Multicast in IPv6

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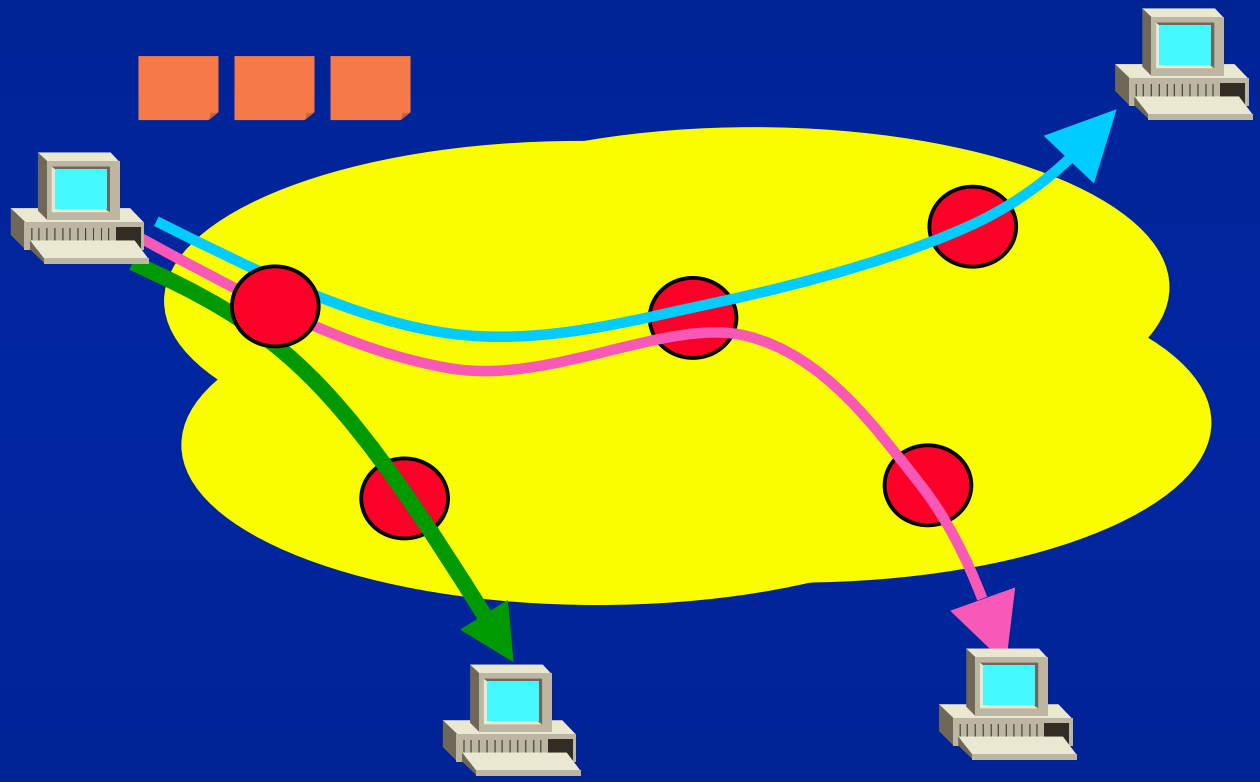
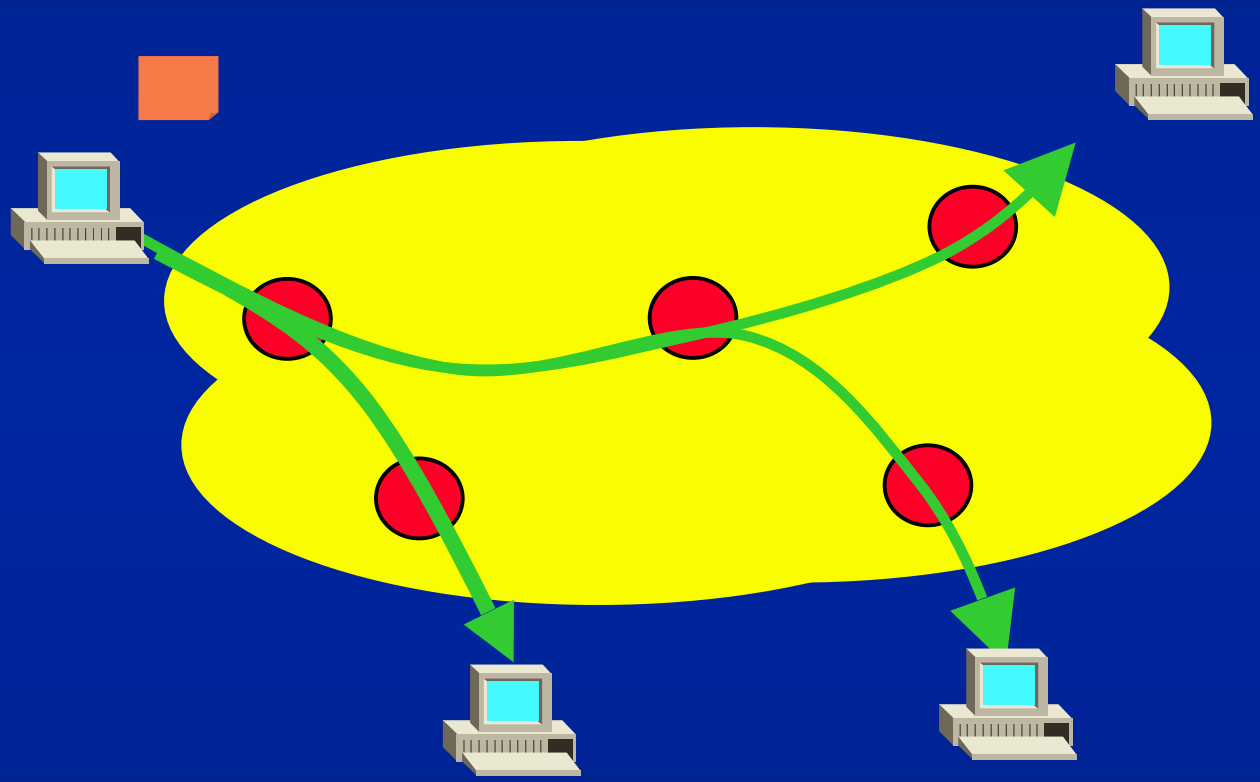
The concept

The Concept ... Unicast scenario



The Concept ... Multicast scenario



Applications

Applications

- Multimedia:
  - Telephony and Videoconference
  - Groupware (CSCW)
  - Radio/TV broadcast and VoD
  - Games
  - Group VR
- Data base replication
  - ☞simultaneous update
- Parallel computing
  - ☞e.g. Convey intermediate results, GRID
- Real-time news
  - stock market
  - conference announcements

Applications II

- Network control info exchange
  - routing protocols e.g. OSPF
- Resource seeks
  - autoconfiguration: DHCP agents
  - Services: NTP, GK, DNS, ...
- ICMPv6
  - Neighbour discovery
  - Router Advertisements/Solicitations

IP multicast service model

Standard IP multicast service model

- deliver packets to a set of hosts in the internet that had previously joined a given group
- connection-less, unordered unreliable delivery
- difference unicast - multicast packet:
  - destination_address = group address
- individuals free to join/leave group at any time no restriction in # of members or groups.
- Sending to the group does not mean membership

Multicast addresses
Group management: MLD
Multicast Routing

Multicast addressing

IPv4 addresses vs IPv6 addresses

- **IPv4**
  - Unicast
    - an ID for an interface
    - explict assignment
  - Broadcast
    - limited: 255.255.255.255
    - directed: <net>11..1
  - Multicast
    - an ID For a set of interfaces.
    - Deliver to all of them
    - Clase D:
      224.0.0.0 - 239.255.255.255
  - Especial
    - 0.0.0.0, 127.0.0.1

- **IPv6**
  - Unicast
    - n per interface
    - based on IEEE EUI-64
  - Multicast
  - Anycast
    - an ID for a set of interfaces. Deliver to the nearest one.
    - undistinguishible from unicast
  - Especial
    - ::, ::1

IPv6 Multicast Addresses

Format Prefix (FP)

11111111	FLAGS (4)	SCOPE (4)	Group ID (80+32 bits)

FLAGS

- 000T: T=1 Transient, T=0 Well-known

SCOPE

- 0 reserved
- 1 node-local scope
- 2 link-local scope
- 5 site-local scope
- 8 organization-local scope
- E global scope
- F reserved -> rest unassigned

Reserved multicast addresses

Node-Local Scope

- FF01:0:0:0:0:0:0:1 All Nodes Address
- FF01:0:0:0:0:0:0:2 All Routers Address

Link-Local Scope

- FF02:0:0:0:0:0:0:1 All Nodes Address
- FF02:0:0:0:0:0:0:2 All Routers Address
- FF02:0:0:0:0:0:0:4 DVMRP Routers
- FF02:0:0:0:0:0:0:5 OSPFIGP
- FF02:0:0:0:0:0:0:6 OSPFIGP DR
- FF02:0:0:0:0:0:0:9 RIP Routers
- FF02:0:0:0:0:0:0:B Mobile-Agents
- FF02:0:0:0:0:0:0:D All PIM Routers
- FF02:0:0:0:0:0:1:2 All-dhcp-agents
- FF02:0:0:0:0:1:FFXX:XXXX Solicited-Node Address

Site-Local Scope

- FF05:0:0:0:0:0:0:2 All Routers Address
- FF05:0:0:0:0:0:1:3 All-dhcp-servers
- FF05:0:0:0:0:0:1:4 All-dhcp-relays

Variable Scope Multicast Addresses

- FF0X:0:0:0:0:0:0:101 NTP
- FF0X:0:0:0:0:0:0:129 gatekeeper
- FF0X:0:0:0:0:0:2:0000 - FF0X:0:0:0:0:0:2:7FFD
  Multimedia Conference Calls
- FF0X:0:0:0:0:0:2:7FFE SAPv1 Announcements
- FF0X:0:0:0:0:0:2:8000 - FF0X:0:0:0:0:0:2:FFFF
  SAP Dynamic Assignments

Important multicast addresses

- ff01::1 , ff02::1 All-nodes
- ff01::2, ff02::2, ff05::2 All routers
- Solicited Node address of a unicast address: SN( )
  - The SN of an IP address ending with .....

    ....*XY:ZTUV*

    is:

    FF02:0:0:0:0:1:FF*XY:ZTUV*

EVERY IPV6 NODE MUST:

- *JOIN the SN associated to each unicast and anycast address of the node*
- *JOIN all-nodes*

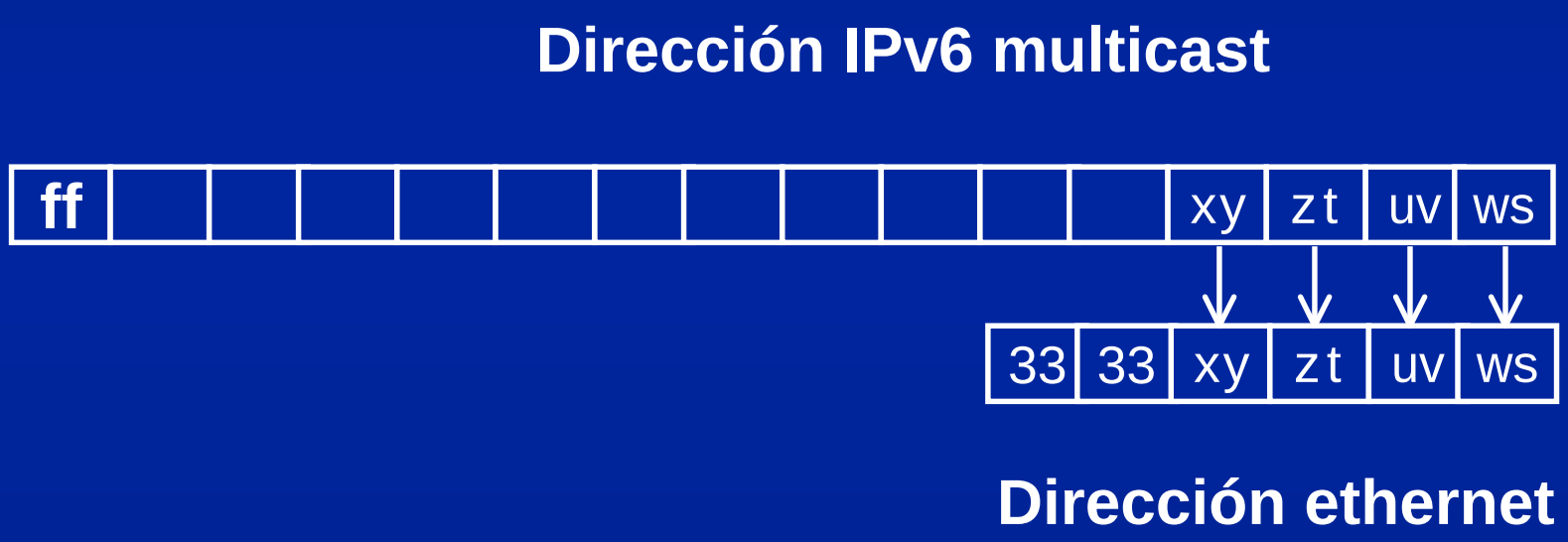
ICMPv6 Neighbour Discovery (rfc2461)

- ARP function generalized and included in ICMPv6
  - objetive: neighbour cache <IP2 , IP2-link_address>
  - IPv6 must know the length of link-level addresses
  - based on multicast
  - 135 Neighbour Solicitation LL(IP1)-> SN(IP2)
    - parameters: <IP2, [IP1_link_address]>
    - duplicate detection
    - bidirectional reachability, react to changes
  - 136 Neighbour Advertisement LL(IP1) <-IP2
    - parameters: <IP2, IP2-link_address>
    - unsolicited: fast updates -> all-nodes

- Efecto lateral: emulación de multicast en medios NBMA
  - rfc2491 IPv6 over Non-Broadcast Multiple Access (NBMA)

IPv6 Multicast over Ethernet

- IPv6 datagram encapsulated in an Ethernet frame
- Mapping IPv6 multicast addresses to Ethernet multicast addresses:



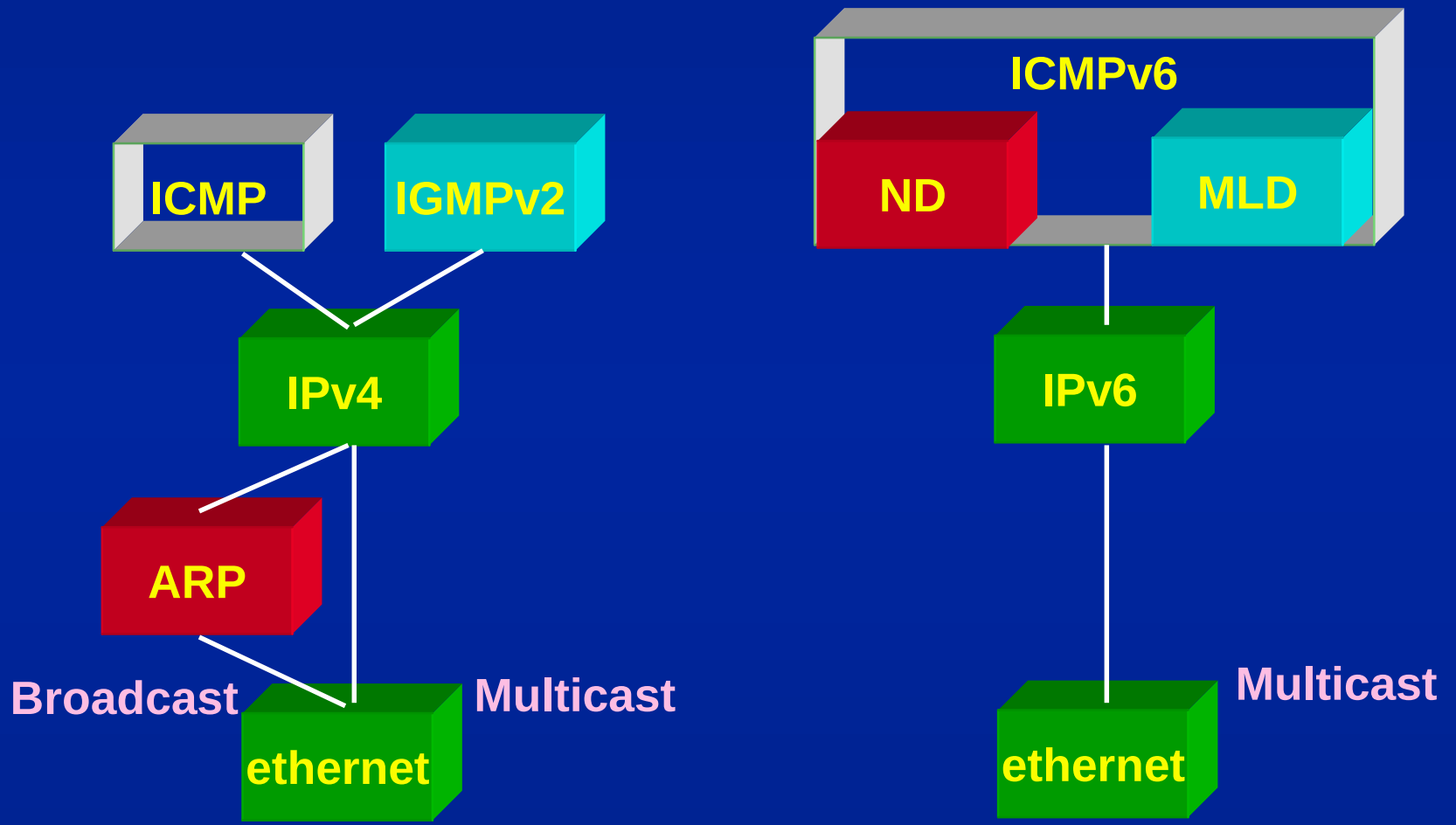
- association not unique! IP must discriminate according to the whole address whether it is an actual receiver of the multicast frame

Host - router interaction: MLD

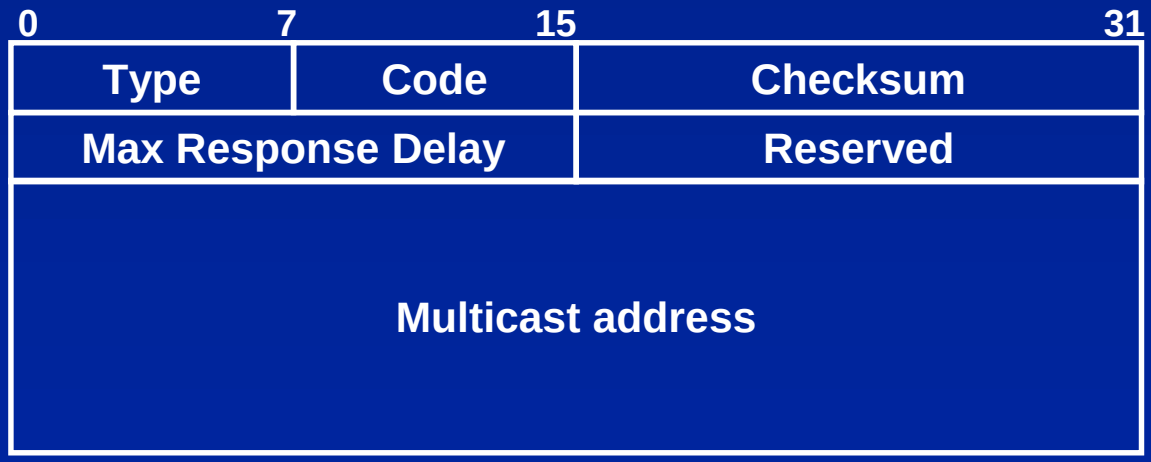
IPv6 Group Management

- MLD : Multicast Listener Discovery (RFC2710)
  - MLD enables each IPv6 router to learn which multicast addresses have listeners on each of its directly attached links
  - Keeps a list: < interface, multicast_address, timeout >
- Compulsory Funcionality included in ICMPv6
  - there is no IGMP-v6

IPv4 vs IPv6 Control planes

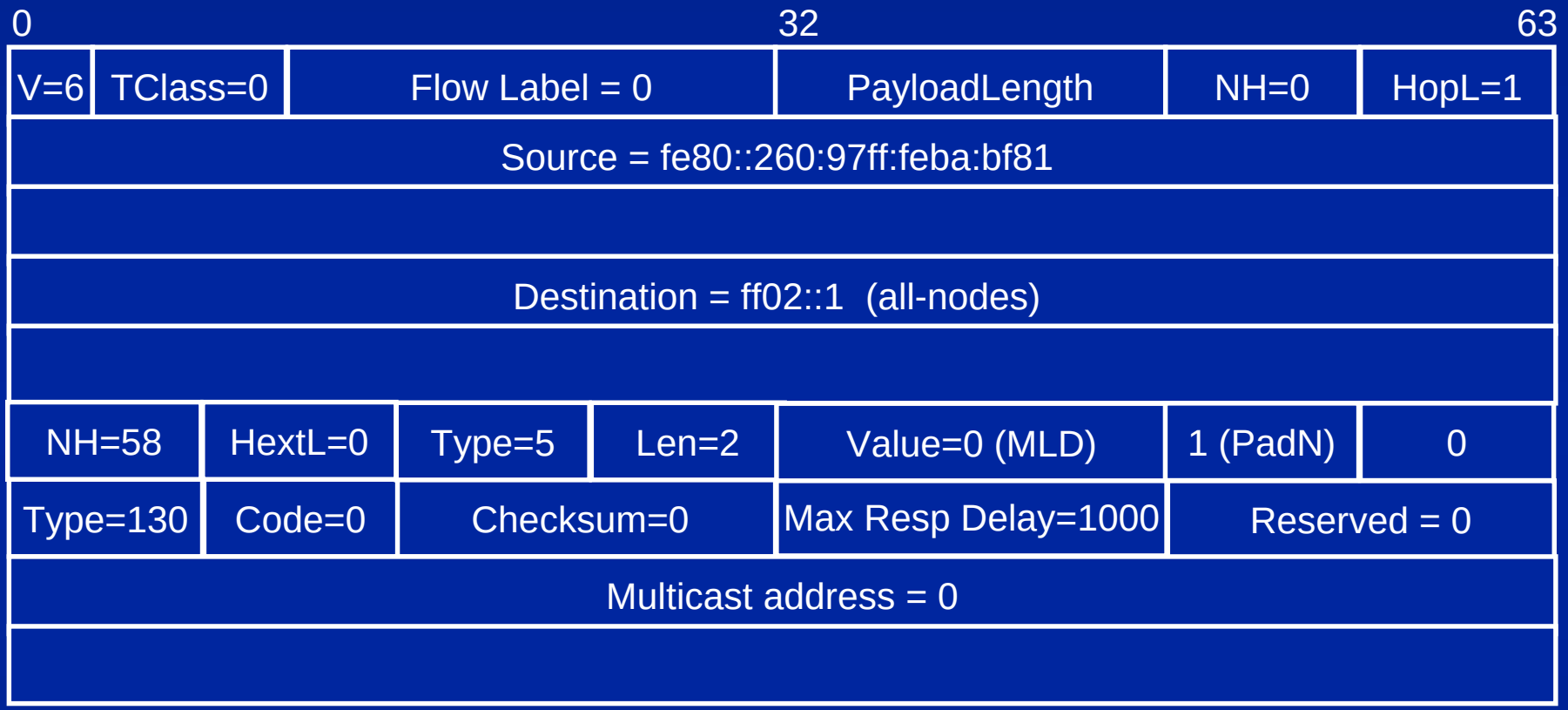


MLD Messages

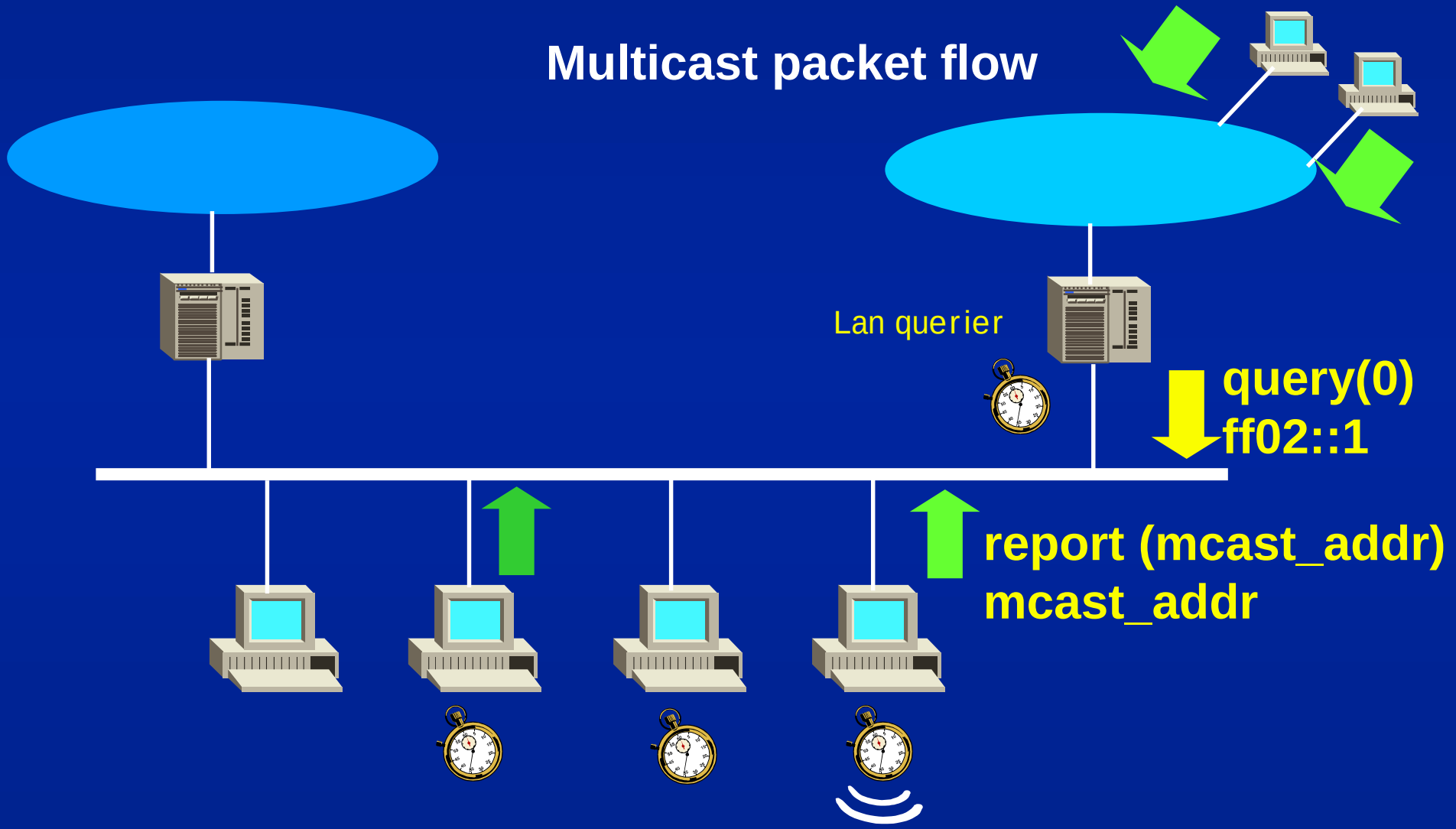


- ICMPv6 MLD messages
  - 130 Group Membership Query
    - ☞ General Query
    - ☞ Multicast-Address-Specific Query
  - 131 " " Report
  - 132 " " Done
  - Max response delay (ms)
    - ☞ (in query) interval for Reports

Example: ICMPv6 MLD General Query



MLD



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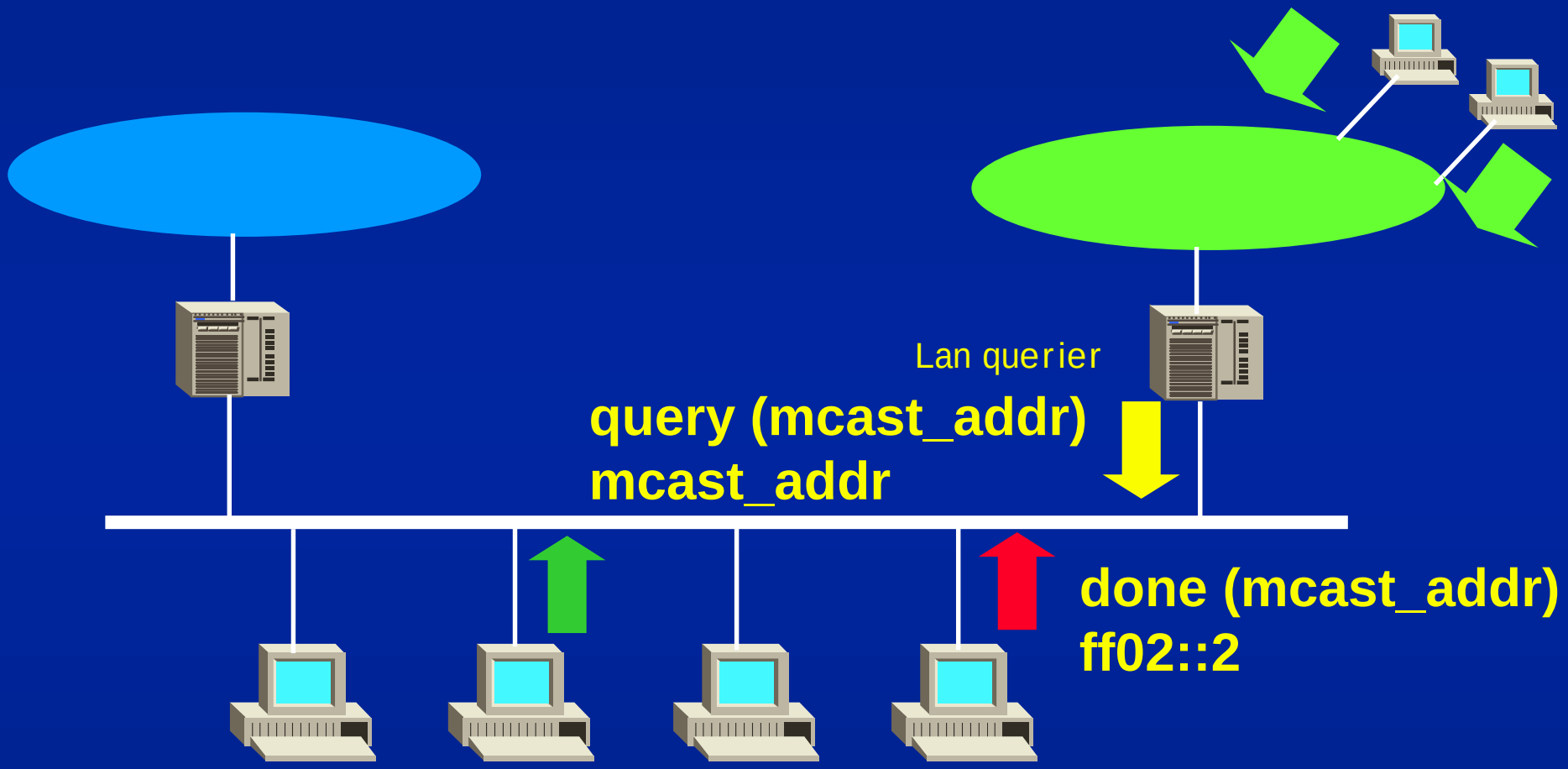


Router-router interaction: multicast routing

Multicast routing

- Communication between routers:
  - Exchange group membership information
  - Compute a spanning tree for each group
- Routers listen to all the groups
- Multicast routing protocols:
  - Dense Mode
    - ☞DVMRP
    - ☞PIM-DM
    - ☞MOSPF
  - Disperse Mode
    - ☞CBT
    - ☞PIM-SM

Multicast routing & IPv6

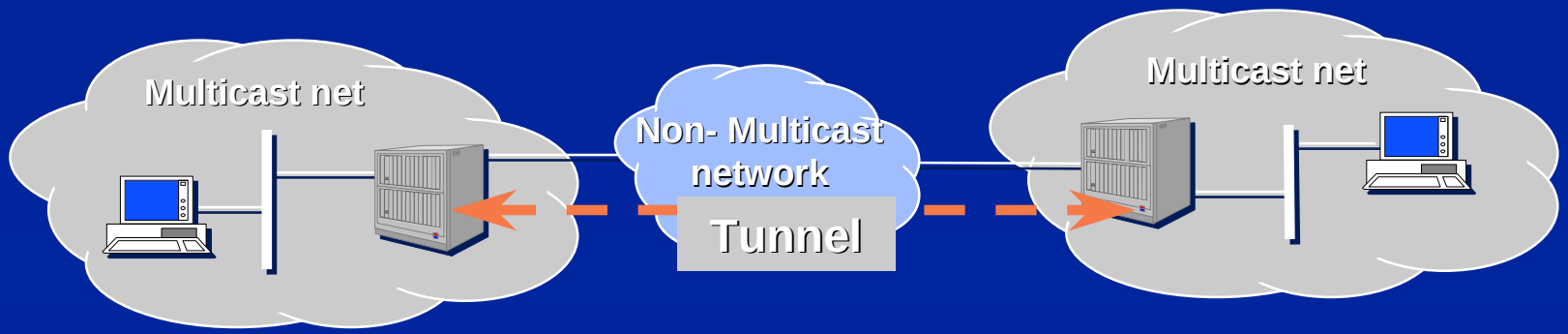
- PIM for IPv6
  - Implementation in KAME
- RPC = Reverse Path Check
  - ☞Link-Local addresses, like IGP protocols: RIPNG, OPPF6
  - ☞Avoid multiple Link-local
  - ☞BGP4+ global unicast addresses
- Scoping in address causes trouble
  - ☞ Differences multicast-unicast : organisation-local
  - ☞ unicast scope should match multicast scope
    - PIM Register
    - Candidate-RP-Advertisement to Bootstrap Router (BSR)

MBONE

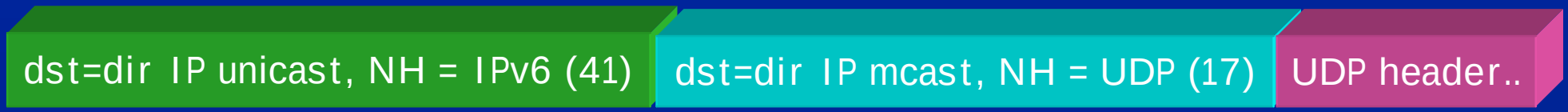
- Experimental Multicast Backbone
- Uses for videoconferencing
  - ☞ mbone tools: vic, vat, sdr, wb, ...ported to IPv6
- Tunnels

Multicast/Unicast tunnels

- Enable interconnection of multicast islands through non-multicast networks



- Example: IPv6 on IPv6 unicast encapsulation



Trends

Source-Specific Multicast (SSM)

- "many-to-many" problem too complex
  - re-focus on:
    - "few-to-few" (closed videoconferences): PIM-SM + MSDP
    - "1-to-many" (broadcast content delivery networks): SSM
  - ideas moving to IPv6
- Concept
  - receivers suscribe a "Channel" = < S, G > rather than a group G
  - routing based on destination + source address
- Advantages
  - no need to manage globally unique groups
    - alocation is local to the source
  - base for access control: only S sends to <S,G>
  - No need for RP en PIM-SM nor MSDP between domains to notify active sources

SSM

- Elements
  - IGMPv3 -> MLDv2
  - PIM-SSM -> PIM-SSM for IPv6
    - ☞compatible with a PIM-SM backbone
  - Subrange reserved for SSM:
    - ☞232.0.0.0-232.255.255.255

IETF Drafts
<draft-ietf-ssm-overview-02.txt>
<draft-ietf-pim-sm-v2-new-04.txt>
Proyecto IST GCAP
Implementación KAME

IGMPv3 under development = IGMPv2 adapted to SSM
New messages:
1. GROUP_SOURCE_REPORT(S,G) => Inclusion: ({S},G)
2. GROUP_SOURCE_LEAVE(S,G) => Exclusion:({S},G)

Conclusions

Conclusions

- Multicast service important for its applications
  - growing native support in research networks
  - limited commercial development today

- Protocols
  - Fundamental element in IPv6
    - ☞ signaling, resource location
  - Evolution parallel to development in IPv4
    - ☞ not essential differences :
      - administrative scoping VS hop-limit
    - ☞ future: SSM