

ICMPv6 Information

- ◊ Echo Request/Reply
 - Identical to IPv4 Echo
- ◊ No: Address Mask, Timestamp, Info Request
- ◊ Router Solicitation
- ◊ Router Advertisement
- ◊ Neighbour Solicitation
- ◊ Neighbour Advertisement
- ◊ Redirect
 - Much more structured messages
 - NS/NA new

ICMPv6 Redirect

Type	Code	Checksum
(Reserved)		
Target Address		
Destination Address		
Options		

ICMPv6 Redirect

- ◊ Target Address
 - Address of Router (Link Local)
 - Or of destination host
- ◊ Destination Address
 - Address that is being redirected
- ◊ Options:

Type	Length	Value
(more value)		

- ◊ Target Link Layer Address
- ◊ Redirected Header

ICMPv6 Router Advertisement

Type	Code	Checksum
Cur Hop Limit	M O (Reserved)	Router Lifetime
Reachable Timer		
Retransmit Timer		
Options		

- ◊ Announce sender as a router
- ◊ Provide information to nodes on link

- ◊ Always sent from Link Local Address
 - Hop Limit == 255

ICMPv6 RA Information

- ◊ Fixed Fields:
 - Cur Hop Limit
 - Hop Limit hosts should use
 - M
 - Managed Configuration
 - O
 - Other stateful config
 - Reserved
 - Now contains router preference (2 bits)
 - Router Lifetime
 - seconds for default router list
 - Reachable Time
 - How long confirmation implies reachable
 - Retrans Timer
 - Neighbour Solicitation retransmit timer

ICMPv6 RA Information

- ◊ Options:
 - Source Link Layer Address
 - MTU
 - Prefix Information

Type	Length	Prefix Length	LA	(resvd)
Valid Lifetime				
Preferred Lifetime				
(Reserved)				
Prefix				

ICMPv6 Router Solicitation

Type	Code	Checksum
(Reserved)		
Options		

- ◊ Options:
 - ◊ Source Link Layer Address

ICMPv6 Information

- ◊ Echo Request/Reply

- ◊ Router Solicitation
- ◊ Router Advertisement
- ◊ Redirect

- ◊ Neighbour Solicitation
- ◊ Neighbour Advertisement

ICMPv6 echo

```
11:52:37.819986 0:6:5b:da:45:ad 0:10:5a:76:e9:b4 86dd 70:
fe80::206:5bff:feda:45ad > fe80::210:5aff:fe76:e9b4:
icmp6: echo request
                (len 16, hlim 64)
```

```
6000 0000 0010 3a40 fe80 0000 0000 0000
0206 5bff feda 45ad fe80 0000 0000 0000
0210 5aff fe76 e9b4 8000 ed19 6ec5 0001
3f17 7d15 000c 82d1
```

```
11:52:37.820127 0:10:5a:76:e9:b4 0:6:5b:da:45:ad 86dd 70:
fe80::210:5aff:fe76:e9b4 > fe80::206:5bff:feda:45ad:
icmp6: echo reply
                (len 16, hlim 64)
```

```
6000 0000 0010 3a40 fe80 0000 0000 0000
0210 5aff fe76 e9b4 fe80 0000 0000 0000
0206 5bff feda 45ad 8100 ec19 6ec5 0001
3f17 7d15 000c 82d1
```

Neighbour Discovery

- ◊ Find Mac Address for address on Link
- ◊ Also
 - Duplicate Address Detection
 - Neighbour Unreachability Detection
- ◊ First:
 - The IPv4 method...

Address Resolution Protocol

- ◊ Have IP address from application/transport
- ◊ Want MAC (link layer address) so packet can be transmitted
- ◊ How to translate?

ARP Possibilities

- ◊ Could embed IP address in MAC address
 - using defined value for the extra bytes
 - (DECNET 4 used that method)
- ◊ With 3 Mbps ethernet
 - 16 bit addresses
 - embed ethernet address in IP address
 - simply extract it when needed
- ◊ Build a DNS like server mechanism (database) and send a query

ARP Solution

- ◊ Simply ask!
- ◊ Broadcast packet sent to the link layer
 - ◊ "Who has the IP address a.b.c.d?"
 - ◊ Broadcast because when this was invented,
 - multicast was not defined
 - Means that every node
 - on the link layer
 - receives the packet

ARP Examples

```
18:11:54 arp who-has 172.30.0.77
        tell 172.30.0.9

18:11:54 arp reply
        172.30.0.77 is-at 0:10:a4:f:41:cf

18:11:55 arp who-has 172.30.0.161
        tell 172.30.0.77

18:11:55 arp reply
        172.30.0.161 is-at 0:1:3:40:8a:e5
```

ARP Example (with link layer)

```
0:e0:29:1d:ec:c8 ff:ff:ff:ff:ff:ff 0806 60:
0001 0800 0604 0001 00e0 291d ecc8 ac1e
0040 0000 0000 0000 ac1e 0005 0a2b 5cfb
0000 0000 0000 0000 0000 0000 0000

arp who-has 172.30.0.5 tell 172.30.0.64

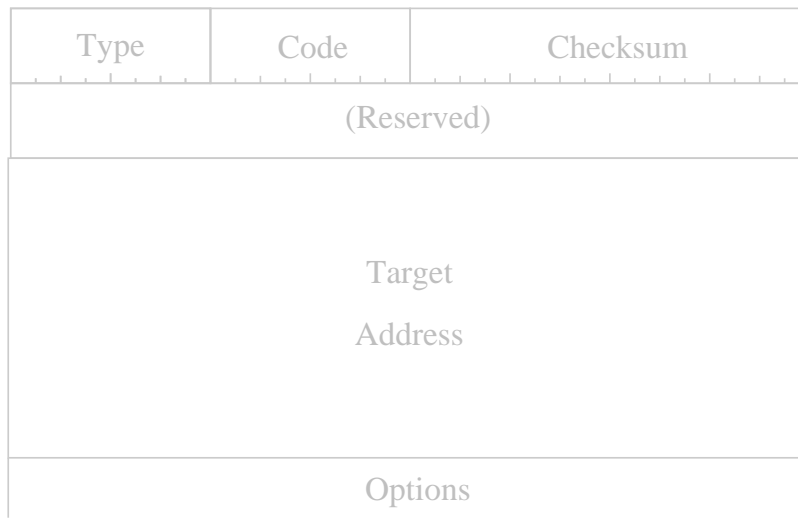
0:c0:4f:9a:20:56 0:e0:29:1d:ec:c8 0806 60:
0001 0800 0604 0002 00c0 4f9a 2056 ac1e
0005 00e0 291d ecc8 ac1e 0040 0040 0040
0040 0040 0040 0040 0040 0040 0040

arp reply 172.30.0.5 is-at 0:c0:4f:9a:20:56
```

IPv6 Neighbour Discovery

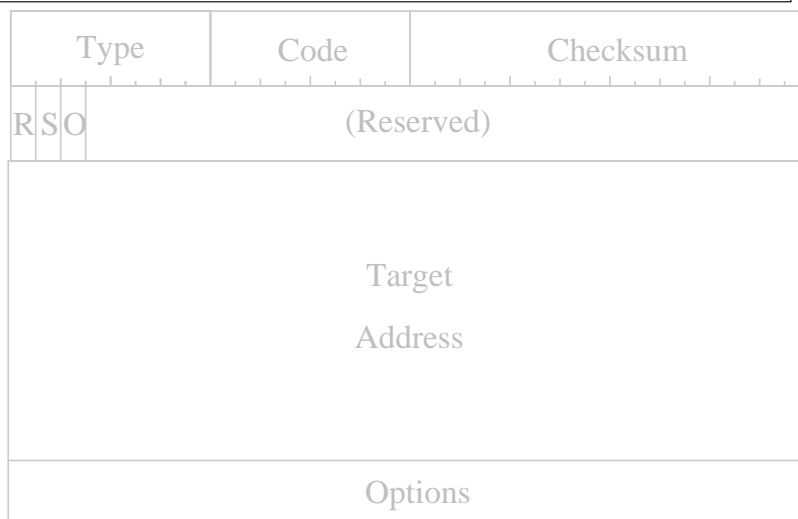
- ◊ Same general principles as ARP
- ◊ But
 - ICMP instead of link level
 - Means same protocol on all links
 - Multicast instead of Broadcast
 - Multicast group depends upon target address
 - Often only one node will receive request

IPv6 Neighbour Solicitation



- ◊ Target Address
 - The IPv6 address sought
- ◊ Options
 - Source Link Layer Address

ICMPv6 Neighbour Advert



- ◊ R Sender is a router
- ◊ S Solicited
- ◊ O Override
- ◊ Options

ND Examples

```
11:52:36.832814 0:6:5b:da:45:ad 33:33:ff:76:e9:b4 86dd 86:
    fe80::206:5bff:feda:45ad > ff02::1:ff76:e9b4:
        icmp6: neighbor sol:
            who has fe80::210:5aff:fe76:e9b4
                (src lladdr: 00:06:5b:da:45:ad)
                    (len 32, hlim 255)

11:52:36.833011 0:10:5a:76:e9:b4 0:6:5b:da:45:ad 86dd 86:
    fe80::210:5aff:fe76:e9b4 > fe80::206:5bff:feda:45ad:
        icmp6: neighbor adv:
            tgt is fe80::210:5aff:fe76:e9b4(SO)
                (tgt lladdr: 00:10:5a:76:e9:b4)
                    (len 32, hlim 255)
```

ND Examples expanded

```
11:52:36.832814 0:6:5b:da:45:ad 33:33:ff:76:e9:b4 86dd 86:
    fe80::206:5bff:feda:45ad > ff02::1:ff76:e9b4:
        icmp6: neighbor sol:
            who has fe80::210:5aff:fe76:e9b4
                (src lladdr: 00:06:5b:da:45:ad)
                    (len 32, hlim 255)

        6000 0000 0020 3aff fe80 0000 0000 0000
        0206 5bff feda 45ad ff02 0000 0000 0000
        0000 0001 ff76 e9b4 8700 091c 0000 0000
        fe80 0000 0000 0000 0210 5aff fe76 e9b4
        0101 0006 5bda 45ad

        6000 0000 0020 3aff
        fe80 0000 0000 0000 0206 5bff feda 45ad
        ff02 0000 0000 0000 0000 0001 ff76 e9b4

        8700 091c 0000 0000
        fe80 0000 0000 0000 0210 5aff fe76 e9b4
        0101 0006 5bda 45ad
```

ND Examples expanded

```
11:52:36.833011 0:10:5a:76:e9:b4 0:6:5b:da:45:ad 86dd 86:
    fe80::210:5aff:fe76:e9b4 > fe80::206:5bff:feda:45ad:
        icmp6: neighbor adv:
            tgt is fe80::210:5aff:fe76:e9b4(SO)
                (tgt lladdr: 00:10:5a:76:e9:b4)
                    (len 32, hlim 255)

        6000 0000 0020 3aff fe80 0000 0000 0000
        0210 5aff fe76 e9b4 fe80 0000 0000 0000
        0206 5bff feda 45ad 8800 a8e1 6000 0000
        fe80 0000 0000 0000 0210 5aff fe76 e9b4
        0201 0010 5a76 e9b4

        6000 0000 0020 3aff
        fe80 0000 0000 0000 0210 5aff fe76 e9b4
        fe80 0000 0000 0000 0206 5bff feda 45ad

        8800 a8e1 6000 0000
        fe80 0000 0000 0000 0210 5aff fe76 e9b4
        0201 0010 5a76 e9b4
```

ICMP echo sequence

```
11:52:36.832814 0:6:5b:da:45:ad 33:33:ff:76:e9:b4 86dd 86:
fe80::206:5bff:feda:45ad > ff02::1:ff76:e9b4:
icmp6: neighbor sol:
      who has fe80::210:5aff:fe76:e9b4
      (src lladdr: 00:06:5b:da:45:ad)
      (len 32, hlim 255)

11:52:36.833011 0:10:5a:76:e9:b4 0:6:5b:da:45:ad 86dd 86:
fe80::210:5aff:fe76:e9b4 > fe80::206:5bff:feda:45ad:
icmp6: neighbor adv:
      tgt is fe80::210:5aff:fe76:e9b4(SO)
      (tgt lladdr: 00:10:5a:76:e9:b4)
      (len 32, hlim 255)

11:52:36.833050 0:6:5b:da:45:ad 0:10:5a:76:e9:b4 86dd 70:
fe80::206:5bff:feda:45ad > fe80::210:5aff:fe76:e9b4:
icmp6: echo request
      (len 16, hlim 64)

11:52:36.833162 0:10:5a:76:e9:b4 0:6:5b:da:45:ad 86dd 70:
fe80::210:5aff:fe76:e9b4 > fe80::206:5bff:feda:45ad:
icmp6: echo reply
      (len 16, hlim 64)
```