IPv6 Mobility
Outline

- Components of IPv6 mobility
- IPv6 mobility messages and options
- IPv6 mobility data structures
- Communication between the mobile node and the correspondent node
- Communication between the mobile node and the home agent
- IPv6 mobility processes
- IPv6 mobility changes to the host sending and receiving algorithms
IPv6 Mobility Overview

- IPv6 mobility allows an IPv6 node to be mobile—to arbitrarily change its location on the IPv6 Internet—and still maintain existing connections.

- Connection maintenance for mobile nodes is handled at the Internet layer.
  - IPv6, Routers, Special Gateways.
Components of IPv6 Mobility

IPv6 Internet

Correspondent Node

Mobile Node

Care-of Address

Foreign Link

Virtual Mobile Node

Home Address

Home Agent

Home Link
IPv6 Mobility

Questions

- How do I get a Home Agent
- How do I tell HA to act for me
- How do I get home traffic
- How do I get a care-of-address
- How does traffic get to me at care-of-address
- Timing for changes
- etc
IPv6 Mobility Messages And Options

- Destination Options Header options
  - Binding Update
    - update Home Agent with new care of, and correspondent
  - Binding Acknowledgement
    - got your update
  - Binding Request
    - from Home Agent or Correspondent
  - Home Address
    - source address = care-of-address

- ICMPv6 messages
  - Home Agent Address Discovery Request
  - Home Agent Address Discovery Reply
    - sent to Mobile Home Agents anycast address...
**ICMPv6 Home Agent Address Discovery Request Message** — sent when mobile

- **Type** = 150, Find home agent
- **Code** = 0
- **Checksum** = 0
- **Identifier** = ID, copied to reply
- **Reserved** = 0
- **Home Address of home node**

v6 source addr = care of Address; v6 target address = mobile home agent anycast address
ICMPv6 Home Agent Address Discovery Reply Message – who can be your home agent

<table>
<thead>
<tr>
<th>Type</th>
<th>151</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>0</td>
</tr>
<tr>
<td>Checksum</td>
<td></td>
</tr>
<tr>
<td>Identifier</td>
<td></td>
</tr>
<tr>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

Home Agent Address 1

list of possible home agents

Home Agent Address n
IPv6 Mobility Messages And Options

- Neighbor Discovery messages and options
  - Modified Router Advertisement message, .5 to 1.5 sec
    - Home Agent (H) flag, on home link, indicates router is home agent capable
  - Modified Prefix Information option
    - Router Addresses are in general Link Addresses
    - Router Address (R) flag
    - New definition of Prefix field, Router Global Address
  - New Advertisement Interval option
    - how often router will advertise
  - New Home Agent Information option
    - preference and lifetime as a home agent
IPv6 Mobility Data Structures

- Binding cache
  - Contains the **current** bindings for mobile nodes
  - Maintained by each correspondent node and home agent, so everyone knows addresses to use

- Binding update list
  - Lists the most recent binding updates sent for the home agent and correspondent nodes
  - Maintained by a mobile node, i.e., what I have told everyone else

- Home agents list
  - Lists the routers that sent a router advertisement with the Home Agent (H) bit set
  - Maintained by home agents and mobile nodes
    - So I can select my HA
IPv6 Mobility Communication

- Between a mobile node and a correspondent node
  - Data and Address Updates

- Between a mobile node and a home agent
  - Binding updates
Communication Between a Mobile Node and a Correspondent Node

- From the mobile node to the correspondent node
  - Binding updates – where Mobile Node really is.
  - Data
- From the correspondent node to the mobile node
  - Binding maintenance
  - Data
**Binding Update from Mobile Node to Correspondent Node**

- **IPv6 Header**
  - Source Address is CoA, no outgoing router issue
  - Destination Address is CNA

- **Destination Options Header**
  - Home Address Option
    - Home Address is HA, allows Application to deal with HA
  - Binding Update Option

---

**IPv6 Internet**

- **Mobile Node**
- **Home Agent**
- **Correspondent Node**
- **Virtual Mobile Node**
- **IPv6 Internet**
- **Home Link**
- **Foreign Link**
- **CoA**
- **HA**
Data from Mobile Node to Correspondent Node

IPv6 Header
- Source Address is CoA
- Destination Address is CNA

Destination Options Header
- Home Address Option
  - Home Address is HA, given to Application

Upper Layer PDU

IPv6 Internet

Home Agent

Foreign Link

CoA

IPv6: Mobility
**IPv6: Mobility**

**Binding Maintenance from Correspondent Node to Mobile Node**

IPv6 Header
- Source Address is CNA
- Destination Address is CoA

Routing Header
- Segments Left is 1
- Address 1 is HA, CN and MN use HA
- Game is to pretend MN is home

Destination Options Header
- Binding Acknowledgement or Request
Data from Correspondent Node to Mobile Node—Binding Cache Entry Present

already know where you are

IPv6 Header
- Source Address is CNA
- Destination Address is CoA
Routing Header
- Segments Left is 1
- Address 1 is HA
Upper Layer PDU

IPv6 Internet

Correspondent Node

Mobile Node

Virtual Mobile Node

Home Agent

Home Link

Foreign Link
Data from Correspondent Node to Mobile Node - Binding Cache Entry not Present

IPv6 Header
- Source Address is CNA
- Destination Address is HA

Upper Layer PDU

Correspondent Node

Virtual Mobile Node

Mobile Node

IPv6 Header

• Source Address is CNA
• Destination Address is HA

Upper Layer PDU

Correspondent Node

Virtual Mobile Node

Mobile Node

IPv6 Internet

Home Agent

Home Link

Foreign Link

CoA

do i need to tunnel

IPv6: Mobility
Communication Between a Mobile Node and a Home Agent

- From the mobile node to the home agent
  - Binding updates
    - I’m moving
  - ICMPv6 Home Agent Address Discovery Request message
- From the home agent to the mobile node
  - Binding maintenance
    - Acks or requests
  - ICMPv6 Home Agent Address Discovery Reply message
  - Tunneled data
    - data sent to MN from home link
**Binding Update from Mobile Node to Home Agent**

IPv6 Header
- Source Address is CoA
- Destination Address is HAA

Destination Options Header
- Home Address Option
  - Home Address is HA
- Binding Update Option
  - Home Registration flag set
  - Be my HA still
IPv6 Home Agent Address Discovery Request Message

IPv6 Header
- Source Address is CoA
- Destination Address is Mobile IPv6 Home Agents anycast address – possible many HAs

ICMPv6 Message
- Home Agent Address Discovery Request
Binding Maintenance from the Home Agent to the Mobile Node

IPv6 Header
- Source Address is HAA
- Destination Address is CoA
Routing Header
- Segments Left is 1
- Address 1 is HA
- Again HA available to Apps
Destination Options Header
- Binding Acknowledgment or Request

IPv6 Internet
- Correspondent Node
- Mobile Node
- Home Agent
**ICMPv6 Home Agent Address Discovery Reply Message**

IPv6 Header
- Source Address is HAA
- Destination Address is CoA

ICMPv6 Message
- Home Agent Address Discovery Reply
  - list of HAs in preference
**Tunneled Data from the Home Agent to the Mobile Node**

IPv6 Header
- Source Address is HAA
- Destination Address is CoA

IPv6 Header
- Source Address is CNA
- Destination Address is HA

Upper Layer PDU

**IPv6 Internet**

- **Home Link**
- **Foreign Link**

**Home Agent**

**Correspondent Node**

**Virtual Mobile Node**

**Mobile Node**

**IPv6 Over IPv6 Tunnel**

**IPv6 Header**
- Source Address is HAA
- Destination Address is CoA

**IPv6 Internet**

- **Home Link**
- **Foreign Link**
IPv6 Mobility In operation Processes

- Attaching to the home link
- Moving from the home link to a foreign link
- Moving from a foreign link to another foreign link
- Returning home
**Attaching to the Home Link**

- Once on the home link, a mobile node can store:
  - Home subnet prefix
  - Home address
  - Global address of their home agent

- Methods of configuring mobile node for home link:
  - Manual configuration - keyboard
  - Pseudo-automatic configuration
  - Automatic configuration
    - Node listens – uses ‘security relationship’ to determine if really home.
Mobile Node Attaches to its First Foreign Link

1. Multicast Router Solicitation
2. Unicast Router Advertisement
3. Home Agent Address Discovery Request from MN
4. Home Agent Address Discovery Reply
5. Binding Update to Home Agent
6. Multicast Neighbor Advertisement
   HA takes over locally for MN
7. Binding Acknowledgment

IPv6 Internet

Correspondent Node

Home Agent

Mobile Node

Home Link

Foreign Link
IPv6 Mobility Communication with Mobile Node - Moving Data

- Mobile node initiates a TCP connection with a new correspondent node
- Mobile node initiates non-TCP communication with a new correspondent node
- New correspondent node initiates a TCP connection with a mobile node
- Home link host sends data to a mobile node
**Mobile Node Initiates a TCP Connection with a New Correspondent Node**

1. TCP SYN with Home Address and Binding Update options from MN to CN
   CN builds binding update cache
2. TCP SYN-ACK with Binding Acknowledgment
3. TCP ACK from MN with Home Address option

**Diagram:**
- **Mobile Node** initiates a TCP connection with a **Correspondent Node**.
- **Home Agent** and **Home Link** are connected to the **IPv6 Internet**.
- A **Foreign Link** connects the **Mobile Node** to the **IPv6 Internet**.

**IPv6: Mobility**
IPv6: Mobility

**Mobile Node Initiates non-TCP Communication with a New Correspondent Node**

1. Initial message with Home Address option
2. no binding yet
3. Response message to home address
4. Tunneled response message to Mobile Node
5. Second message with Binding Update
6. Binding Acknowledgment

---

IPv6 Internet

**IPv6 Over IPv6 Tunnel**

- Virtual Mobile Node
- Correspondent Node
- Home Agent
- Mobile Node
- Foreign Link
- HA
- Home Link
New Correspondent Node Initiates a TCP Connection with a Mobile Node

1. TCP SYN to Home Address
2. TCP SYN tunneled to Care-of Address
3. TCP SYN-ACK with Binding Update
4. TCP ACK with Binding Acknowledgment

IPv6 Over IPv6 Tunnel

IPv6 Internet

Home Link

Foreign Link

IPv6: Mobility
Home Link Host Sends Data to a Mobile Node

1. Multicast Neighbor Solicitation
2. Proxied unicast Neighbor Advertisement
3. TCP SYN to Home Agent’s link-layer address
4. Tunneled packet to Mobile Node
5. TCP SYN-ACK with Binding Update
6. TCP ACK with Binding Acknowledgment
Mobile Node Changes to a New Foreign Link

1. Multicast Router Solicitation
2. Unicast Router Advertisement
3. Binding Update to Home Agent
4. Binding Update to Correspondent Node
5. Binding Acknowledgments

IPv6 Internet

Mobile Node Changes to a New Foreign Link

- Multicast Router Solicitation
- Unicast Router Advertisement
- Binding Update to Home Agent
- Binding Update to Correspondent Node
- Binding Acknowledgments
Mobile Node Returns Home

1. Multicast Router Solicitation
2. Unicast Router Advertisement
3. Binding Update to Home Agent
4. Binding Update to Correspondent Node
5. Binding Acknowledgments
6. Multicast Neighbor Advertisement
IPv6 Mobility Host
Sending Algorithm

Check destination cache for an entry matching the destination address.

Entry found in destination cache?

Check routing table for longest matching route to the destination.

Is there a longest matching route?

Set the next-hop address to the destination address.

Set the next-hop address to the next-hop address of the route.

Check neighbor cache for an entry matching the next-hop address.

Entry found in neighbor cache?

Obtain the next-hop address from the destination cache entry.

Does entry contain a pointer to a binding cache entry?

Obtain the next-hop address from the destination cache entry.

Update destination cache.

Was address resolution successful?

Use address resolution to determine the link-layer address of the next-hop address.

Update neighbor cache.

Send packet using link-layer address of neighbor cache entry.

Set source address to sending host’s care-of address. Insert Destination Options header with Home Address option.

Is sending host away from home?

Start

Check neighbor cache for an entry matching the next-hop address?

Yes

Send packet using link-layer address of neighbor cache entry.

No

Use address resolution to determine the link-layer address of the next-hop address.

Was address resolution successful?

Update neighbor cache.

Indicate an error.
IPv6 Mobility Host Receiving Algorithm

Is a Routing header present?  
No  
  - Process Routing header. Set destination address to value in Address 1 field.  
  - Is there an application listening on the destination UDP port?  
    No  
      - Send ICMPv6 Destination Unreachable-Port Unreachable message and discard the packet.  
    Yes  
      - Is the upper layer PDU a TCP segment?  
        No  
          - Set destination address to destination address in inner IPv6 header. Queue binding update to source address in inner IPv6 header.  
        Yes  
          - Send TCP Connection Reset segment.

Is there an application listening on the destination TCP port?  
No  
  - Send ICMPv6 Parameter Problem-Unrecognized Next Header Type Encountered message and discard the packet.  
  - Does the protocol for the Next Header field value exist?  
    No  
      - Is there a Home Address Option in the Destination Options header?  
        No  
          - Is a Routing header present?  
            Yes  
              - Process Routing header. Set destination address to value in Address 1 field.  
            No  
              - Is the packet tunneled from the home agent?  
                Yes  
                  - Set destination address to home address in Home Address option.  
                  - Is destination address assigned to a local interface?  
                    No  
                      - Silently discard the packet.  
                    Yes  
                      - Is the upper layer PDU a UDP message?  
                        Yes  
                          - Pass upper layer PDU to upper layer protocol.  
                        No  
                          - Is there an application listening on the destination UDP port?  
                            Yes  
                              - Process contents.  
                            No  
                              - Send TCP Connection Reset segment.

Is the upper layer PDU a UDP message?  
No  
  - Is there an application listening on the destination UDP port?  
    Yes  
      - Is there an application listening on the destination TCP port?  
        Yes  
          - Process contents.  
        No  
          - Is the upper layer PDU a TCP segment?  
            Yes  
              - Send TCP Connection Reset segment.

Is the packet tunneled from the home agent?  
Yes  
  - Set destination address to destination address in inner IPv6 header. Queue binding update to source address in inner IPv6 header.  
  - Is destination address assigned to a local interface?  
    No  
      - Silently discard the packet.  
    Yes  
      - Is there a Home Address Option in the Destination Options header?  
        No  
          - Is a Routing header present?  
            Yes  
              - Process Routing header. Set destination address to value in Address 1 field.  
            No  
              - Is the packet tunneled from the home agent?  
                Yes  
                  - Set destination address to home address in Home Address option.  
                  - Is destination address assigned to a local interface?  
                    No  
                      - Silently discard the packet.  
                    Yes  
                      - Is the upper layer PDU a UDP message?  
                        Yes  
                          - Pass upper layer PDU to upper layer protocol.  
                        No  
                          - Is there an application listening on the destination UDP port?  
                            Yes  
                              - Process contents.  
                            No  
                              - Send TCP Connection Reset segment.

Is there a Home Address Option in the Destination Options header?  
No  
  - Is the upper layer PDU a UDP message?  
    Yes  
      - Pass upper layer PDU to upper layer protocol.  
    No  
      - Is there an application listening on the destination UDP port?  
        Yes  
          - Process contents.  
        No  
          - Is the upper layer PDU a TCP segment?  
            Yes  
              - Send TCP Connection Reset segment.
Differences between v4 and v6 Mobility

- IPv6 does not need foreign agents, on the visited network there is no support.
- IPv6 incorporates route optimization as a required feature, i.e., few tunnels from mobile host and the correspondent.
- IPv6 uses header extensions, not encapsulation in tunnels.
- Neighbor Discovery handles many issues.
Summary

- Components of IPv6 mobility
- IPv6 mobility messages and options
- IPv6 mobility data structures
- Communication between the mobile node and the correspondent node
- Communication between the mobile node and the home agent
- IPv6 mobility processes
- IPv6 mobility changes to the host sending and receiving algorithms