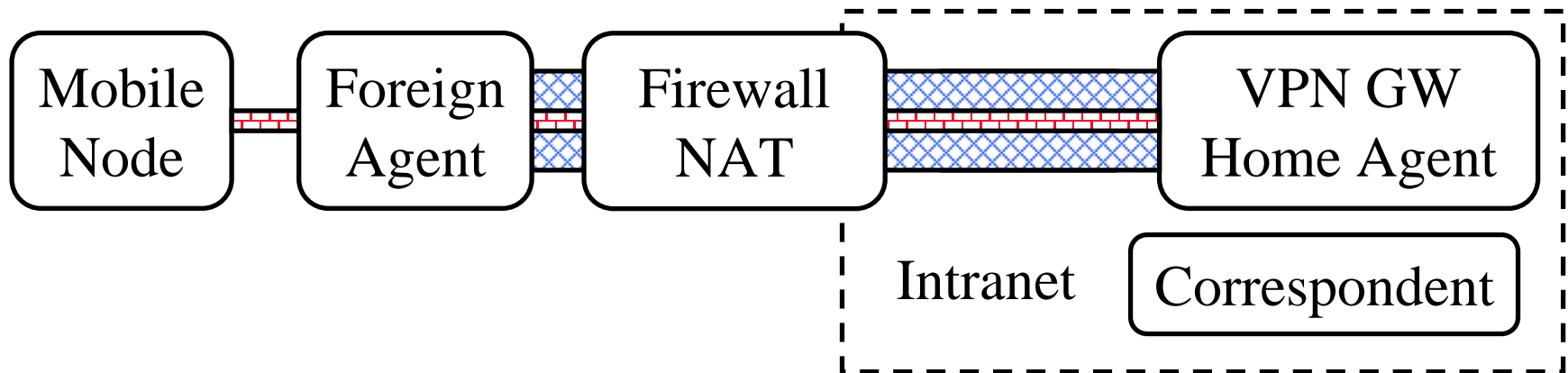
Mobile IP and VPN (Cont)

5. Combined VPN Gateway and HA in the Intranet:

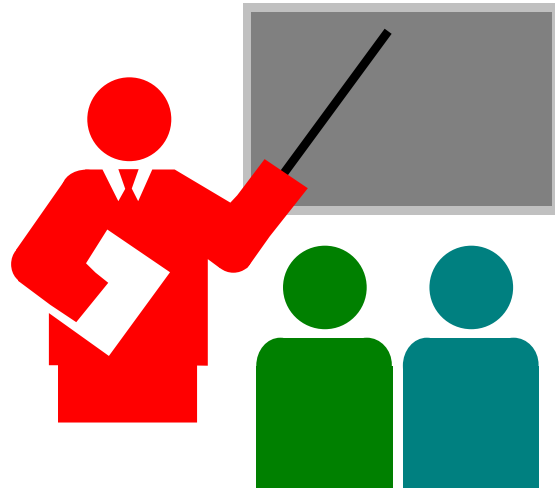
This works without any problems or modifications.

IPsec in MIPv4

Not scalable to thousands of mobile users



Summary



- ❑ Mobile node gets its packet via a tunnel from the home agent to care-of-address
- ❑ Reverse tunnel from mobile to home agent is optional
- ❑ It is possible to dynamically assign home address and home agents
- ❑ Network mobility is supported. Requires reverse tunneling.
- ❑ Need to carefully position VPN gateway and home agents for proper nesting of IPsec and Mobile-IP tunnels

Reading Assignment

Text Books:

- ❑ Dixit and Prasad, Chapter 16, pp. 335-439.
- ❑ Murthy and Manoj, Section 4.3, pp. 158-172

Key RFCs:

- ❑ RFC 3344 IP Mobility Support for IPv4
- ❑ RFC 3753 Mobility Related Terminology

Other Papers:

- ❑ Y. Chen, “A Survey Paper on Mobile IP,”
http://www.cse.wustl.edu/~jain/cis788-95/mobile_ip/index.html
- ❑ Charlie Perkins, “Mobile IP,” IEEE Communications Magazine, May 1997, pp. 84-99
- ❑ Charlie Perkins, “Mobile IP,” IEEE Communications Magazine, May 2002, pp. 66-82

Mobile IPv4: RFCs

Secondary RFCs:

- ❑ RFC 3024 Reverse Tunneling for Mobile IP
- ❑ RFC 2005 Applicability Statement for IP Mobility Support
- ❑ RFC 2041 Mobile Network Tracing
- ❑ RFC 2290 Mobile-IPv4 Configuration Option for PPP IPCP
- ❑ RFC 2356 Sun's SKIP Firewall Traversal for Mobile IP
- ❑ RFC 2794 Mobile IP Network Access Identifier Extension for IPv4
- ❑ RFC 2977 Mobile IP AAA Requirements

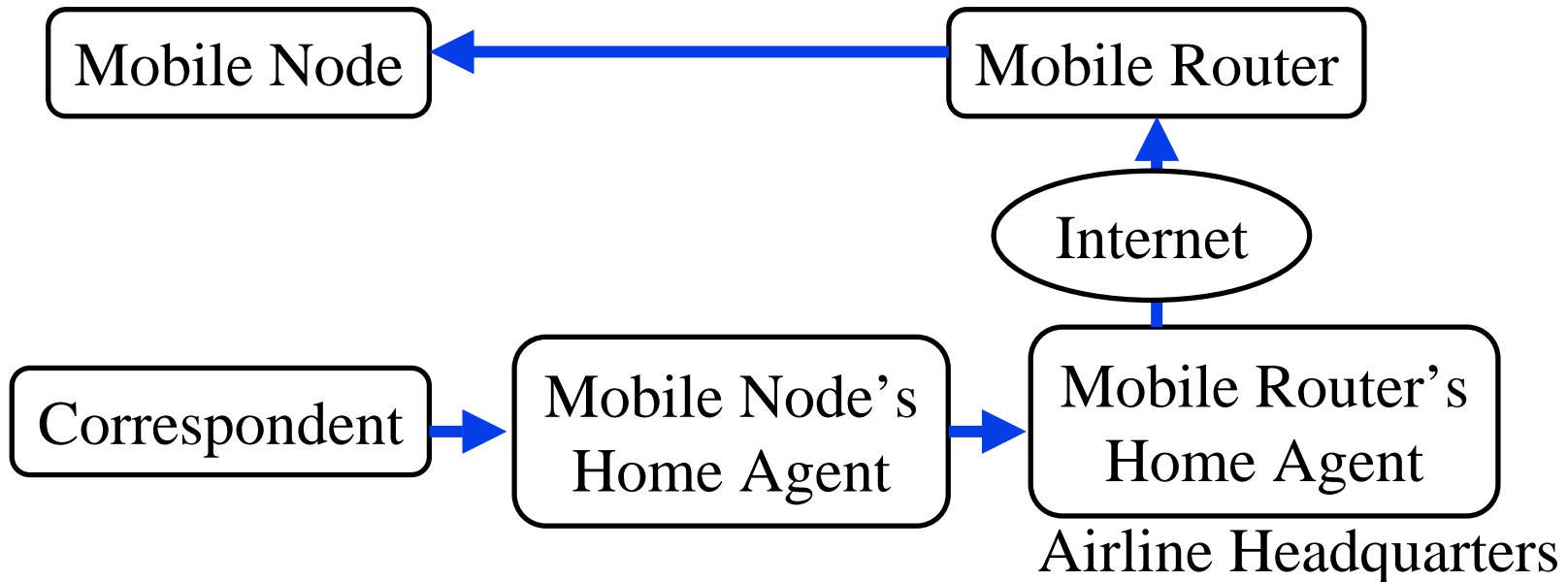
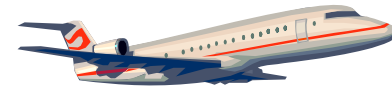
Mobile IPv4: RFCs (Cont)

- ❑ RFC 3012 Mobile IPv4 Challenge/Response Extensions
- ❑ RFC 3115 Mobile IP Vendor/Organization-Specific Extensions
- ❑ RFC 3519 Mobile IP Traversal of Network Address Translation (NAT) Devices
- ❑ RFC 3543 Registration Revocation in Mobile IPv4
- ❑ RFC 3583 Requirements of a Quality of Service (QoS) Solution for Mobile IP
- ❑ RFC 3846 Mobile IPv4 Extension for Carrying Network Access Identifiers
- ❑ RFC 3957 AAA Registration Keys for Mobile IPv4
- ❑ RFC 3963 Network Mobility (NEMO) Basic Support Protocol
- ❑ RFC 4004 Diameter Mobile IPv4 Application

Mobile IPv4: RFCs (Cont)

- ❑ RFC 4064 Experimental Message, Extensions, and Error Codes for Mobile IPv4
- ❑ RFC 4065 Instructions for Seamoby and Experimental Mobility Protocol IANA Allocations
- ❑ RFC 4093 Problem Statement: Mobile IPv4 Traversal of Virtual Private Network (VPN) Gateways
- ❑ RFC 4332 Cisco's Mobile IPv4 Host Configuration Extensions
- ❑ RFC 4433 Mobile IPv4 Dynamic Home Agent (HA) Assignment

Homework



- A mobile node with home address in WUSTL.EDU is traveling in a plane with a router that serves as COA . But the router itself is mobile and has a home address at AA.COM. How many Mobile IP tunnels will be setup and indicate IP addresses of the end points of each tunnel. Hint: See RFC3344.