IPv6 associated protocols
New Protocols

• New features specified in IPv6 Protocol (RFC 2460 DS)
• Neighbor Discovery (ND) (RFC 2461 DS)
• Auto-configuration :
  – Stateless Address Auto-configuration (RFC 2462 DS)
  – DHCPv6: Dynamic Host Configuration Protocol for IPv6 (RFC 3315 PS)
  – Path MTU discovery (pMTU) (RFC 1981 PS)
New Protocols (2)

MLD (Multicast Listener Discovery) (RFC 2710 PS)
- Multicast group management over an IPv6 link
- Based on IGMPv2
- MLDv2 (equivalent to IGMPv3 in IPv4)

ICMPv6 (RFC 2463 DS) "Super" Protocol that:
- Covers ICMP (v4) features (Error control, Administration, …)
- Transports ND messages
- Transports MLD messages (Queries, Reports, …)
IPv6 nodes which share the same physical medium (link) use Neighbor Discovery (NDP) to:

- discover their mutual presence
- determine link-layer addresses of their neighbors
- find routers
- maintain neighbors’ reachability information (NUD)
- not directly applicable to NBMA (Non Broadcast Multi Access) networks

ND uses multicast for certain services.
Neighbor Discovery (2)

- Protocol features:
  - Router discovery
  - Prefix(es) discovery
  - Parameters discovery (link MTU, Max Hop Limit, ...)
  - Address auto-configuration
  - Address resolution
  - Next Hop determination
  - Neighbor Unreachability Detection
  - Duplicate Address Detection
  - Redirect
Neighbor Discovery (3): Comparison with IPv4

- It is the synthesis of:
  - ARP
  - R-Disc
  - ICMP redirect
  - ...

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Neighbor Discovery (4)

- **Router Advertisement (RA):**
  - periodic advertisement (of the availability of a router) which contains:
    - list of prefixes used on the link (autoconf)
    - a possible value for Max Hop Limit (TTL of IPv4)
    - value of MTU

- **Router Solicitation (RS):**
  - the host needs RA immediately (at boot time)
Neighbor Discovery (5)

- **Neighbor Solicitation (NS):**
  - to determine the link-layer address of a neighbor
  - or to check its impeachability
  - also used to detect duplicate addresses (DAD)

- **Neighbor Advertisement (NA):**
  - answer to a NS packet
  - to advertise the change of physical address

- **Redirect:**
  - Used by a router to inform a host of a better route to a given destination
Address Resolution

- Find the mapping: Dst IP → Link-Layer (MAC) @

- Recalling IPv4 & ARP
  - ARP Request is broadcasted
    - e.g. et her net @ FF- FF- FF- FF- FF- FF
    - Btw, it contains the Src’s LL @
  
  - ARP Reply is sent in unicast to the Src
    - It contains the Dst’s LL @
At boot time, every IPv6 node has to join 2 special multicast groups for each network interface:

- All-nodes multicast group: \texttt{ff02::1}
- Solicited-node multicast group: \texttt{ff02:1:ff\text{X}:xxxx} (derived from the lower 24 bits of the node’s address)

### Address Resolution (2)
**IPv6 with Neighbor Discovery**

<table>
<thead>
<tr>
<th>NS</th>
<th>D3 = Multi(IP2)</th>
<th>? D2 (MAC2)</th>
<th>S3 = IP1</th>
<th>S2 = MAC1</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>D3 = IP1</td>
<td>D2 = MAC1</td>
<td>S3 = IP2</td>
<td>S2 = MAC2</td>
</tr>
</tbody>
</table>

H1: IP1, MAC1

H2: IP2, MAC2
Address Resolution (3)
Solicited Multicast Address

- **Concatenation** of the prefix FF02: : 1: FF00: 0/ 104 with the last 24 bits of the IPv6 address

  *Example:*


  ↓

- Sol. Mcast @: FF02: 0000: 0000: 0000: 0000: 0001: FF24: 87c1

  ↓

- ethernet: 33- 33- FF- 24- 87- c1
Path MTU discovery (RFC 1981)

- Derived from RFC 1191, (IPv4 version of the protocol)
- **Path**: set of links followed by an IPv6 packet between source and destination
- **link MTU**: maximum packet length (bytes) that can be transmitted on a given link without fragmentation
- **Path MTU** (or pMTU) = min \{ link MTUs \} for a given path
- Path MTU Discovery = automatic pMTU discovery for a given path
Path MTU discovery (2)

- Protocol operation
  - makes assumption that pMTU = link MTU to reach a neighbor (first hop)
  - if there is an intermediate router such that link MTU < pMTU it sends an ICMPv6 message: "Packet size Too Large"
  - source reduces pMTU by using information found in the ICMPv6 message

=> Intermediate network element aren’t allowed to perform packet fragmentation