CNL Lab3 Report

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IPv6

- 解釋IPv6的Unicast、Multicast與Anycast並舉例說明
- 解釋Router Solicitation與Router Advertisement的用途與功能
- 解釋何謂Stateful與Stateless address configuration
- 何謂DAD(Duplicate Address Detection)與其運作方式

Addressing Methods

IPv6 addresses are classified into three categories :

Unicast address

- A Unicast address acts as an identifier for a single interface.
- An IPv6 packet sent to a unicast address is delivered to the interface identified by that address.
- Examples :
  - Unspecified address `::/128`
  - Unicast localhost address `::1/128`
  - IPv4-mapped IPv6 address with prefix `::ffff:0:0/96`

Multicast address

- A Multicast address acts as an identifier for a set of interfaces that may belong to different nodes.
- An IPv6 packet sent to a multicast address is delivered to all interfaces within the corresponding multicast group.
- IPv6 does not implement broadcast addressing. Broadcast's traditional role is replaced by multicast addressing to the all-nodes link-local multicast group (ff02::1).
- Examples :
  - all nodes address `ff0X::1`
  - all routers address `ff0X::2`
  - (X identifies the address scope, e.g. X=2 means link-local scope)

Anycast address

- Anycast addresses act as identifiers for a set of interfaces that may belong to different nodes.
- An IPv6 packet sent to an anycast address is delivered to one of the interfaces identified by the address, typically the nearest host, according to the routing protocol's definition of distance.
- Features :
  - Anycast addresses have the same format as unicast addresses.
  - Usually implemented by using Border Gateway Protocol (BGP).
  - Benefits : best effort delivery, link source reduction, load balancing
- Examples :
  - Root DNS servers : 13 logical servers, hunderds of physical servers
  - Content distribution network (CDN) : use IP anycast to select "good" CDN server to stream to client

Router Advertisement and Router Solicitation

Router Advertisement (RA) and Router Solicitation (RS) messages enable a node on a link to discover routers on the same link. These two IPv6 packet types are defined in Neighbor Discovery Protocol (NDP).

Router Advertisement

- Type field of the ICMPv6 packet header : 134
- RA message is sent periodically by a router to all nodes on the same link.
  - Source address : The unicast IPv6 address of the router interface
  - Destination address : The all-nodes link-local multicast address `ff02::1`
- RA message is also sent in response to an RS message from a node on the same link.
  - Source address : The unicast IPv6 address of the router interface

    - Destination address : The unicast IPv6 address of the node that sent the RS message
- RA message provides the following information to hosts:
    - Router information such as link-layer address and lifetime of the prefix
    - IPv6 prefixes for address auto configuration
    - Network information such as maximum transmission unit (MTU) and hop limit
    - Additional information such as reachable time, retransmission time for neighbor solicitations…

Router Solicitation

- Type field of the ICMPv6 packet header : 133
- At system startup, a host on a link sends RS message to all routers on the same link.
    - Source address : The unicast IPv6 address of the host interface or the unspecified IPv6 address `::/128` (since a host at system startup typically does not have a unicast IPv6 address)
    - Destination address : The all-routers multicast address `ff02::2`
- Sending RS message immediately enables the host to configure its IPv6 address automatically, instead of having to wait for the next periodic RA message.

Address Configuration : Stateful vs Stateless

Stateless Auto Configuration

- Allow a node to automatically configure IPv6 address
- Steps :
    - Link Local Address Generation : Create link local address comprises of `1111111010` as the first ten bits followed by 54 zeroes and a 64 bit interface identifier.
    - Link Local Address Uniqueness Test (DAD) : The host ensures that the link local address generated by it is not already used.
    - Link Local Address Assignment : The host IP interface is assigned the link local address. The address becomes usable on the local network but not over the Internet.
    - Router Contact : The host makes contact with a local router to determine its next course of action in the auto configuration process.
    - Router Direction : The node receives specific directions from the router on its next course of action in the auto configuration process.
    - Global Address Configuration : The host configures itself with its globally unique Internet address. The address comprises of a network prefix provided by the router together with the interface identifier.

- Pro : Without need of DHCP server
- Con : Only focus on configuration of IP address while overlooking the configuration of other parameters such as the DNS domain, DNS server, time servers, etc.

Stateful Auto Configuration : DHCPv6

- Allow a node to configure IPv6 address by contacting DHCPv6 server.
- The DHCPv6 server maintains a list of nodes and the information about their state to know the availability of each IP address from the range specified by the network administrator. (thus called stateful)
- Pro : DHCPv6 configures IPv6 hosts with not only IP addresses but also IP prefixes and other configuration data.
- Con : Overhead at DHCPv6 server

Duplicate Address Detection

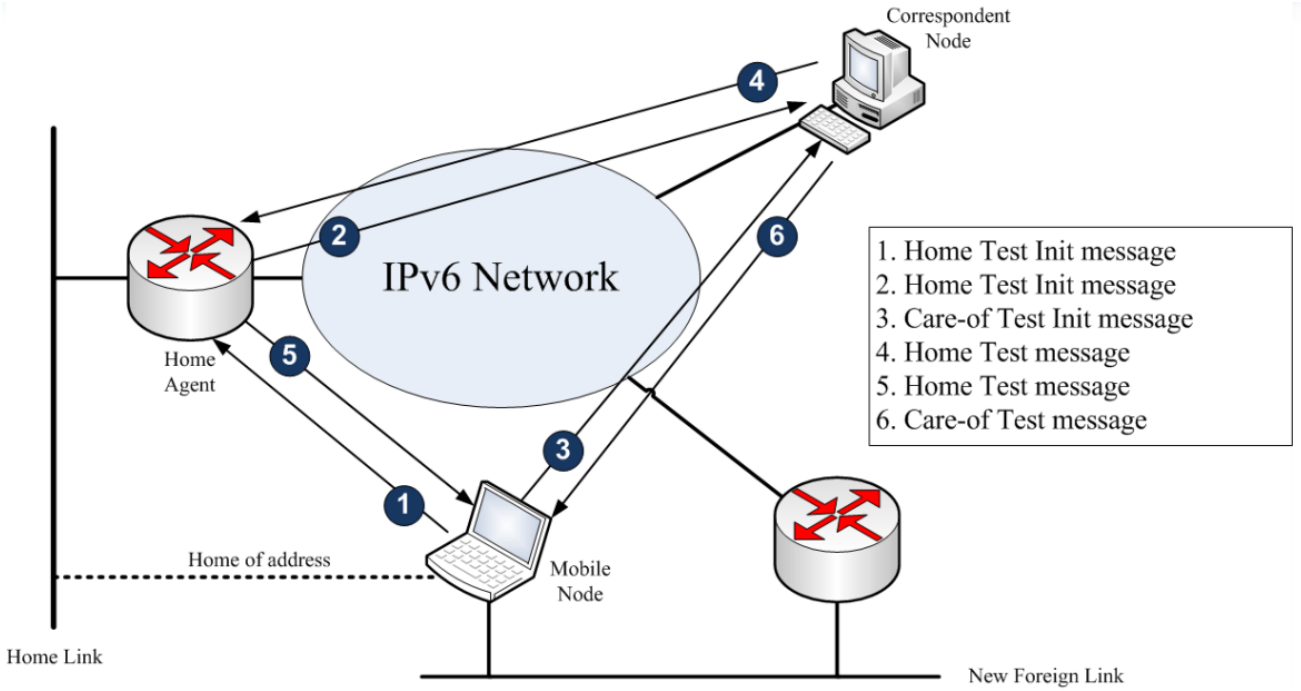
- Assigning a unicast IPv6 address to an interface requires an uniqueness test.
- Make use of Neighbor Solicitation and Neighbor Advertisement messages defined in ICMPv6.
- Steps :
  - Initially, when a node wants to test for address uniqueness, the address is in tentative state.
  - The node joins the all-hosts multicast address `ff02::1` , so it will be able to receive Neighbor Advertisements.
  - The node sends Neighbor Solicitations.
    Source address : The unspecified address `::/128`
    Destination address : The tentative address
  - The tentative address is not unique if
    Any node receives a neighbor solicitation with the tentative address as the destination address.
    Or the node receives a neighbor advertisement with the tentative address as the source of the advertisement.

Mobile IPv6

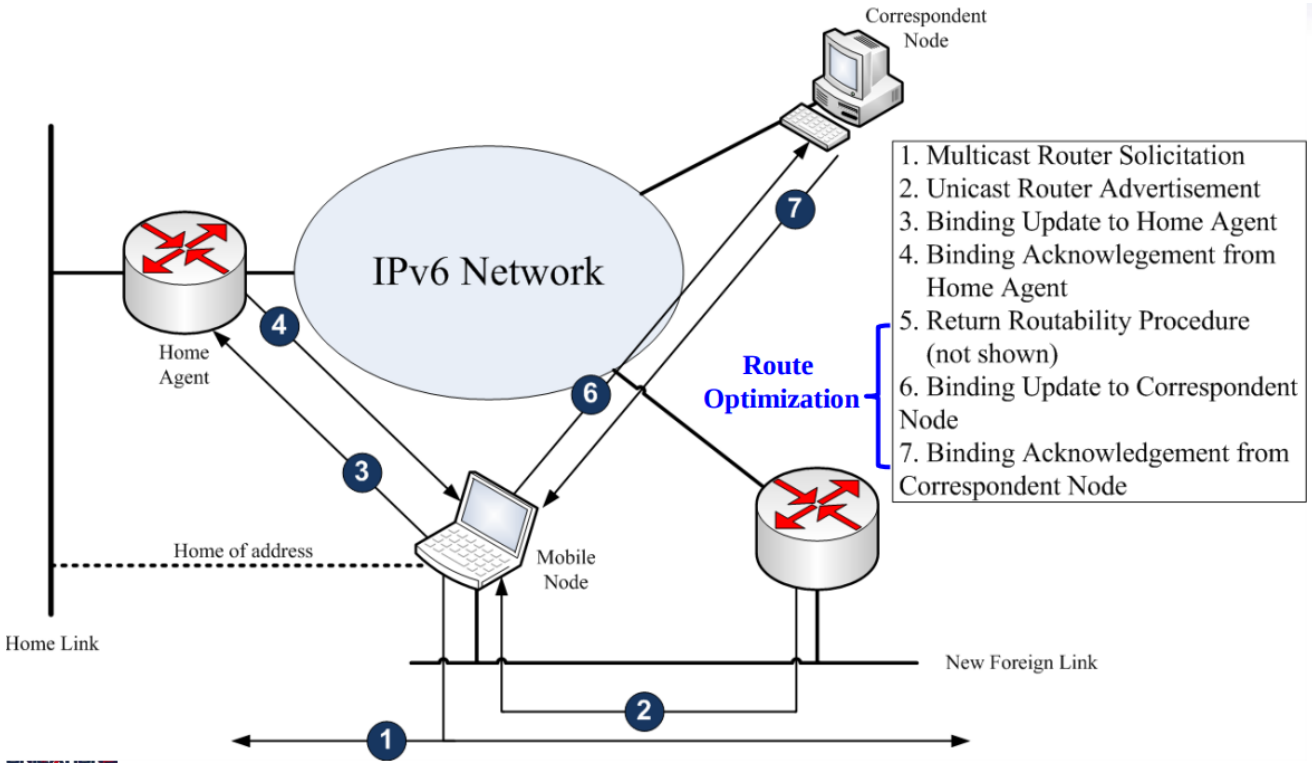
How does MIPv6 solve the triangular Routing Problem?

- MN can register the CoA with its HA via a binding update
- Mobile IPv6 defines the header of the route that the CN can use directly to send data packets to the MN, avoiding the triangular routing problem

- Return routability procedure



- Handover



Difficulties and Solutions in our experiment

- Question: Can't connect to AP
  - Solution: Change Bridged Adapter for MAG
- Question: The user's name is not EUI-64 address in LMA
  - Solution: Take user's name from MAG

Experiences and Things We Learned

- b03902080 黃子賢
  In this experience, I learn how to compile kernel. When the step of compiling kernel is finished, the dots per inch of VirtualBox screen become small, and need to install some package to let dots per inch become large. I also learn how to calculate EUI-64 address and how LMA and MAG work. MAG connect to AP. When user connect to AP, MAG ask LMA for the user's information. When cross AP to another AP, they ask same LMA such that the network will not be broken.

- b03902024 鄭筱樺
  In Lab3, I learn some strategies when compiling a linux kernel and the mobility of IPv4 and IPv6 in detail. For one thing, when compiling, we can use `-j` parameter to indicate how many cores are assigned to use. This can accelerate the compiling procedure. For another, I understand the routing processure between HN, MN, CN and also the difference between IPv4 and IPv6.

- b03902084 王藝霖
  First thing I leared is more problem solving ability when compiling kernel. Although I have compiled kernel before, I still faced some problems this time. Second, I learned about mobility of IPv4 and IPv6, and some issues about IPv4 mobility such as triangular routing problem and how to solve it.

- b03902022 于建民
  I learned how to compile kernel in this experiment. Also, while searching information about IPv6, I got to figure out specific details of IPv6, such as the addressing format and scope, special addresses, how address auto-configuration works…, which granted me deeper understandings of network layer protocols.

- b03902026 徐新凱
  I know IPv6 can solve address space exhaustion problem in other class, but I don't know that IPv6 handles the mobility issue in different manner, compared with IPv4.
  In lab3, I learn more about IPv6, especially the stateless auto-configuration and how IPv6 handles the mobility issue.

- b03902126 高翊軒
  This experiment we learned how to bulid a MAG server and provide mobility wifi service. (Though we only used a router) However, we had a weird problem that only my phone could not conntect to internet. We thought this problem is related to Android phone, since a few other teams had the same problem with there Android phone.

References

1. IPv6.com (http://ipv6.com/index.htm)
2. Router Advertisement and Router Solicitation
   (http://www.brocade.com/content/html/en/configuration-guide/nos-601-l3guide/GUID-DCF17973-1B75-48B5-9FEE-

5BFEF98AEAC0.html)

3. Wikipedia : IPv6 Address (https://en.wikipedia.org/wiki/IPv6_address)
4. Wikipedia : ICMP Router Discovery Protocol
   (https://en.wikipedia.org/wiki/ICMP_Router_Discovery_Protocol)
5. Wikipedia : Neighbor Discovery Protocol (https://en.wikipedia.org/wiki/Neighbor_Discovery_Protocol)
6. Problems with Mobile IP and Their Solutions
   (http://wwwen.zte.com.cn/endata/magazine/ztecommunications/2004year/no2/articles/200412/t20041214_162286.html)
7. NTU CNL Lab3 slides
   (http://www.pcs.csie.ntu.edu.tw/views/courses/cnl/2017/2017_Lab3_IPv6_Mobility(concept).pdf)