

# Mobile IPv6

## Internet Protocols

CSC / ECE 573

Fall, 2005

N. C. State University

## Announcements

- I. Dropper is ready!
- II. Project due Thursday Dec 1!
- III. Final Exam and Study Guide!

## Today's Lecture

- I. Mobility
- II. Discovering the Care-of Address
- III. Registering the Care-of Address
- IV. Normal Data Delivery
- V. Security
- VI. Other Issues

# MOBILITY

## Motivation

- Many wireless devices offer IP connectivity
  - laptops, PDAs, cellular phones, ...
- Users (mobile hosts) want to stay connected wherever they may be
  - connections should not be disrupted as mobile hosts move from network to network
- To route a packet to a mobile host, the network first has to find where the host is located
  - means: what IP address to use

## Why is this Hard?

- Cellphone networks have done this for years – what's the difference?
- Non-technical reasons
- Technical reasons
- Cellphone mobility isn't perfect, either...

## Tradeoffs

- Can you receive **incoming** connections at new address?
- Movements **transparent** to other nodes?
- Can you **maintain currently-established connections** while moving?
- **Revisions to current protocols** required?
  - particularly, **routing** protocols and information
- **Security** risks?

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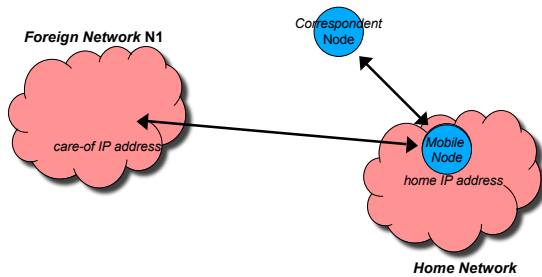
## Possible Approaches

1. Just get a new IP address when you attach to a different network
2. Get a new IP address, announce to other hosts (using DNS? direct messages?)
3. Get a new IP address, but let the rest of the world think you are still at your old IP address

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## Mobile IPv6 (RFC 3775)



- Note: we are ignoring Mobile IPv4 for a reason

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## Some Terminology (cont'd)

- **Home address**
  - all hosts have a home address, always reachable there
  - When MN is attached to home network, mobile IPv6 not used; packets are routed normally to / from home address
- **Care-of address**
  - IP address used by mobile host in the visited network
  - changes with each new point of attachment
- A **Home agent** keeps track of where MN is currently located, forwards traffic to / from it

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## Mobile IP Mechanisms

- Requires several mechanisms
- Mobile node **discovers** the care-of address
- Mobile node **registers** the care-of address with the **home agent**
- Mobile node and home agent **tunnel** data using the care-of address
- Optionally, mobile node **registers** the care-of-address with the **correspondent node**

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## New / Revised Messages

- New IPv6 Extension: Mobility Header
  - main purpose: Binding Updates
- New IPv6 Extension: Destination Option
  - provides home address in IP datagram, as well as care-of-address used for delivery
  - for MN to CN communication
- Modified IPv6 Extension: Source Routing
  - for CN to MN communication

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## DISCOVERING "CARE-OF" ADDRESSES

## New Network Detection

- How detect that MN is attached to a new network?
  1. layer 2 notification (non-standardized), or...
  2. MN receives new Router Advertisement, or does not receive refreshing Advertisement in the time expected
  3. MN receives new Router Discovery Reply to a Request it issued
- In these cases, the mobile host should attempt to autoconfigure a new care-of address

## Home Agents

- Specialized routers
- Each maintains home agent list for network (routers who have sent Router Advertisements with HA bit set)

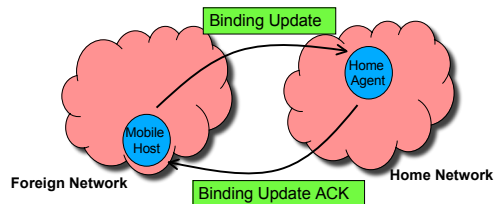
## Configuring Care-of Addresses

- Uses the standard configuration mechanisms to get an IPv6 care-of address on the foreign network
  - IPv6 auto configuration
  - DHCPv6
  - ...
- Home agent can act as DHCP relay or server for MNs that want to do stateful autoconfiguration
- When address about to expire, MN sends Mobile Prefix Solicitation to HA

## REGISTRATION

## Registering Care-of Address

- Once a MN has a care-of address, its home agent must be notified of the new address
  - home agent is a router in the home network, providing specialized mobility services



## Binding Update Message

- New IPv6 Extension: the Mobility Header
  - contains a set of messages
  - most important: Binding Update Message
- Request for router to function as home agent
  - home agent has to check for error conditions (home address not part of its network, host with that address already exists, etc.)
- Care-of address for the MN is specified by the Source IPv6 Address of the datagram containing the Binding Update

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## Binding Update Message (cont'd)

- Home address specified by:
  - Home Address destination option (if present), or
  - Source IPv6 Address of packet
- Registration must be refreshed periodically, otherwise it times out
  - **Lifetime** = number of seconds\*4, 16 bits long, max of 3 days
  - if **Lifetime** = 0, means “delete this binding from the cache”
- MN must maintain Binding Update list (HAs and CNs who know you are at this care-of address)

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## Binding Update Cache

- Maintained by home agents (and correspondent nodes)
- Keeps track of active home address / care-of address bindings
- Contents
  - home address
  - care-of address
  - lifetime
  - sequence number

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## Home Agent Discovery

- A new ICMPv6 message type is required: Home Agent Address Discovery Request and Reply
  - very similar to ICMP Router Request and Reply messages
- MN **anycasts** the Request to the home network
  - one home agent replies (on behalf of all home agents for that network)

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## Returning Home

- A mobile host is back at its home network when auto configuration returns its home address
  - in this case, the mobile host should “unregister” with the home agent

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DELIVERING DATA TO/FROM  
MOBILE NODES

## Mobile IPv6 Tunneling

A packet sent to MN *H* is...

- routed to *H*'s home network
- intercepted by the home agent

The home agent

- "tunnels" the packet to the care-of address
- (i.e., encapsulate IP packet for *H* inside an IP packet sent to care-of address)

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## Mobile IPv6 Tunneling (cont'd)

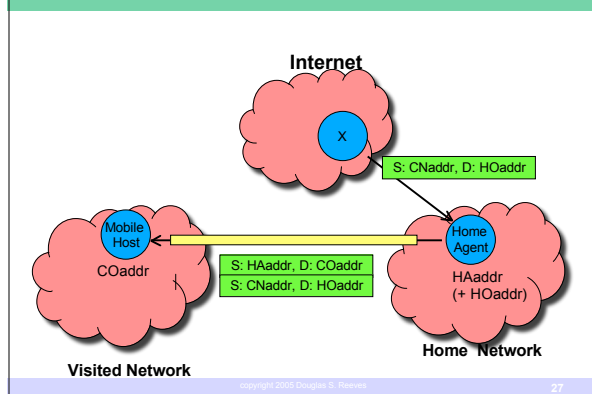
The destination MN decapsulates the packet and delivers it to application

- Data from MN to CN goes through a "reverse" tunnel
  - from MN to HA (tunneled)
  - from HA to CN (not tunneled)

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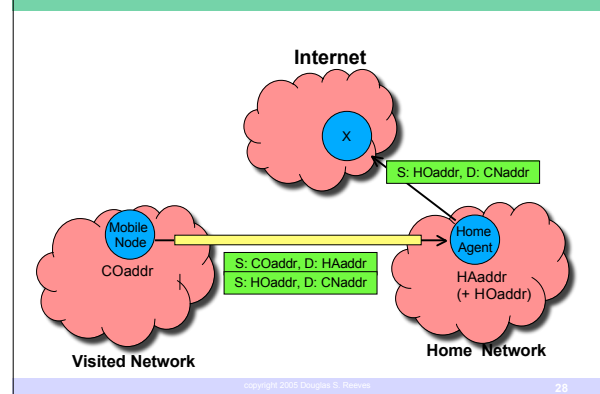
## Example: CN to MN (Tunneled)



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## Example: MN to CN (Tunneled)



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## Home Agent Packet "Interception"

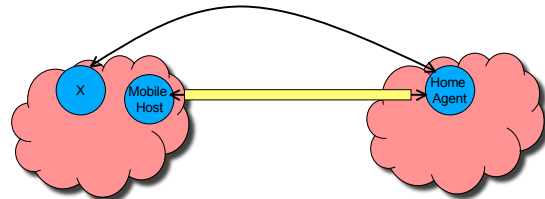
- Home agent multicasts ICMPv6 Neighbor Advertisement message on the home network
  - message binds the MN's home IP address to the HA's MAC address; like proxy ARP!
  - if other hosts send a Neighbor Discovery message for the mobile node's home IP address, HA must respond with its own MAC address
- When HA intercepts packet for mobile node, it tunnels it to MN

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## Routing Inefficiencies

- The two-crossing or triangle routing problem between correspondent node and mobile node



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## Another Option: Direct Communication

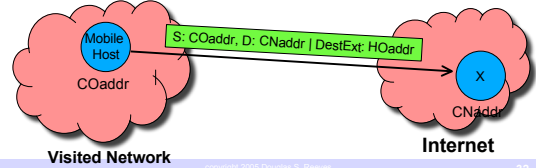
- Inefficiency of forwarding all data through home agent
  - problem of congestion at home agent, also
- Solution: mobile node sends Binding Update message directly to **correspondent node**
  - MN and correspondent node can exchange data directly afterwards (no need to involve HA)
  - CN will have to maintain Binding Update Cache, just like a HA

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## Direct Communication (cont'd)

- Data packets sent from MN → CN
  - must include the new Destination Option, contains the home address of the MN
  - MN's care-of address used as Source Address in the IP header
  - on arrival at CN, home address substituted as "true" Source Address

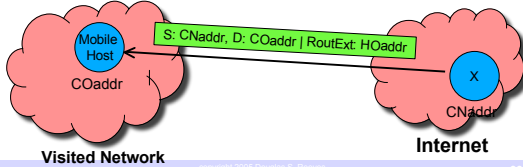


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## Direct Communication (cont'd)

- Data packets sent from CN → MN
  - CN looks up home address in binding cache, if found, substitutes care-of address as the Destination Address
  - Must include MN home address in the new Routing Extension
  - on arrival at MN, home address substituted as "true" Destination Address



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## SECURITY

## Mobile IPv6 Security Threats

- Security is a major issue for mobile IPv6
- Falsified Binding Updates sent to home agents and correspondent nodes could lead to...
  - intercepted data
  - misdirected data
  - reflector attacks

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## Mobile IPv6 Security Threats (cont'd)

- Using Mobile IPv6 to consume resources (impact on correspondent nodes, home agents)
- Visited networks may not provide same level of protection (e.g., firewalls, intrusion detection) as the home network

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## Authentication/Authorization

- Registration requires authentication!
  - 3GPP specifies use of Diameter (for roaming)
  - the home agent must be certain registration originated by the mobile node and not by malicious node
  - false bindings could make a host unreachable
- Each mobile node and home agent must share a security association, and use **HMAC-SHA1** to sign registration requests

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## Return Routability

- Before sending Binding Update to correspondent node, must authenticate reachability of MN at both home address and care-of-address
- **Home Test** and **Care-of Test** Messages accomplish this
  - contained in Mobility Extension Header
  - also negotiate keys that can be used for secure Binding Updates

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## Other Security Issues

- Interaction with IPSec is complicated
- Key distribution is poorly defined at present

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OTHER ISSUES

## Other Capabilities

- MN may choose to directly use one of its care-of addresses as the source of the packet
  - will not require the use of a Home Address option in the packet
  - some communication to/from home address, some to/from local address
- Multicasting
  - multicast datagrams on the home network addressed with a global scope, to which the mobile node has subscribed, should be tunneled to it

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## Other Capabilities (cont'd)

- Lots of error conditions and messages, ACKs, timers and counters, ...
- Network prefix discovery
- Multiple care of addresses
- Interaction with link-layer handoffs
- What if both nodes are mobile?!

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## Summary

- Mobile IP phones are on the way
  - only the “last mile” is (possibly) non-IP
- All IPv6 nodes are (now) IPv6 Mobility-enabled
  - IPv6 Neighbor Discovery and Address Autoconfiguration allow hosts to operate in any location without any special support
- The longest-running standardization effort in IETF history!
  - Mobile IPv4 dead (?)
- Lots of security issues

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## Next Lecture

- RTP, RTCP, and QoS

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