Device Configuration

Mario Baldi
Politecnico di Torino
(Technical University of Turin)
http://www.baldi.info

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What information is needed?

- Address prefix
- Interface identifier
- Default gateway
- DNS server
- Hostname
- Domain name
- MTU (Maximum Transmission Unit)
- …

Options

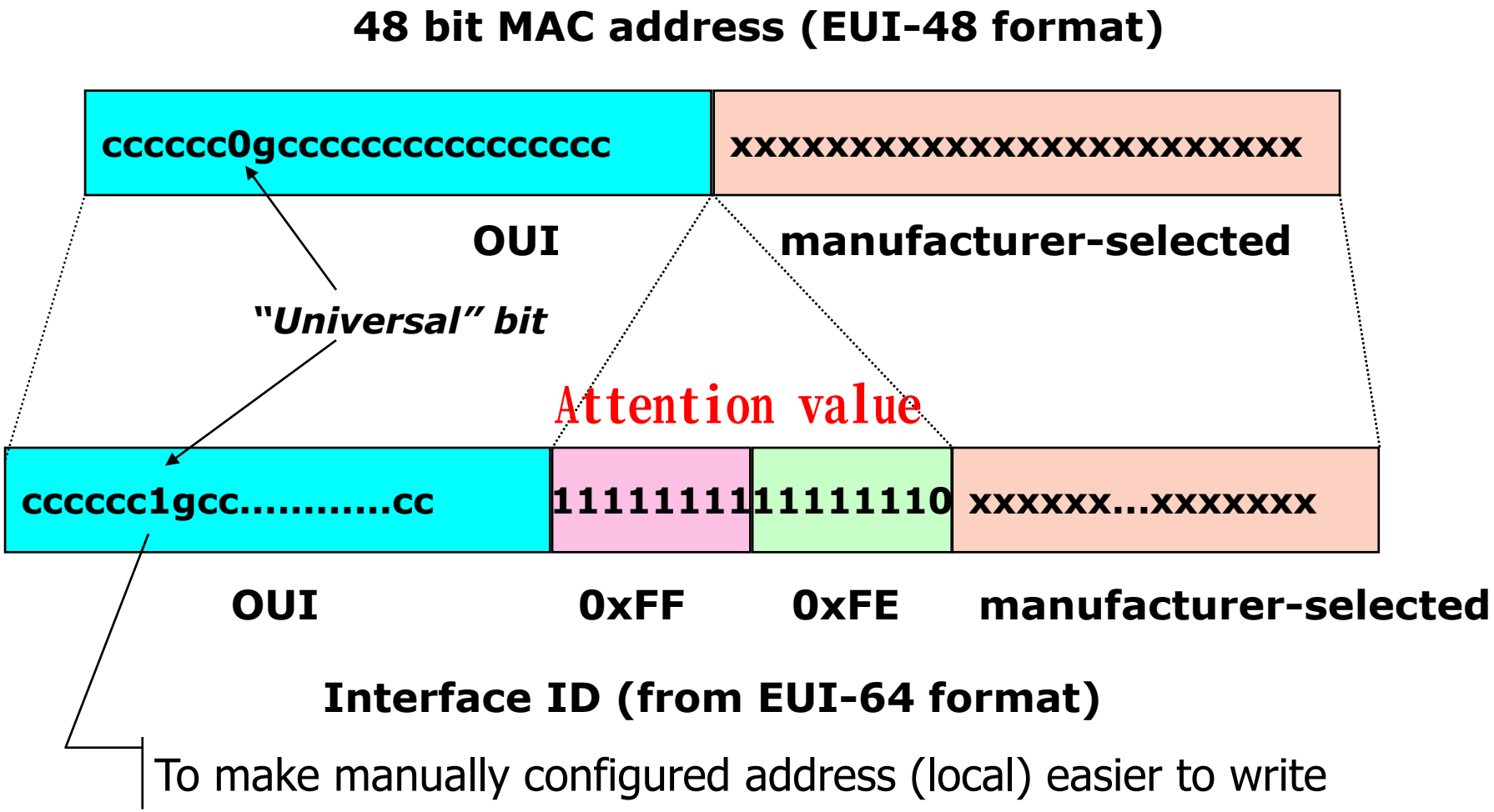
- Manual configuration
- Stateful configuration
  - All information obtained through DHCP
- Stateless configuration
  - Autogenerated
  - Address prefix obtained from router
- Hybrid (Stateless DHCP)
  - Information other than address obtained through DHCP

Interface Identifier

- Manually configured
- Obtained through DHCPv6
- Automatically generated
  - From EUI-64 MAC address
  - Privacy aware

EUI-48 to EUI-64 mapping

EUI = Extended Unique Identifier



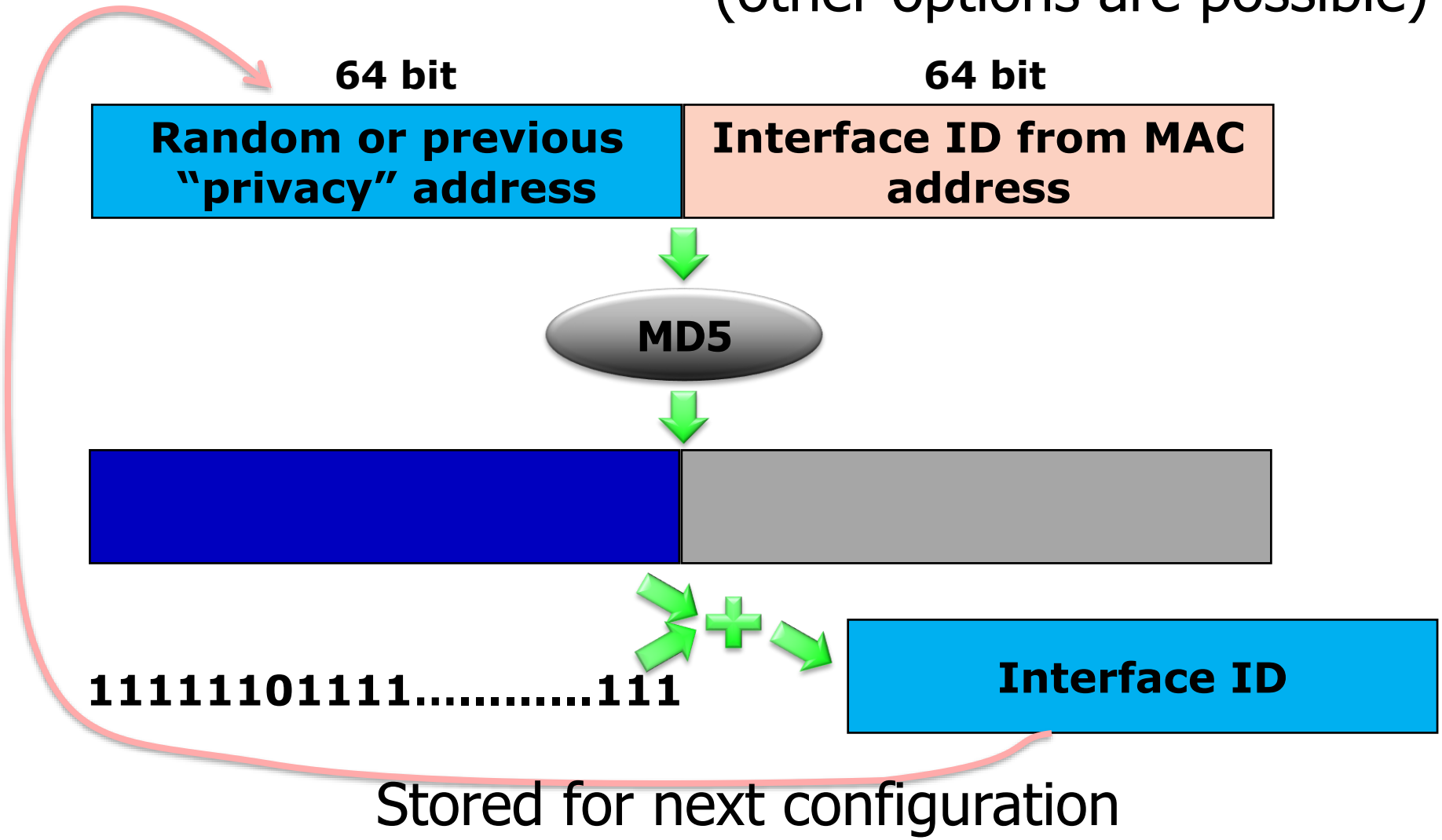
To make manually configured address (local) easier to write

Privacy Concerns

- Traceability
  - The least significant 64 bits of the IPv6 address of an interface never change when MAC address is used
- RFC 4941, “Privacy Extensions for Stateless Address Autoconfiguration in IPv6”

Privacy Extension Algorithm

(other options are possible)



Address Usage

- A host may have several different addresses
  - "default"
  - "privacy aware"
- Usable to accept/initiate connections
- Selection of address may be available to the user/application

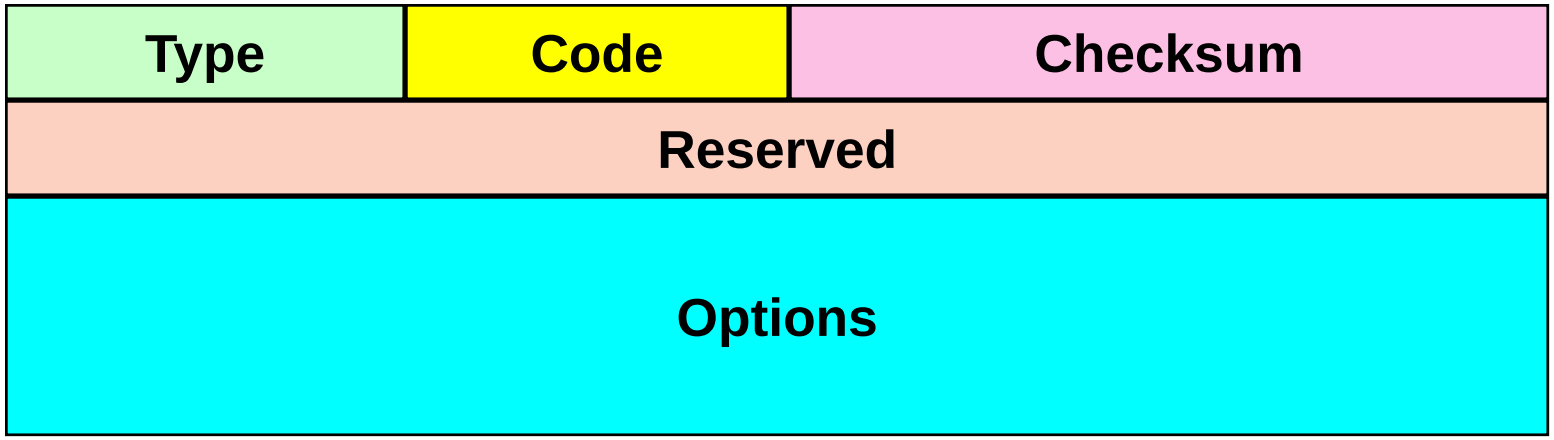
Address Prefix

- Manually configured
- Obtained from DHCPv6
- Automatically generated
  - Link local
- Obtained from a router

Router/Prefix Discovery

- ICMP Router Advertisement message
  - Sent by routers
- Solicited
  - Answering to Router Solicitation by host
- Unsolicited: periodic

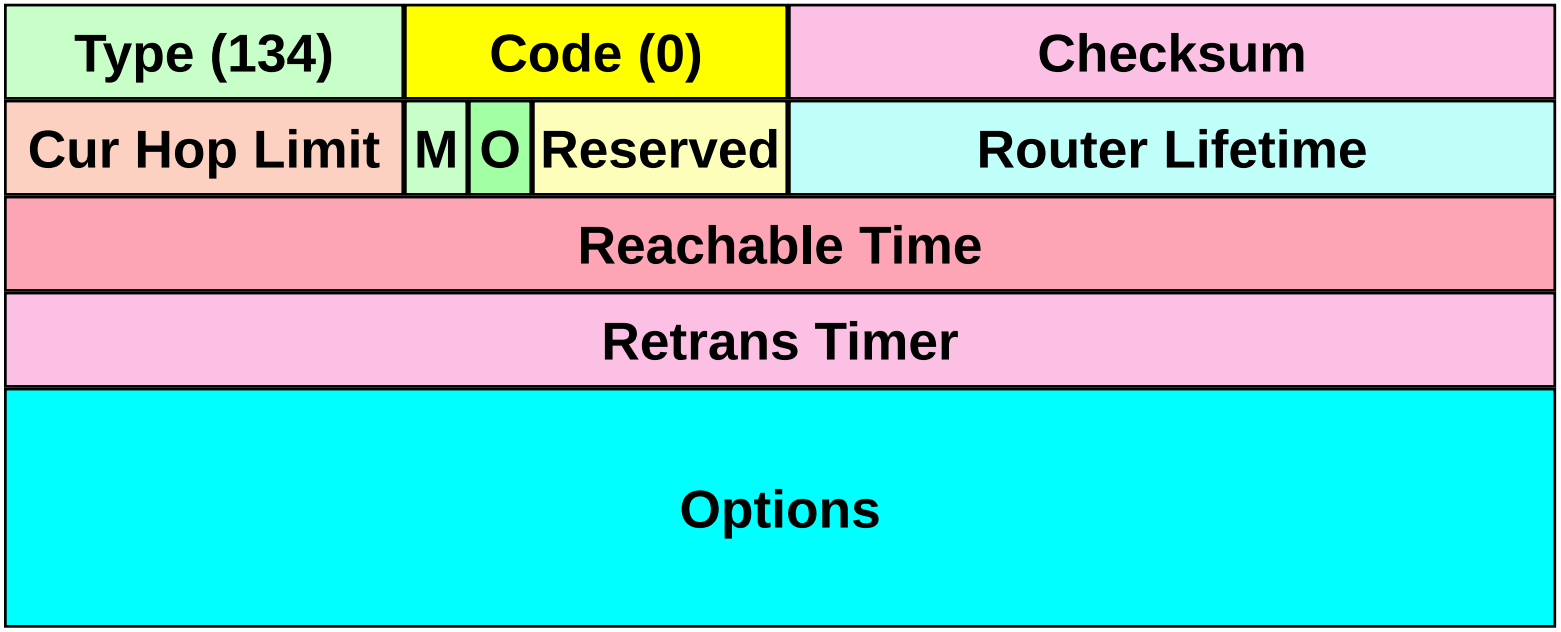
Router Solicitation



Sent to the all-routers multicast address (FF01::2)

code, not used set 0

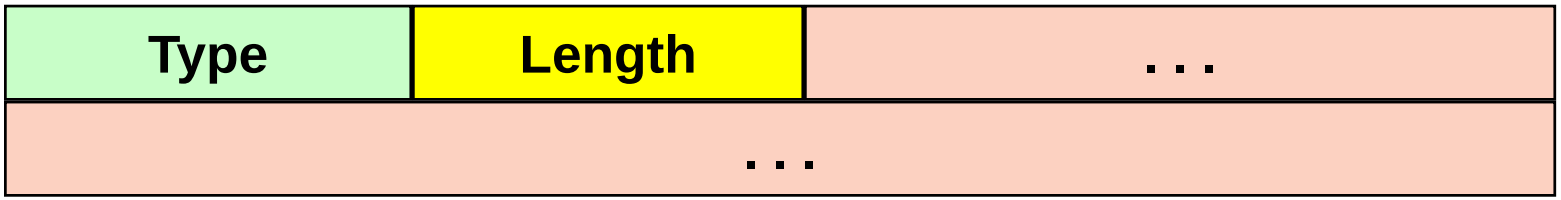
Router Advertisement



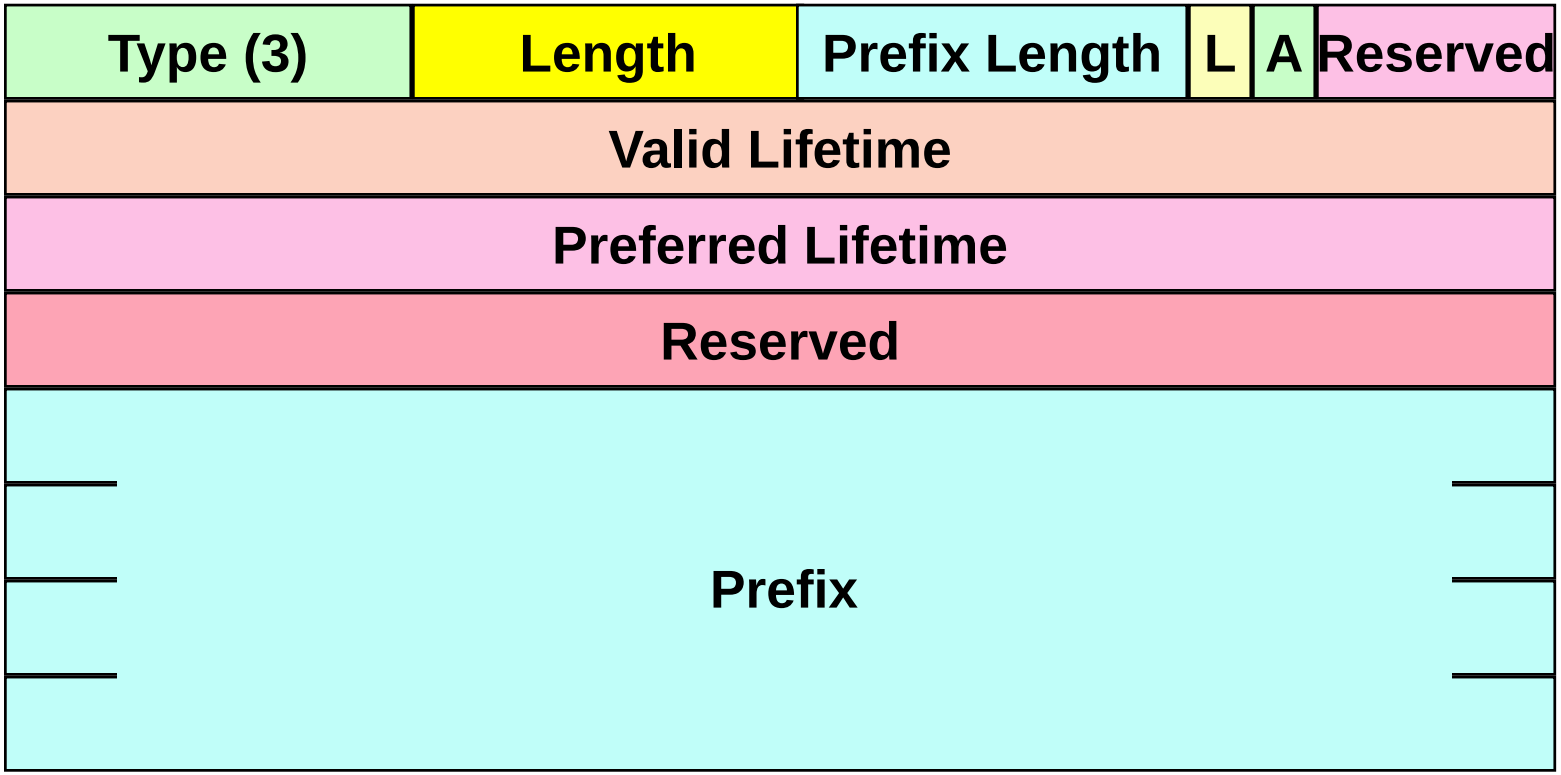
- M (Managed Address Configuration)
  - 1 – address available through DHCP
- O (Other configuration)
  - E.g., DNS server

Options

- General Format
- Length in multiple of 8 bytes



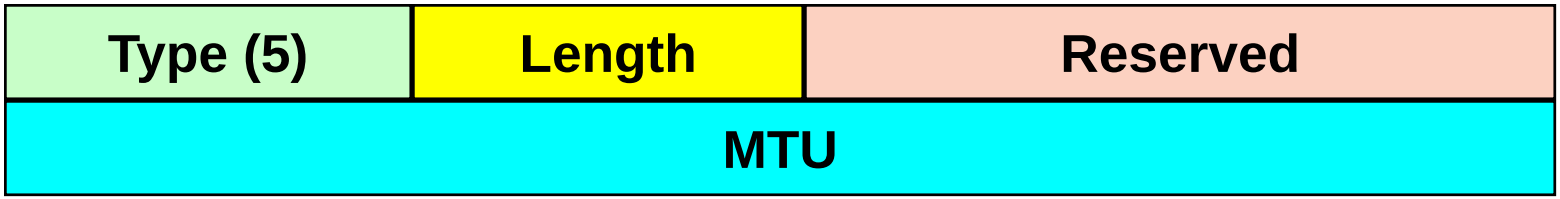
Prefix Information Option



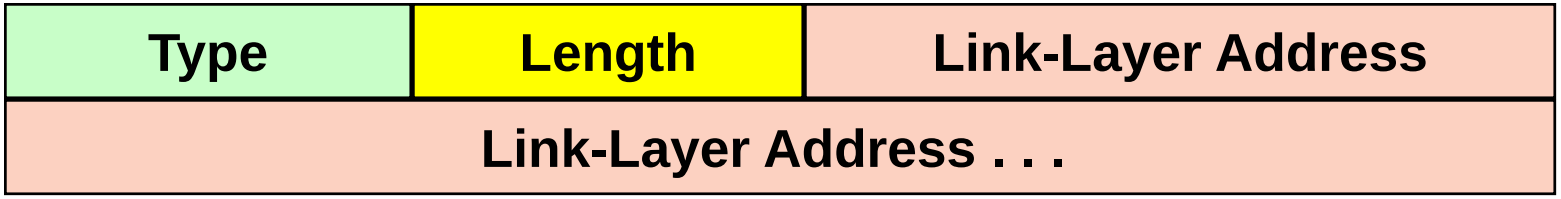
- L – prefix is on-link
- A – prefix can be used for autonomous configuration

MTU Option

Ensures all hosts on-link use the same MTU value



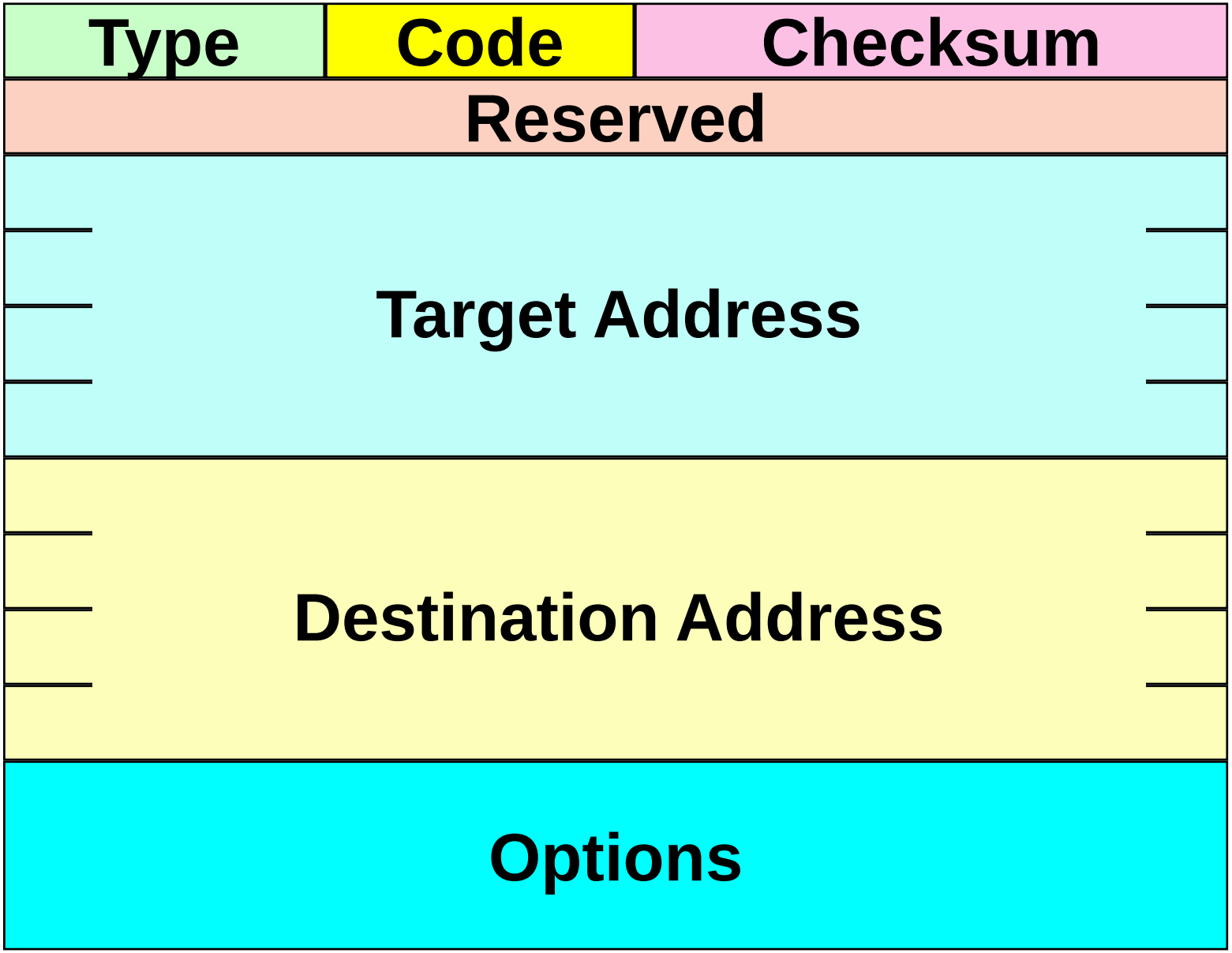
Link Layer Address Option



ICMP Redirect

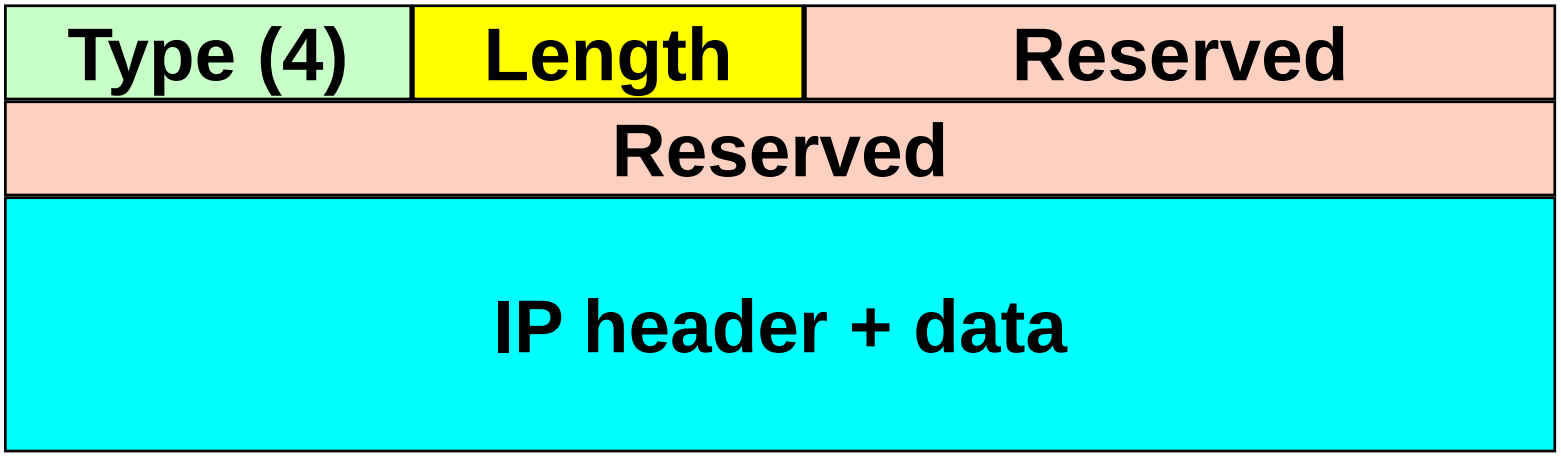
- Sent by a router to advise a host about a best first-hop
- The first-hop is always on-link, irrespective of prefix

ICMP Redirect Message Format



Redirect Header Option

Information about the packet being redirected



Duplicate Address Detection (DAD)

- Probe uniqueness of an IPv6 address
- Neighbor solicitation with address being probed as target
  - Sent to corresponding IPv6 Soliticted Node Multicast Address
  - Corresponding MAC multicast address
- Wait for a response for at least 1 sec
  - If no answer is received, the address is considered valid

Stateless Configuration: Basic Step

- Generate a link local address
- Probe for its uniqueness (DAD)
- Subscribe to the corresponding IPv6 Solicited Node Multicast Address
  - Configure reception of corresponding multicast MAC
  - Send ICMP Multicast Listener Report
- On-link communication enabled

Stateless Configuration: With Router

- Possibly send Router Solicitation
- Listen to Router Advertisements
- Create address from advertised prefix
- Probe for its uniqueness (DAD)
- Subscribe to the corresponding IPv6 Solicited Node Multicast Address
  - Configure reception of corresponding multicast MAC
  - Send ICMP Multicast Listener Report

Stateless Configuration: Renumbering

- Keep listening to Router Advertisements
  - Host can be re-configured any time
  - State of addresses
    - Preferred
    - Deprecated
  - Easier renumbering
    - Possible to switch from a previous (ISP) global address to a new one

Stateful Configuration: Dynamic Host Configuration Protocol

- Client/server model
- M flag = 1 in Router Advertisement
- Messages:
  - Solicit (to all-agents address: FF02::1:2)
  - Advertise
  - Request (all-agents address: FF02::1:2)
  - Reply
  - Release
  - Reconfigure

DHCP Stateless Configuration

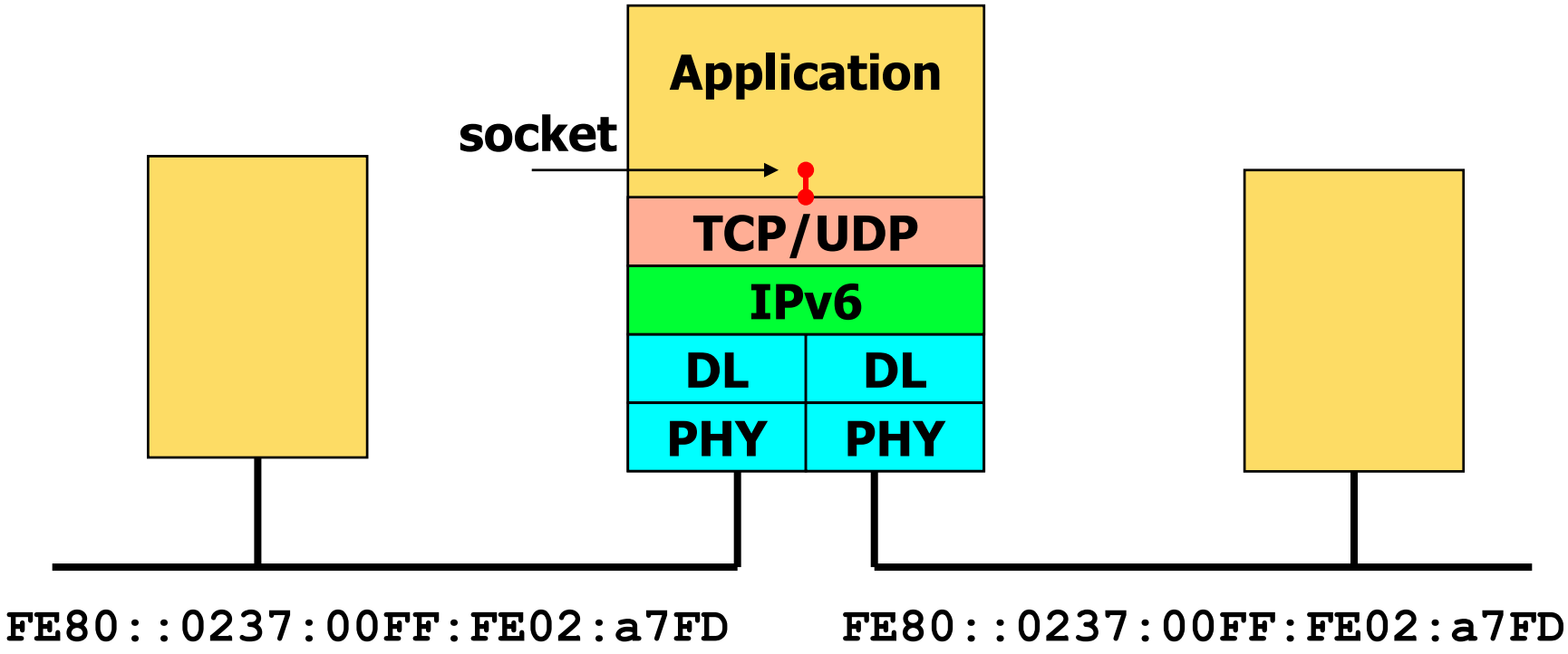
- M flag = 0 in Router Advertisement
  - Address autoconfigured from prefix in Router Advertisement
- O flag = 1 in Router Advertisement
  - Other information configured through DHCP

Autoconfiguration for routers

- Router Renumbering (RFC 2894)
- Router Renumbering packets
  - they include PCOs (Prefix Control Operations)
    - Match-Prefix: specifies the operation
    - Use-Prefix
  - They are transported in ICMPv6 packets
- Two types of Router Renumbering messages

Scoped Addresses

Why is a scope required?



Sintax

- A scoped address is composed of an IPv6 address followed by a % and a number identifying the interface
- Example:
  - FE80::0237:00FF:FE02:a7FD%19

The choice of the actual value of the scope is implementation-specific

Examples of Scoped Addresses

```
c:\>netsh interface ipv6 show address

Interface 1: Loopback Pseudo-Interface 1

Addr Type  DAD State   Valid Life Pref. Life Address
---------  ----------- ---------- ---------- ------------------------
Other      Preferred     infinite   infinite ::1

Interface 10: Wireless Network Connection

Addr Type  DAD State   Valid Life Pref. Life Address
---------  ----------- ---------- ---------- ------------------------
Other      Preferred     infinite   infinite fe80::9832:45b1:96e9:f444%10

Interface 9: Local Area Connection

Addr Type  DAD State   Valid Life Pref. Life Address
---------  ----------- ---------- ---------- ------------------------
Other      Deprecated    infinite   infinite fe80::9158:6fc2:4155:3564%9

Interface 12: Local Area Connection* 12

Addr Type  DAD State   Valid Life Pref. Life Address
---------  ----------- ---------- ---------- ------------------------
Public     Preferred     infinite   infinite 2001:0:5ef5:79fd:14b0:f4d:f50d:a9a9
Other      Preferred     infinite   infinite fe80::14b0:f4d:f50d:a9a9%12

Interface 27: Bluetooth Network Connection

Addr Type  DAD State   Valid Life Pref. Life Address
---------  ----------- ---------- ---------- ------------------------
Other      Deprecated    infinite   infinite fe80::9961:aca4:ff3:3374%27

Interface 31: Local Area Connection* 25

Addr Type  DAD State   Valid Life Pref. Life Address
---------  ----------- ---------- ---------- ------------------------
Other      Deprecated    infinite   infinite fe80::5efe:10.242.86.86%31

c:\>
```

Security and IPv6 addresses

- Network scanning
  - More difficult, from a theoretical point of view. because the larger number of combinations available (64 bits per LAN)
  - In reality, it is possible to used tricks to shrink the address space to be scanned
    - Addresses are assigned sequentially (from ::1 on)
    - Stateless address autoconfiguration (48 bits to be scanned)
    - Hosts with sequential MAC addresses (once one is found, all the others have similar MACs)
    - Start scanning with known OUI (NIC manufacturers ➔ 24 bit)
    - IPv6 addresses derived from IPv4 ones
    - Often, an IPv6 host uses dual stack, hence it is possible to scan the IPv4 space
  - Address harvesting, used to find addresses to be used as "seeds"
    - Host published in DNS
    - Analysis of log files of an host (e.g tracker P2P, web server)
- DDoS
  - An attacker may use several different addresses from the same machine (potentially, a whole /64)