Mobile IPv6

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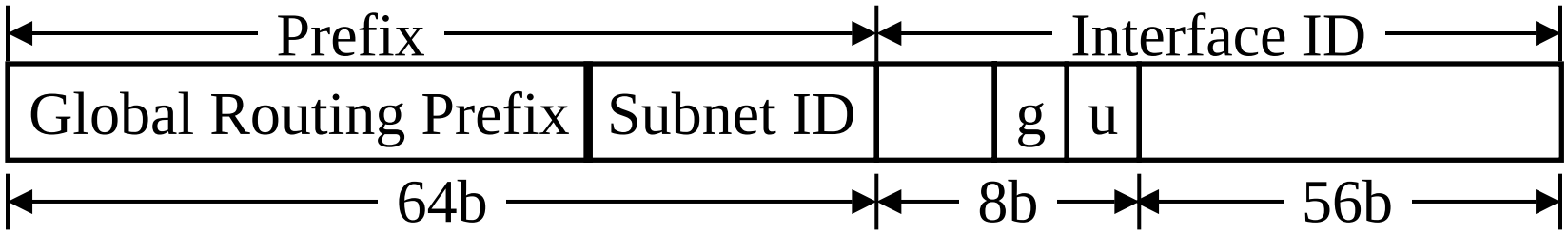
Audio/Video recordings of this lecture are available at:

http://www.cse.wustl.edu/~jain/cse574-10/

- IPv6: Overview, Extension Headers, Neighbor Discovery, Address Auto configuration
- Mobile IPv4 vs. IPv6
- Route Optimization
- Return Routability Procedure
- Cryptographically Generated Addresses (CGAs)
- Fast Handover
- Hierarchical Mobile IPv6 (HMIPv6)

IPv6: Overview



- 128 bit addresses: 64-bit Prefix + 64-bit Interface ID
  lsb of MSB = u = universal or local interface ID
  g = group ID
- Routers advertise network prefix
- Colon-hex notation:
  3FFE:0200:0000:0000:0000:0012:F0C8:79CA
  3FFE:0200::0012:F0C8:79CA
  :: ⇒ Unspecified Address
- Flow Label: SA-DA-Label ⇒ One flow
- Scoped Addresses: Link-Local, Site-Local
- Extension headers: Routing, Hop-by-Hop, Destination Options

Address Auto Configuration

- **Stateful**:
  - Using DHCP
- **Stateless**:
  - Hosts can make a global address using advertised network prefix
  - Interface identifier should be unique
  - Stateless ⇒ No one needs to keep record of what address was allocated

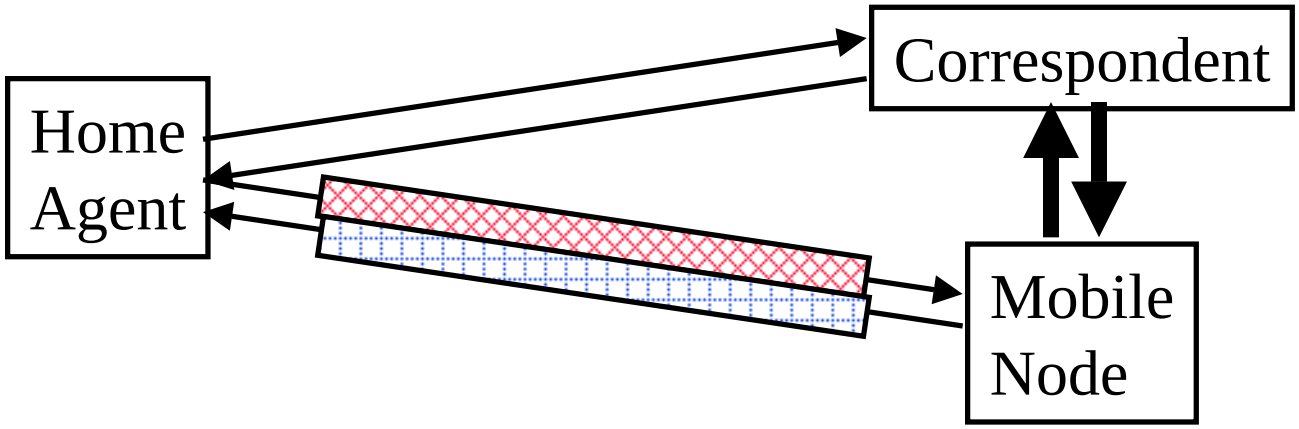
Mobile IPv4 vs. IPv6

1. No need for a foreign agent
2. Route optimization
3. Secure Route optimization
4. New extension header in place of tunneling
   $\Rightarrow$ Less overhead. Less state.
5. Neighbor discovery in place of ARP
   $\Rightarrow$ More general L2
6. Dynamic home agent discovery returns a single reply

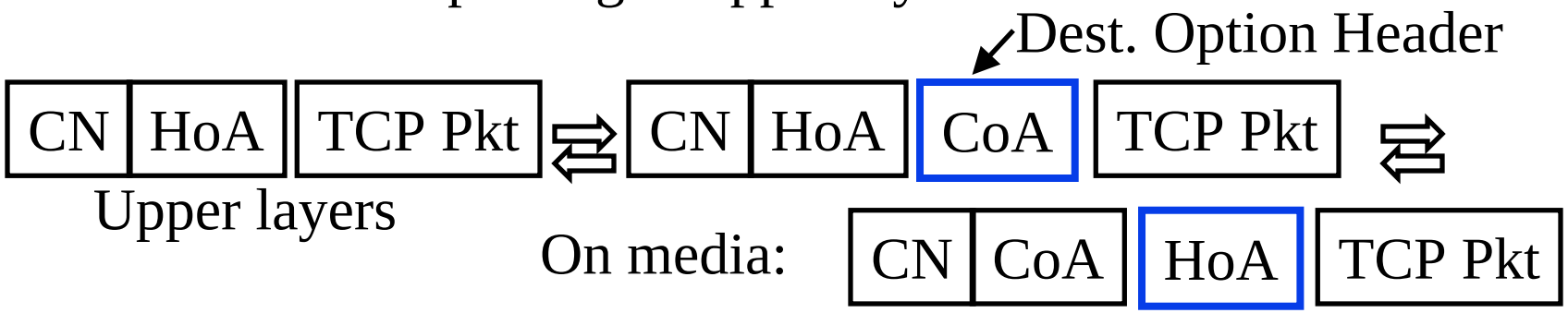
Binding Updates

- Binding Update ⇒ Registration
- New Mobility Header
- MH Type=5 ⇒ Binding Update
- Each binding update has a Sequence Number. Mobile keeps track of last seq # for each destination
- Home agent performs Duplicate Address Detection (DAD), updates binding cache, sends binding ack
- New network prefix and default router unreachable ⇒ Network change

Route Optimization



- Shortest path in both directions
- Mobile sends a binding update to the correspondent
- New Destination Option: Home Address (HoA) Option
- HoA option is used in all packets. Correspondent replaces SA with HoA before passing to upper layer

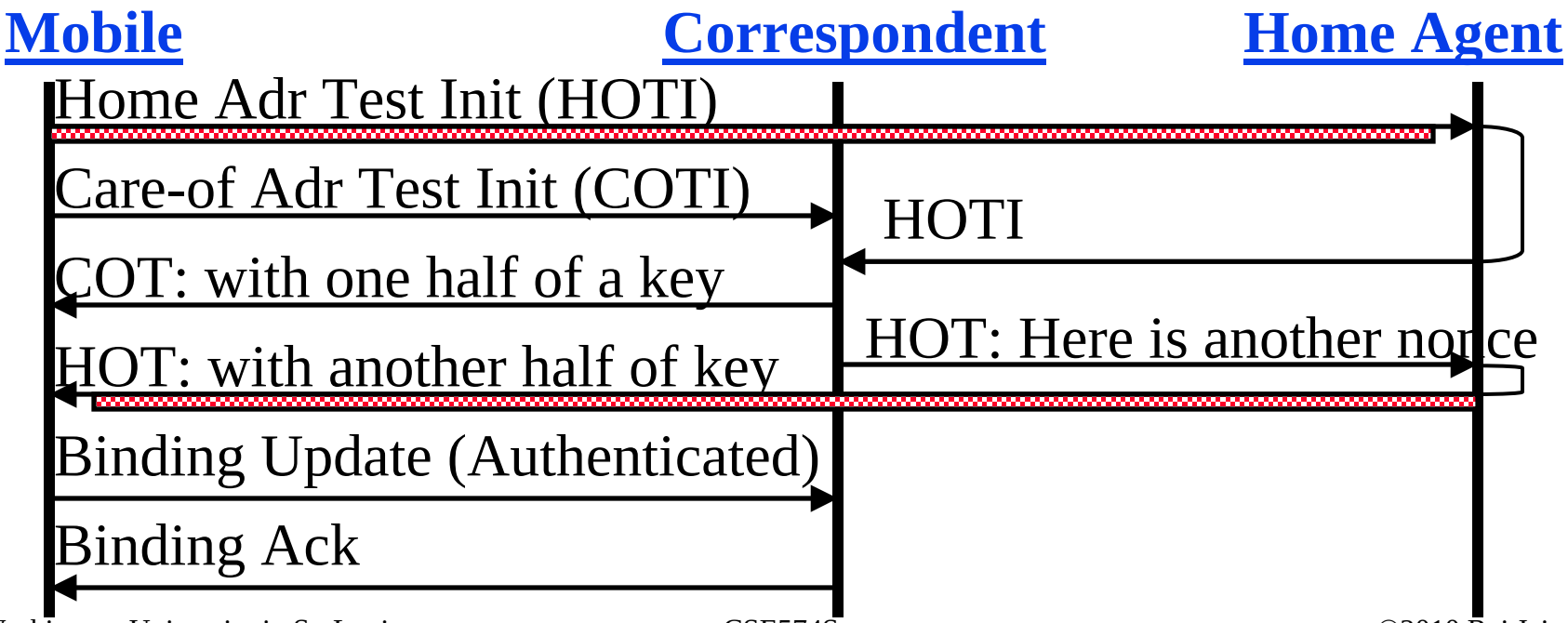


Route Optimization (Cont)

- SA and destination option addresses are interchanged before transmission and after reception
- In the reverse direction:
  - New header type: "Routing Header type 2" contains home address
  - DA and Routing header type 2 addresses are interchanged before transmission and after reception
- Binding error message
  ⇒ Sorry I don't have a binding for this HoA
- IP-in-IP tunneling will require 4 addresses instead of 3 with new headers

Return Routability Procedure

- Mobile must prove to correspondent that it owns both HoA and CoA
- Mobile does not share any secret with correspondent
- Correspondent send messages to HoA and CoA. Mobile responds correctly if it receives both.



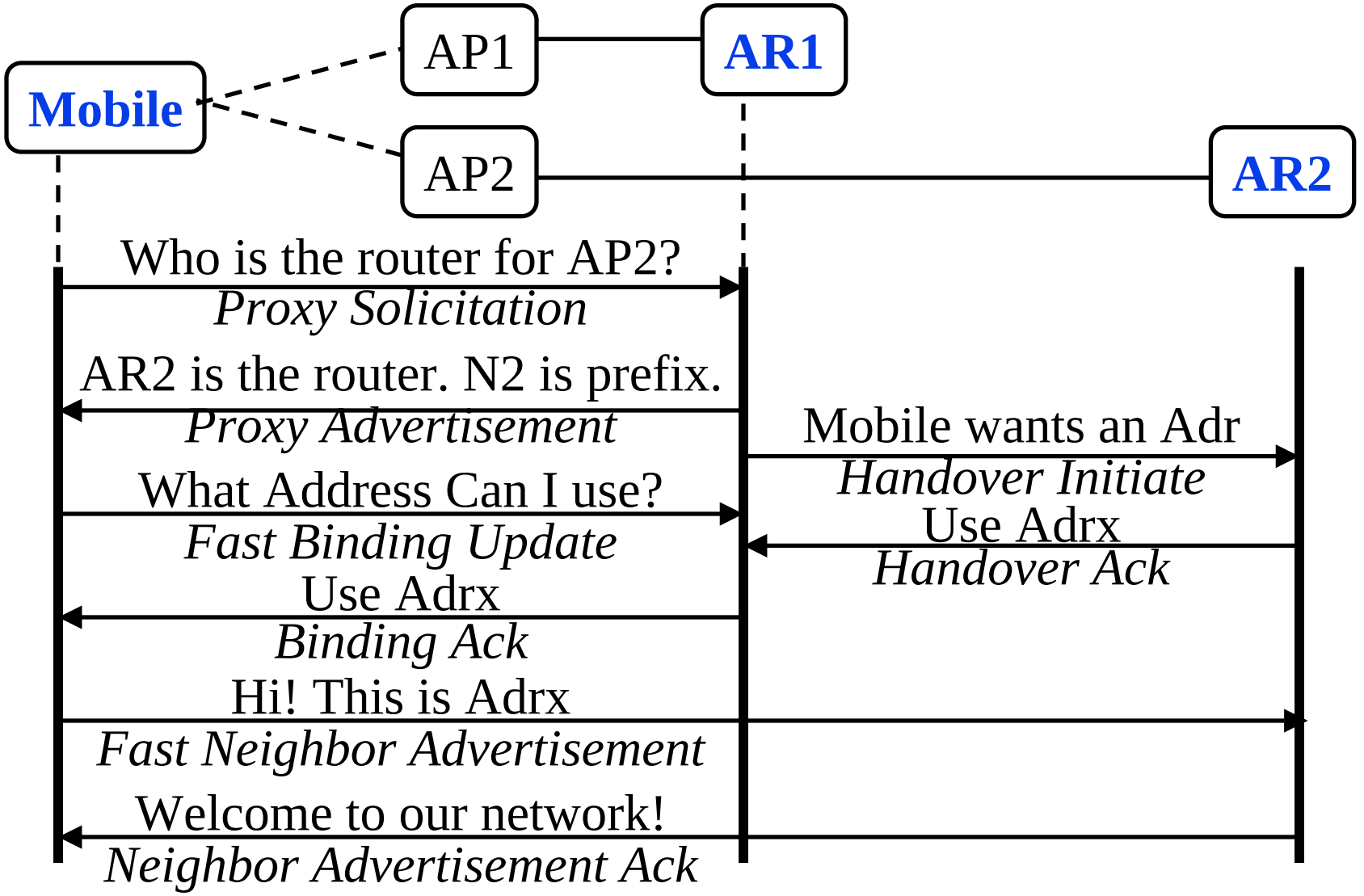
Return Routability Procedure (Cont)

- Mobile starts this test. Sends HoTI via HA with a cookie.
- CN generates "Home Keygen Token"
  = First(64, HMAC_SHA1(Kcn, HoA|nonce|0))
- CN returns HoT containing MN's cookie, Home keygen token, and CN's nonce index
- Mobile sends CoTI directly to CN with another cookie
- CN generates "Care-of Keygen Token"
  = First(64, HMAC_SHA1(Kcn, CoA|nonce|1))
- CN returns CoT containing MN's cookie, Co Keygen Token, CN's nonce index
- Mobile constructs a key and sends an encrypted binding update
  - Kbm = Sha1(Home Keygen Token|Care-of Keygen Token)
  - Auth_data = First(96, MAC(Kbm, Mobility_data))
  - Mobility_data = CoA|final dest address|Mobility Header data
  - Final Dest Address = CN's Home address if CN is mobile

Cryptographically Generated Addresses

- IPv6 address includes 64 bit interface id
- A node can generate Interface ID using its public key on network prefix
- 64-bit Interface ID = First(64, Hash(home_prefix|public key|context) &0xFCFF FFFF FFFF FFFF)
- C $\Rightarrow$ Universal and group bits on the interface id are zero
- Mobile node can sign the binding update using its private key.

Fast Handover

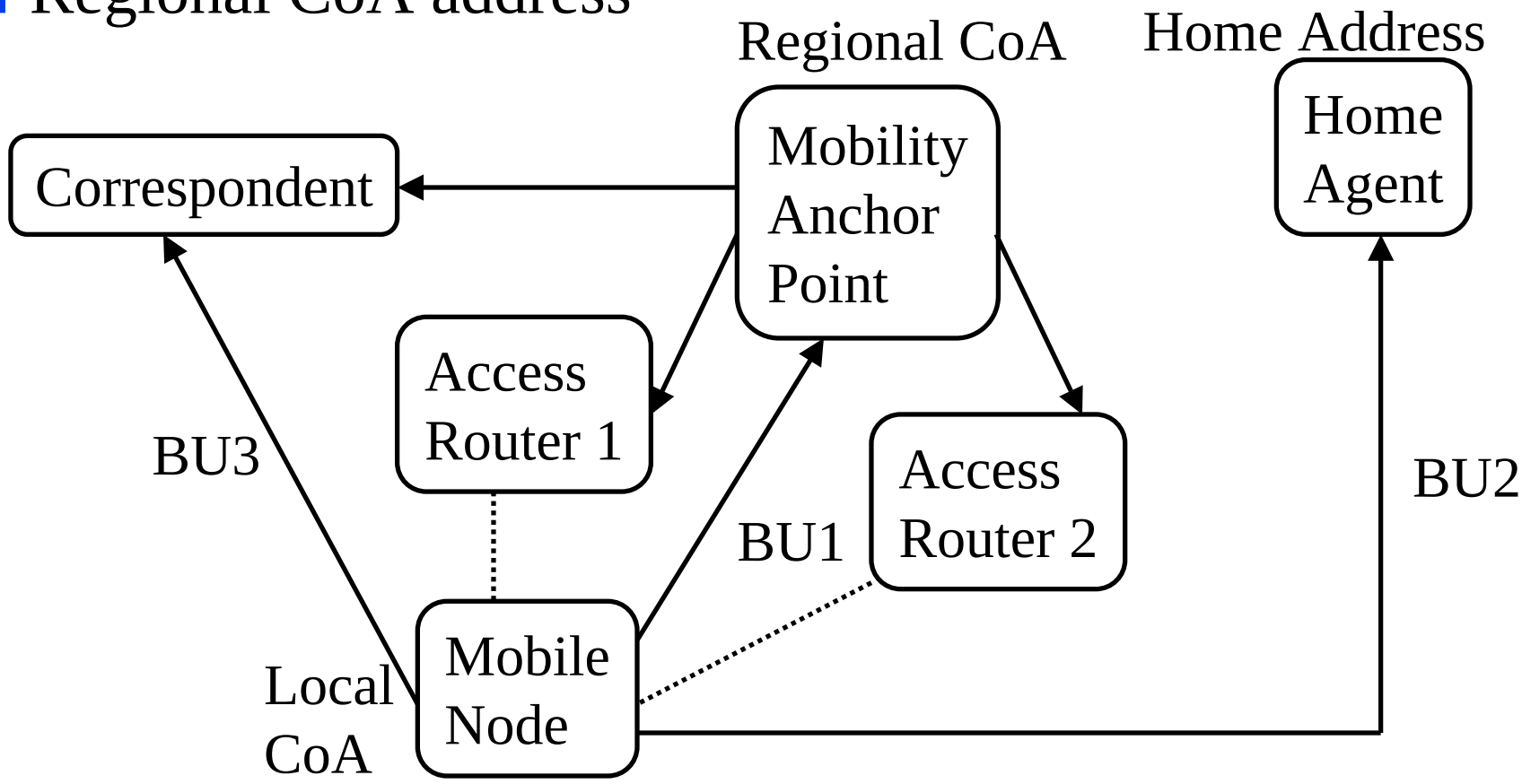


Fast Handover (Cont)

- Ask AR1 about router for AP2
  $\Rightarrow$ *Router Solicitation for Proxy* w list of Access Points
- AR1 returns *Proxy Router Advertisement* w at least one prefix
- AR1 sends *Handover initiate* (HI) message to AR2 and sets up a tunnel
- AR2 does *DAD* and send *Handover Ack* (Hack)
- Mobile sends *Binding update* to AR1
- AR1 sends *Binding Ack* to old CoA or new CoA
- Mobile sends *Fast Neighbor Advertisement* (F-NA) to AR2
- AR2 returns *Fast Neighbor Advertisement Ack* to Mobile
- Mobile can use CGA to avoid HI/Hack

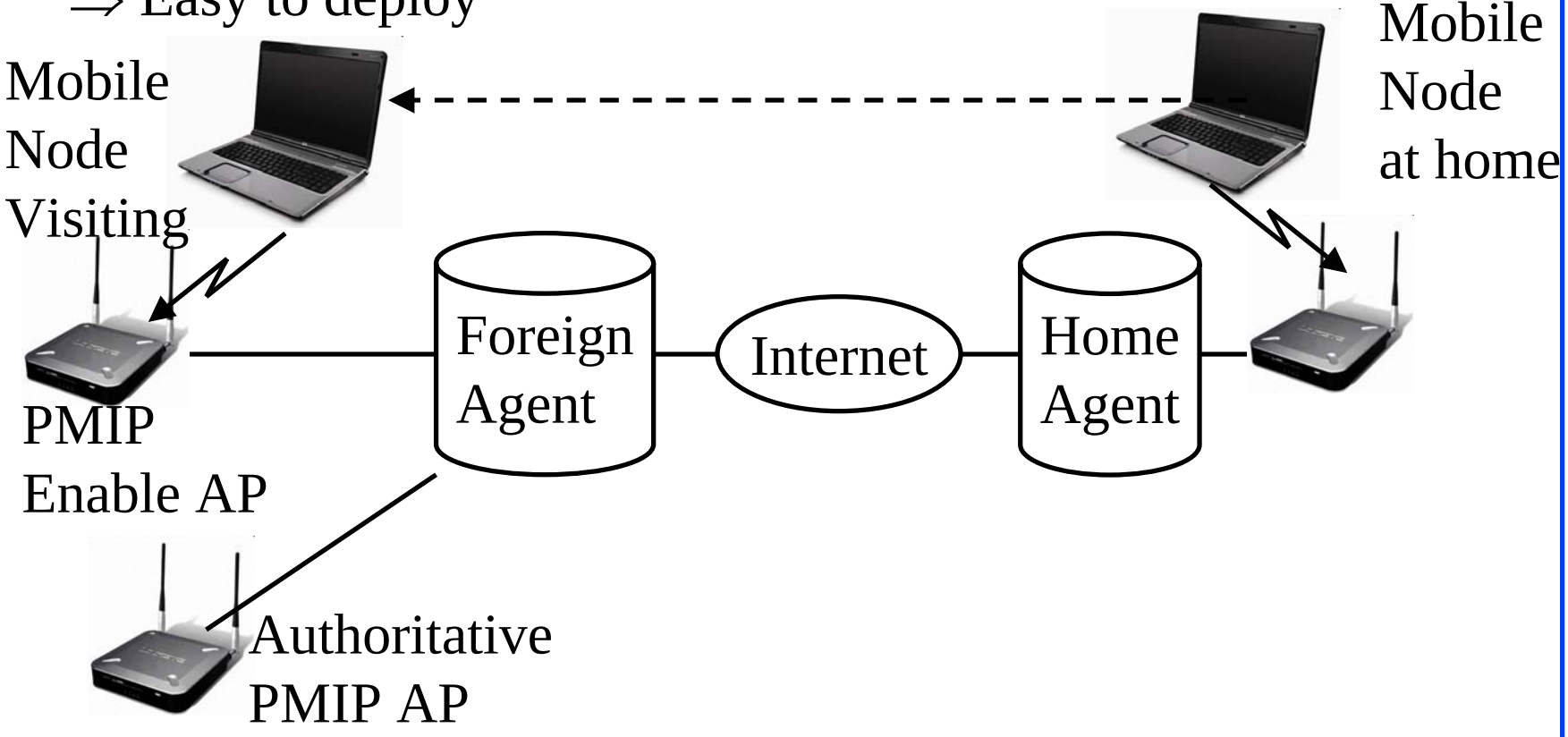
Hierarchical Mobile IPv6 (HMIPv6)

- Regional Home Agent: Mobile Anchor Point (MAP)
- Regional CoA address



Proxy Mobile IPv6

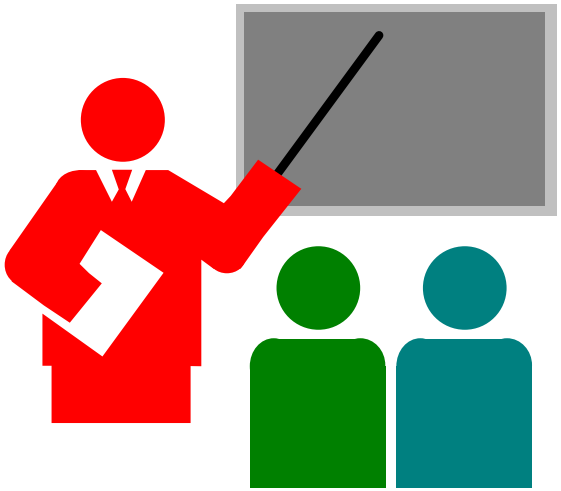
- Mobile nodes do not have any mobility software
- Access points register on behalf of mobile nodes
  ⇒ Easy to deploy



Proxy Mobile IPv6 (Cont)

- IPv6 nodes have 128 bit addresses = Subnet part + Host part
- PMIP enabled access points cache a database of home agents for all subnets that they support
- Authoritative AP keeps the latest copy. Other APs can ask authoritative AP for the correct info.
- When a node connects to the AP, it
  - looks at the subnet address of MN,
  - realizes that it is from a foreign network,
  - finds the home agent and registers its address with it.
  - All packets coming to home address will be forwarded to the AP and then to the mobile.

Summary



- IPv6 has a new "mobility" extension header.
- Two-way optimal route using binding updates with correspondent
- Security using Return Routability procedure
- Fast handover using local mobility
- Hierarchical anchors to minimize mobile overhead
- Proxy Mobile IP allows APs to proxy for mobile nodes

Related Wikipedia Articles

- http://en.wikipedia.org/wiki/Mobile_IPv6
- http://en.wikipedia.org/wiki/Proxy_Mobile_IP
- http://en.wikipedia.org/wiki/Virtual_private_network
- http://en.wikipedia.org/wiki/Mobile_virtual_private_network
- http://en.wikipedia.org/wiki/Proxy_ARP

Reading Assignment

- Configuring Proxy Mobile IP, http://www.ccip.info/en/US/docs/wireless/access_point/350/configuration/guide/ap350ch6.pdf

Key RFCs:

- RFC 3775 "Mobility Support in IPv6," June 2004.
- RFC 5213 "Proxy Mobile IPv6," August 2008.
- RFC 5268 "Mobile IPv6 Fast Handovers," June 2008.
- RFC 5270 "Mobile IPv6 Fast Handovers over IEEE 802," June 2008.
- RFC 5380 "Hierarchical Mobile IPv6 (HMIPv6) Mobility Management," October 2008.

Homework 19

- Read RFC 3775 and make a list of 9 fields that are stored in the binding update list entries.

References: Mobile IPv6 RFCs (Cont)

Secondary RFCs:

- RFC 1688 "IPng Mobility Considerations," August 1994.
- RFC 3776 "Using IPsec to Protect Mobile IPv6 Signaling Between Mobile Nodes and Home Agents," June 2004.
- RFC 4225 "Mobile IP Version 6 Route Optimization Security Design Background," December 2005.
- RFC 4283 "Mobile Node Identifier Option for Mobile IPv6 (MIPv6)," November 2005.
- RFC 4285 "Authentication Protocol for Mobile IPv6," January 2006.
- RFC 4295 "Mobile IPv6 Management Information Base," April 2006.

References: Mobile IPv6 RFCs (Cont)

- RFC 4449 "Securing Mobile IPv6 Route Optimization Using a Static Shared Key," June 2006.
- RFC 4487 "Mobile IPv6 and Firewalls: Problem Statement," May 2006.
- RFC 4584 "Extension to Sockets API for Mobile IPv6," July 2006.
- RFC 4640 "Problem Statement for bootstrapping Mobile IPv6 (MIPv6)," September 2006.
- RFC 4651 "A Taxonomy and Analysis of Enhancements to Mobile IPv6 Route Optimization," February 2007.
- RFC 4866 "Enhanced Route Optimization for Mobile IPv6," May 2007.

References: Mobile IPv6 RFCs (Cont)

- RFC 4877 "Mobile IPv6 Operation with IKEv2 and the Revised IPsec Architecture," April 2007.
- RFC 4882 "IP Address Location Privacy and Mobile IPv6: Problem Statement," May 2007.
- RFC 5026 "Mobile IPv6 Bootstrapping in Split Scenario," October 2007.
- RFC 5094 Mobile IPv6 Vendor Specific Option. December 2007.
- RFC 5096 Mobile IPv6 Experimental Messages. December 2007.
- RFC 5149 Service Selection for Mobile IPv6. February 2008.

References: Mobile IPv6 RFCs (Cont)

- RFC 5269 "Distributing a Symmetric Fast Mobile IPv6 (FMIPv6) Handover Key Using SEcure Neighbor Discovery (SEND)," June 2008.
- RFC 5271 "Mobile IPv6 Fast Handovers for 3G CDMA Networks," June 2008.
- RFC 5419 "Why the Authentication Data Suboption is Needed for Mobile IPv6 (MIPv6)," January 2009.
- RFC 5447 "Diameter Mobile IPv6: Support for Network Access Server to Diameter Server Interaction," February 2009.

List of Acronyms

- AH Authentication Header
- AR Access Router
- ARP Address Resolution Protocol
- CGA Cryptographically Generated Address
- CN Correspondent Node
- DA Destination Address
- DAD Duplicate Address Detection
- DHCP Dynamic Host Control Protocol
- HA Home Agent
- HMAC Hierarchical Message Authentication Code
- ID Identifier
- IP Internet Protocol
- IPv4 Internet Protocol V4
- IPv6 I nternet Protocol V6
- MAC Message Authentication Code

List of Acronyms (Cont)

- MAP Mobile Anchor Point
- MH Mobility Header
- RFC Request for Comment
- SA Source Address
- SIP Session Initiation Protocol
- TCP Transmission Control Protocol