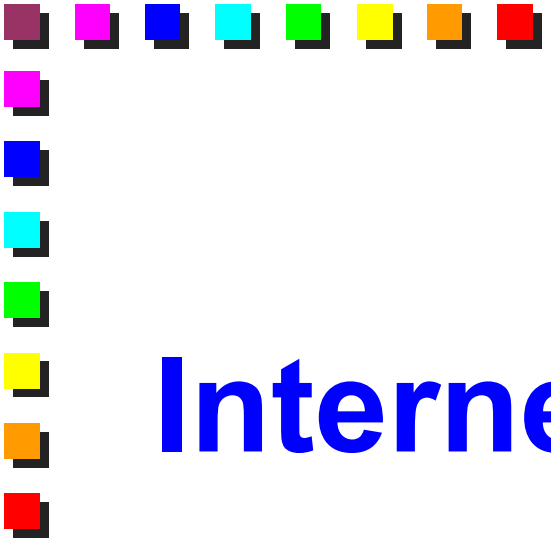


Internet Protocol Version 6

Silvano GAI

http://www.ip6.com

Mario BALDI

http://staff.polito.it/mario.baldi

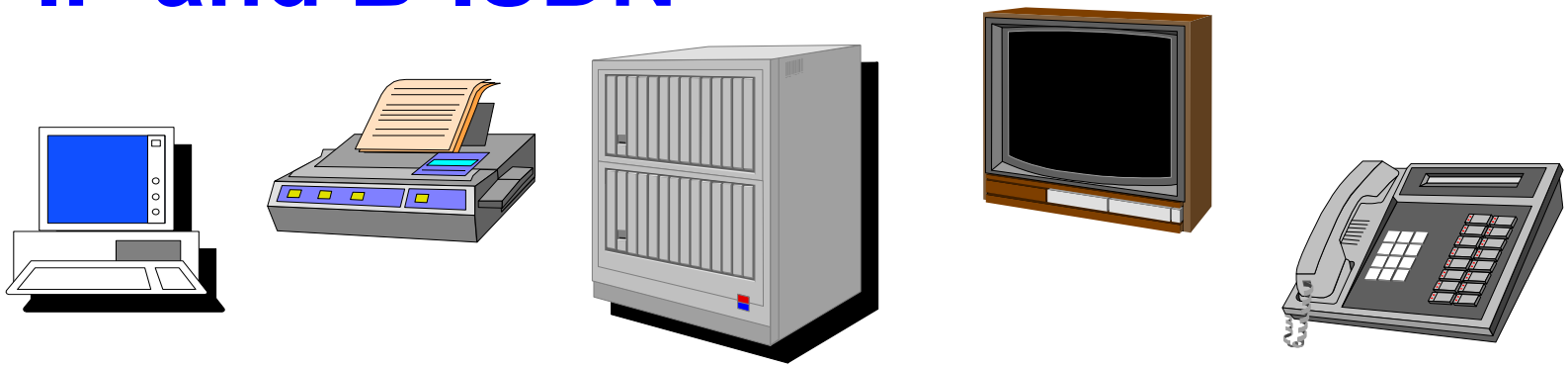
Nota di Copyright

Copyright: see page 2

Why a new IP

- Internet: the real point of contact
- An addresses space wide enough
  - Multicast and Anycast Addresses
- To unify Internet and Intranet
- For a better use of LAN
- Security
- Policy Routing
- Prioritization of traffic (Classes of Service)
- Plug and play
- Mobility
- Simple transition from IPv4 to IPv6

IP and B-ISDN



IP + RSVP

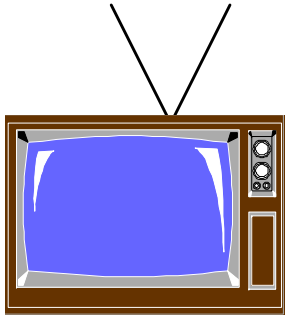
Satellite

CATV

ATM

Frame Relay

The Future

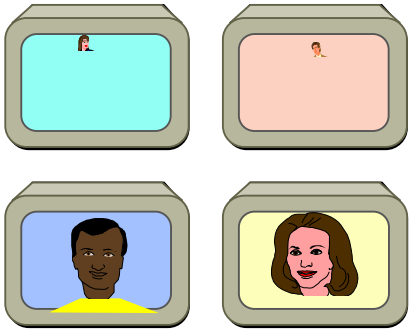


Residential

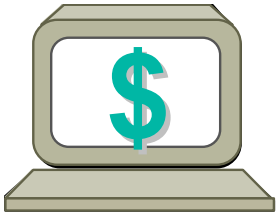
Education

Call Center

The Internet



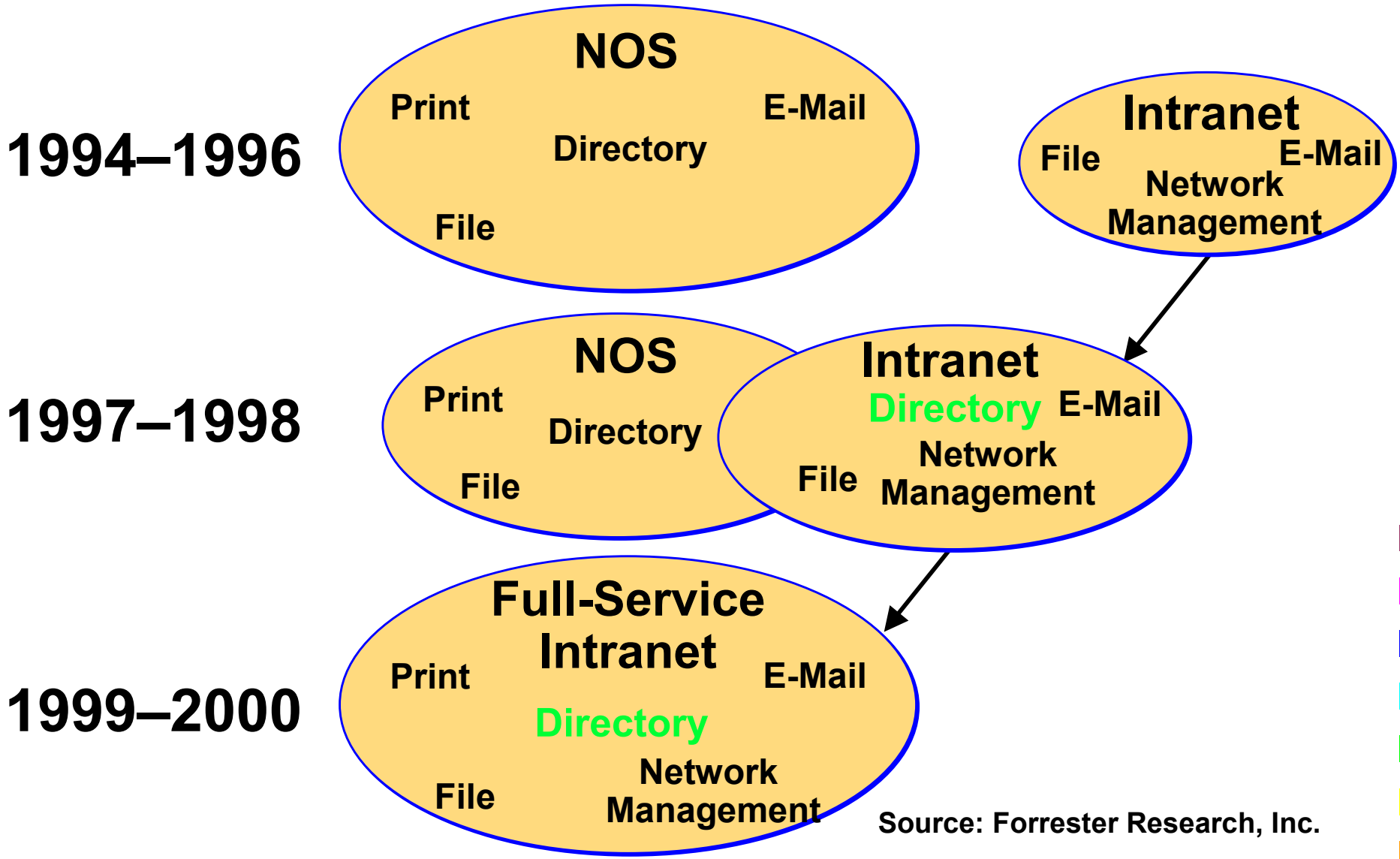
Office



Electronic Commerce

Mobile

Full-Service Intranet



Source: Forrester Research, Inc.

How many IPv6 Addresses

- 1.000.000 milliards of computers in network
- Efficiency:

$$H = \frac{\log_{10}(\text{addresses number})}{\text{bit number}}$$

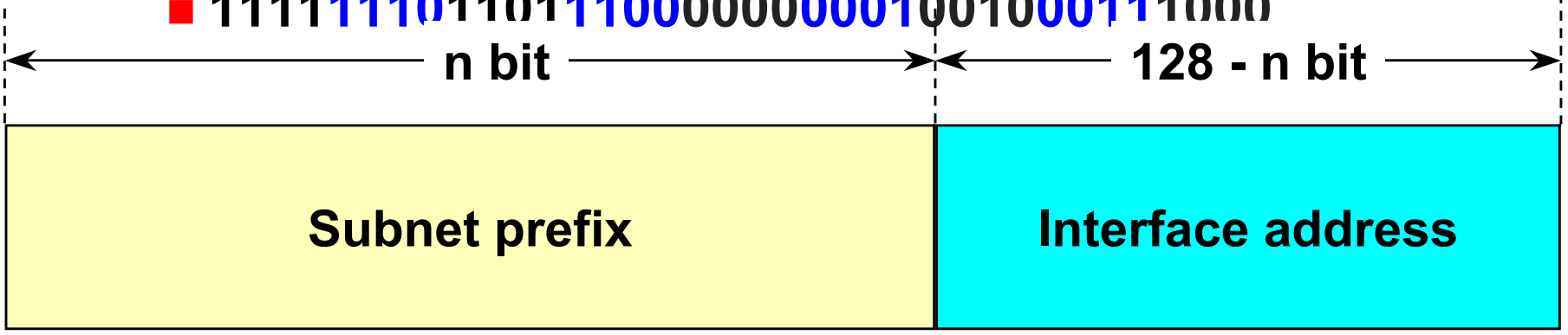
- Real Cases
  - H variation is from 0.22 to 0.26
- 68 bit are requested in the worst case

Syntax

- Hexadecimal notation: 8 natural numbers separated by “:”
  - FEDC:BA98:0876:45FA:0562:CDAF:3DAF:BB01
  - 1080:0000:0000:0007:0200:A00C:3423:A390
- There are simplifications:
  - Leading zeroes can be omitted
    - 1080:0:0:7:200:A00C:3423
  - Groups of zeroes can be replaced by “::”
    - 1080::7:200:A00C:3423
- IPv4 compatible addresses are written as:
  - 0:0:0:0:0:0:A00:1
  - ::A00:1
  - ::10.0.0.1

Prefixes

- The concept of Netmask no longer exists
- It is substituted by the concept of “Prefix”
- A prefix is identified by appending “/N” to the sequence of hexadecimal digits, where N is the prefix length in bits
- Example:
  - FEDC:0123:8700::/36 indica il prefisso
  - 1111111011011100000000010010001111000



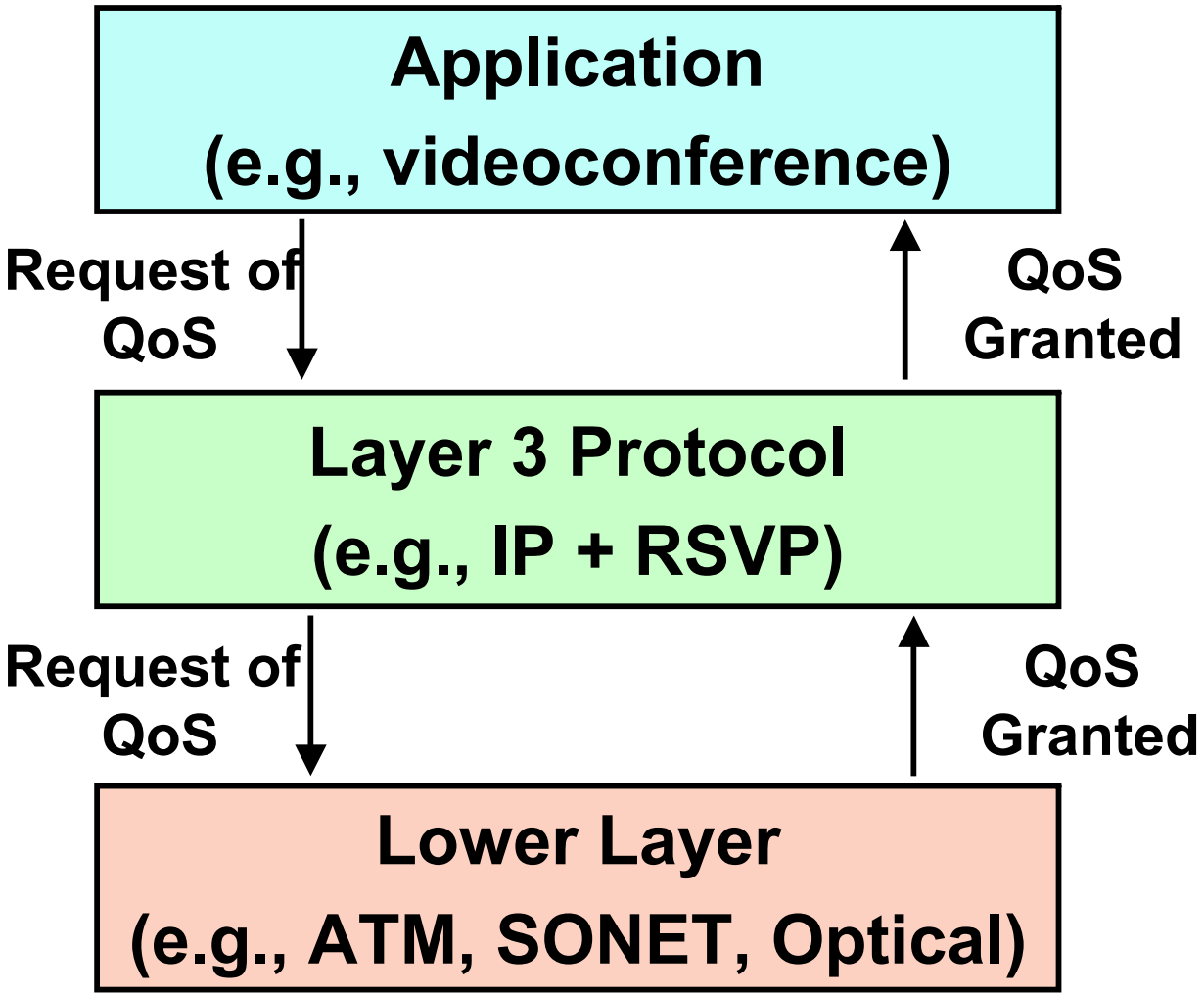
LAN Broadcast

- Broadcast Removal
- Multicast instead of Broadcast
  - LAN Optimization
  - More intelligent Network Cards

Address Assignment

- Unifying Internet and Intranets
  - global addresses
  - local addresses
- Compatible Addresses
  - IPv4
  - IPX
  - OSI NSAP

Best Effort ?



The Concept of Flow in IPv6

Security

- Integral Part of IPv6
  - Legal problems
    - export
    - use
- Authentication
- Privacy

} Cryptography

Routing

- In IPv4
  - Classful
  - CIDR (Classless Inter Domain Routing)
  - Extraordinary Increase of Routing Tables
- In IPv6
  - Classless
  - Provider Based Addresses
    - Efficient aggregation
  - Policy Routing

Priority

- Traffic Differentiation as a function of priority

  Class of Service (CoS)

  - Data traffic
  - Real time traffic

Plug and Play

- To satisfy
  - Dentist Office
  - Thousand computers on the dock
- Stateless
  - no server
- Statefull
  - server DHCP

Mobility

- In 2007 there will be 20-40 millions of mobile users in USA
- Laptop + PCMCIA card + cellular network
  - roaming
  - handoff

Transition

- Dual-stack Approach
- Tunneling
- 6-Bone
- The doomsday

Candidates

- TUBA (TCP and UDP over Bigger Addresses)
  - from OSI CLNP (ISO 8473)
  - NSAP settled on 20 octects
- SIP (Simple IP)
  - An IP with 64 bit addresses
- IPAE (IP Address Encapsulation)
  - IP in IP (two IP layers)
    - 1 IP for world-wide interconnections
    - 1 IP for local interconnections

Candidates

- PIP
  - A New Approach to:
    - policy routing
    - mobility
- SIPP (SIP Plus)
  - SIP and PIP merge
- IPv6
  - based on SIPP
  - 128 bit of address

How to choose

Architecture Simplicity

In every thing you reach the perfection

not when you have no more to add,

but when you have no more to take away.

Antoine de Saint-Exupery

from “Le Petit Prince”

So, What Went Wrong?

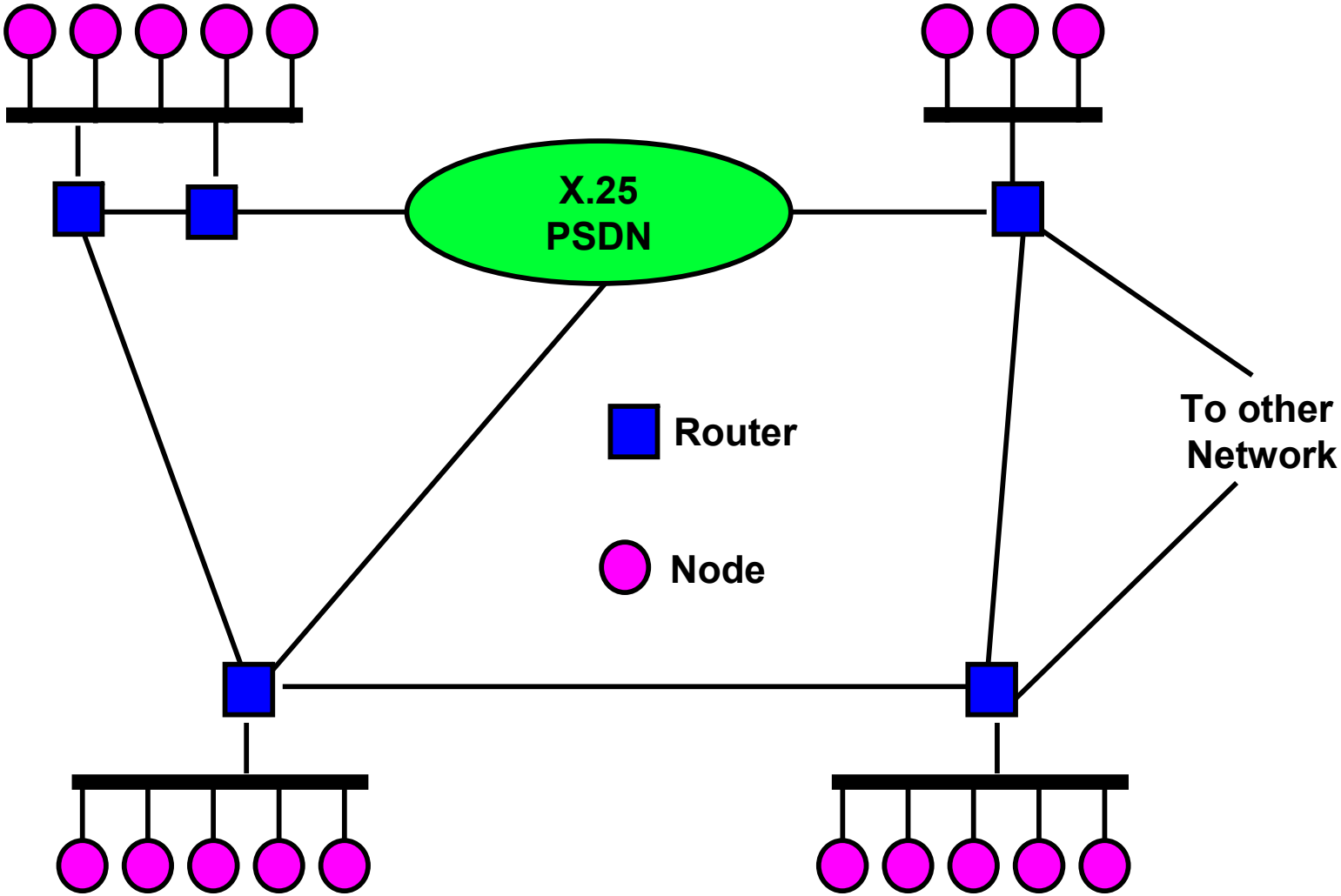
Nothing, but IPv4 is hanging on!

- **Intranet and application proxies**
- **NAT - Network Address Translation**
- **DHCP - Dynamic Host Configuration Protocol**
- **IPsec**
- **Mobility support**

Terminology

- node
  - a device implementing IPv6
- router
  - a routing capacity node
- host
  - each node which is not a router
- link
  - Data Link level (level 2) communication channel; link example are Ethernet, PPP, X.25, Frame Relay e ATM, or tunnel on different protocol
- neighbors
  - nodes connected to the same link;
- interface
  - Node-link interconnection device

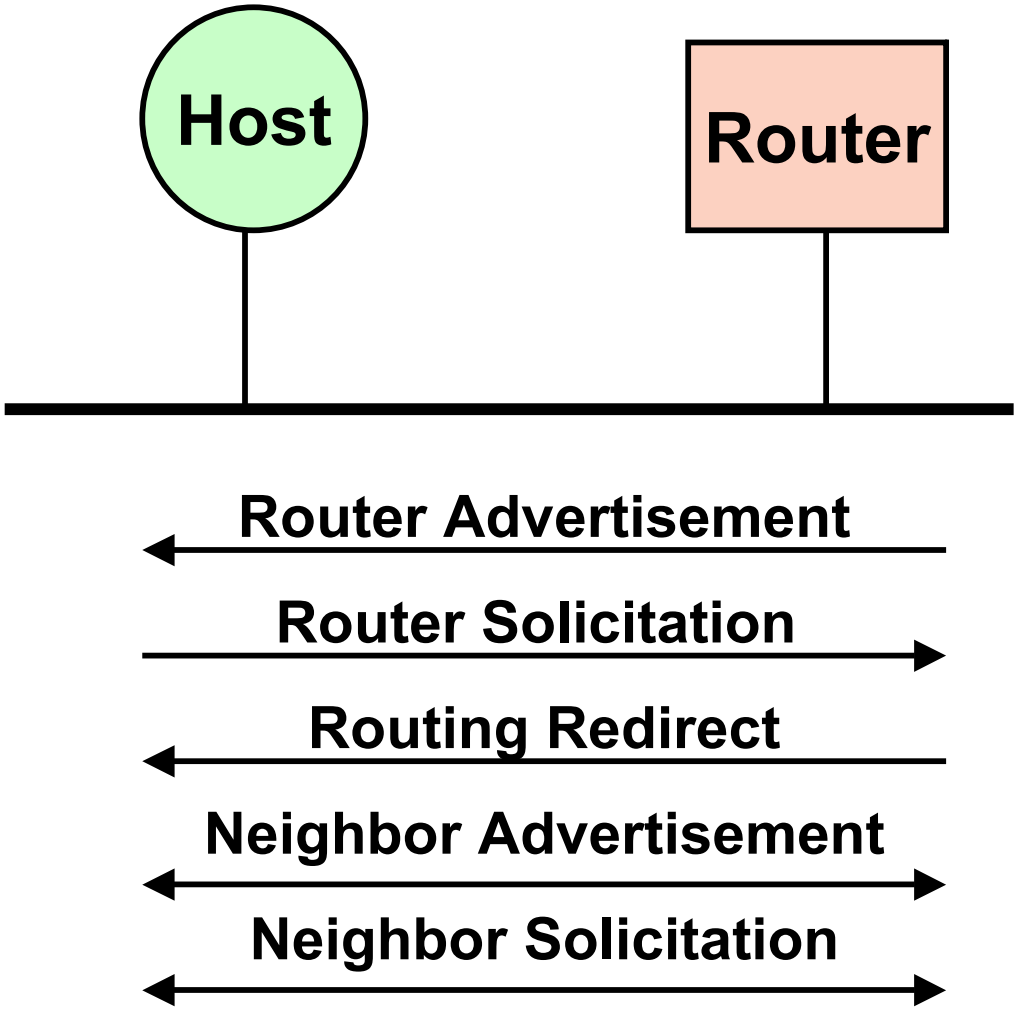
IPv6 Network Architecture



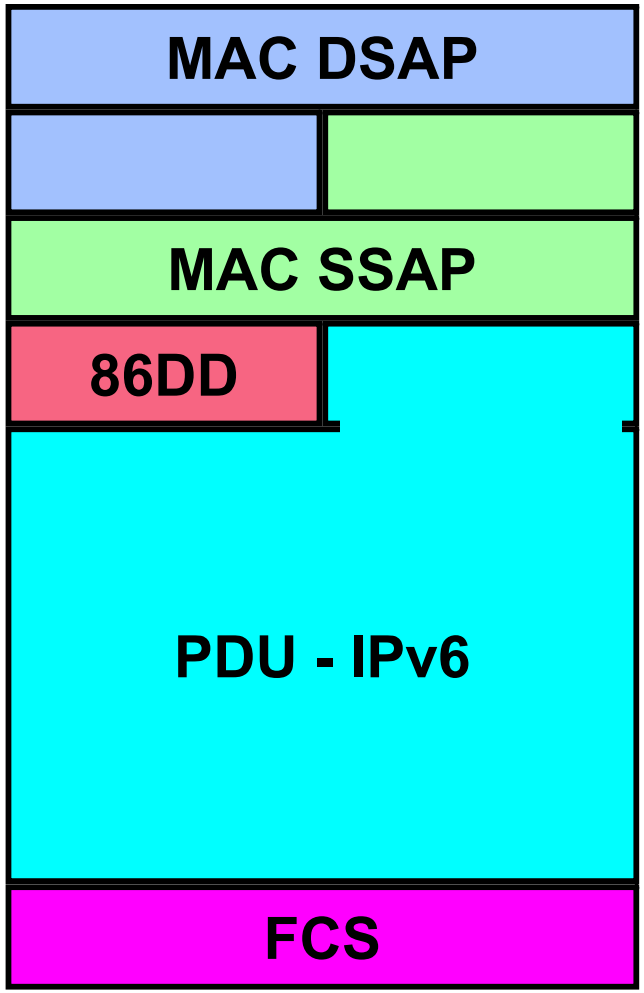
Subnetwork

- Former concept of IPv4
- Subnetwork correspondence with physical network
  - more subnet allowed on the same physical network
- Subnet identified by a prefix
  - a 128 bit address + number of significant bits from the left side

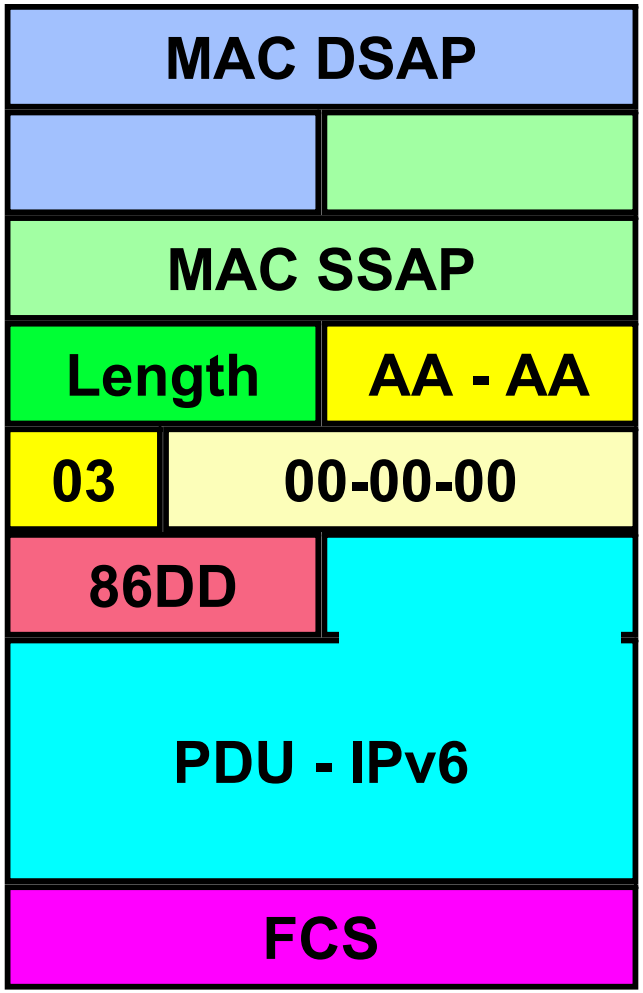
Neighbor Discovery



IPv6 and LAN

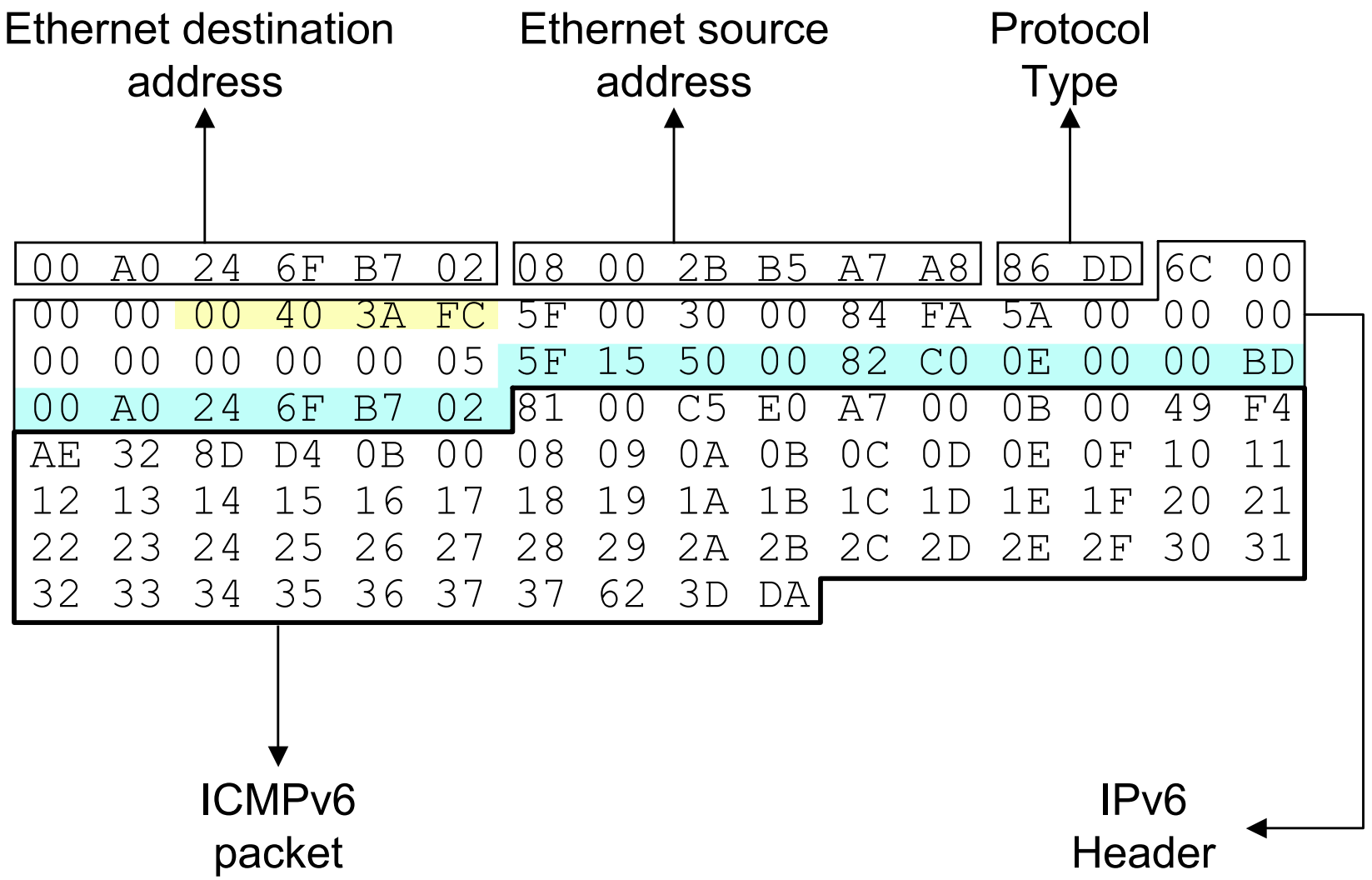


(a)

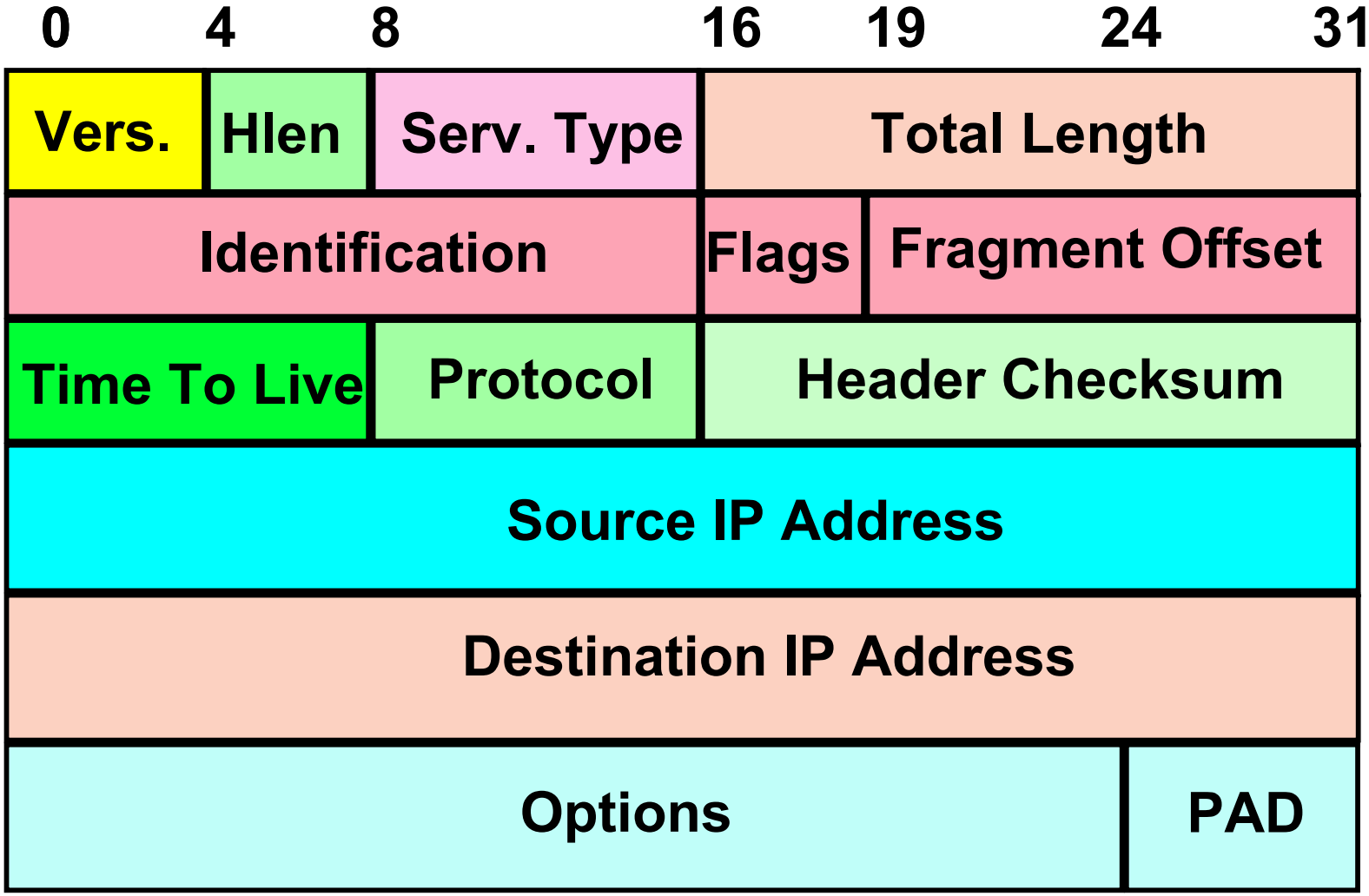


(b)

IPv6 Packet: Example



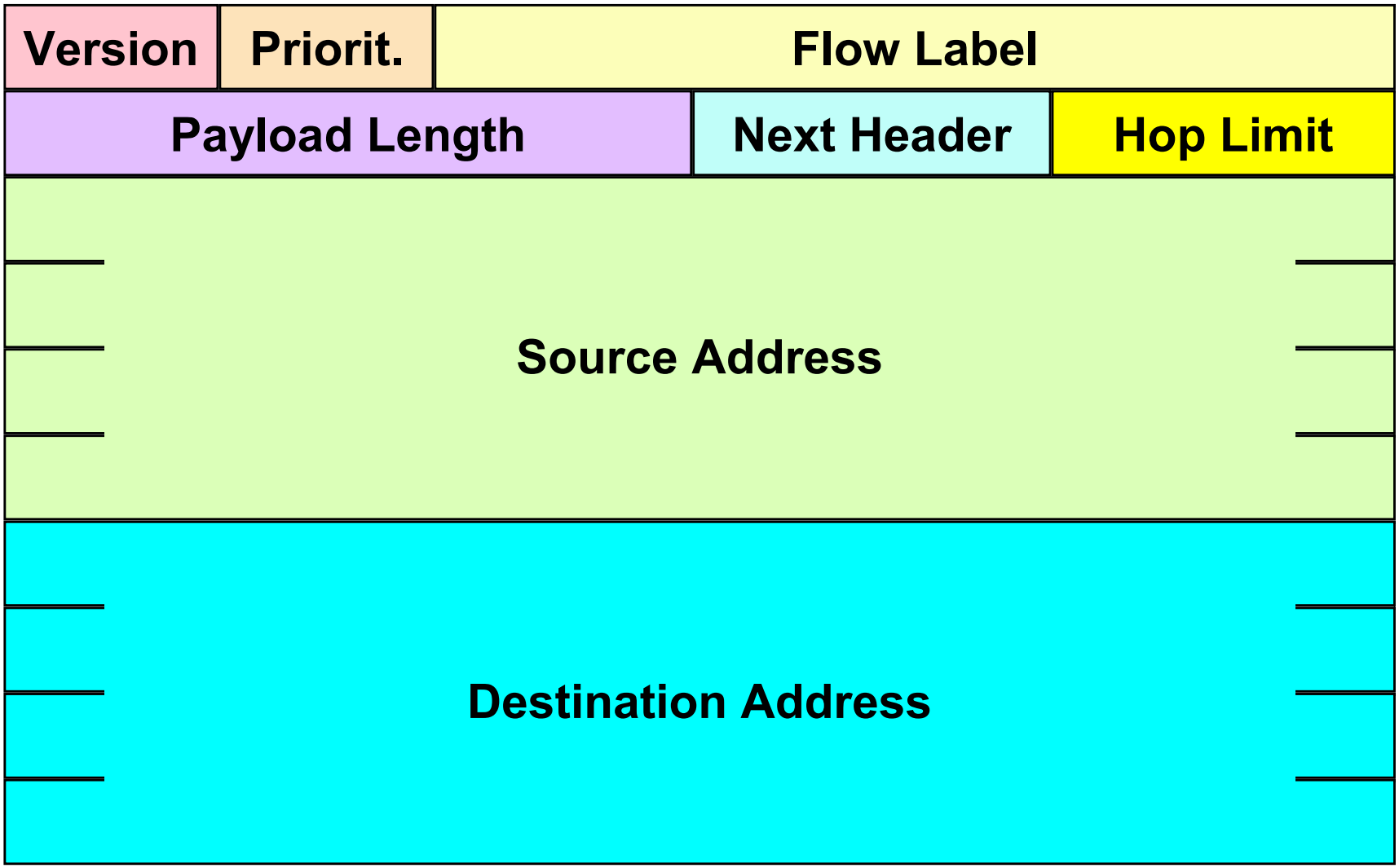
IPv4 Header

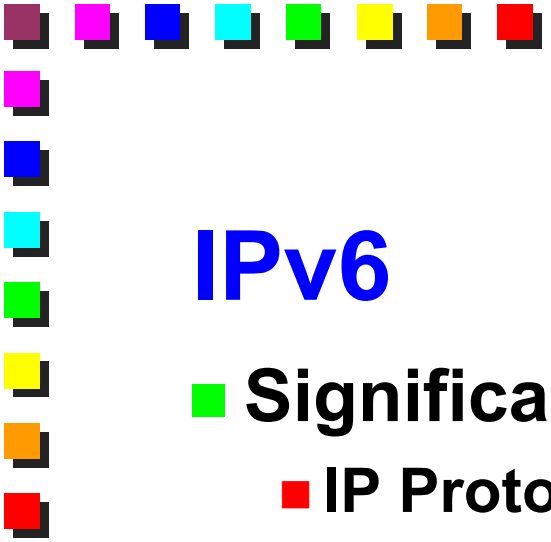


IPv6 Header

- Simple and fixed lenght (40 octets) structure
  - 8 octets with 6 fields
  - Source Address (16 octets)
  - Destination Address (16 octets)
- Some features of the IPv4 header have been removed:
  - header checksum
  - fragmentation
  - options (e.g. source routing)

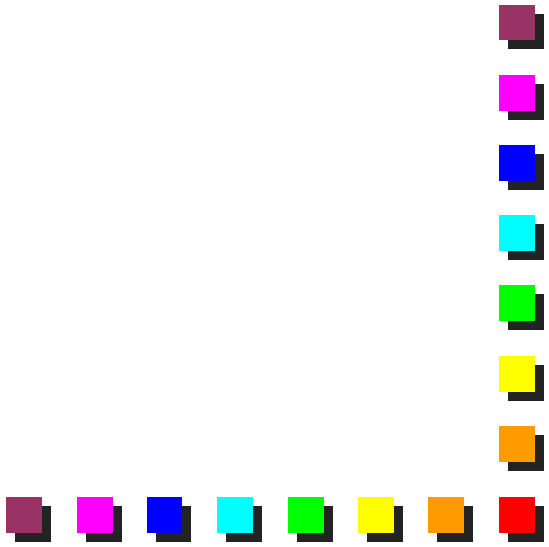
IPv6 Header





IPv6

- Significant Changes
  - IP Protocol
  - ARP Protocol
  - ICMP Protocol
  - IGMP Protocol
- Upgrades
  - TCP and UDP
  - Sockets
  - DNS
  - RIP and OSPF
  - BGPand IDRP



Main protocol changes

- New 128 bit addresses must be included
  - TCP uses them to identify the connection
- UDP calculates the checksum
- The socket interface must be changed
- DNS must be changed

DNS Changes

address definition IPv4

```
HOST1.POLITO.IT IN A 130.192.253.252
```

address definition IPv6

```
HOST1.POLITO.IT IN AAAA 4321:0:1:2:3:4:567:89ab
```

reverse definition IPv4

```
252.253.192.130.IN-ADDR.ARPA. PTR HOST1.POLITO.IT
```

reverse definition IPv6

```
b.a.9.8.7.6.5.0.4.0.0.0.3.0.0.0.2.0.0.0.1.0.0.0.
0.0.0.0.1.2.3.4.IP6.INT. PTR HOST1.POLITO.IT
```

Address Assignment

- The Continental Aggregation yields limited results
  - topology is chosen by providers
  - it is not a good strategy to assign addresses to users
- In order for the CIDR to work, addresses must be assigned to providers that:
  - divide addresses during the assignment phase
  - aggregate them during the announcement phase
- IPv6 will have only provider based addresses
  - easy renumbering

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