IPv6

Refs: Chapter 10, Appendix A

IPv6 availability

- Generally not part of O.S.
- Available in beta for many operating systems.
- Experimental IPv6 internet - may be coming to campus!

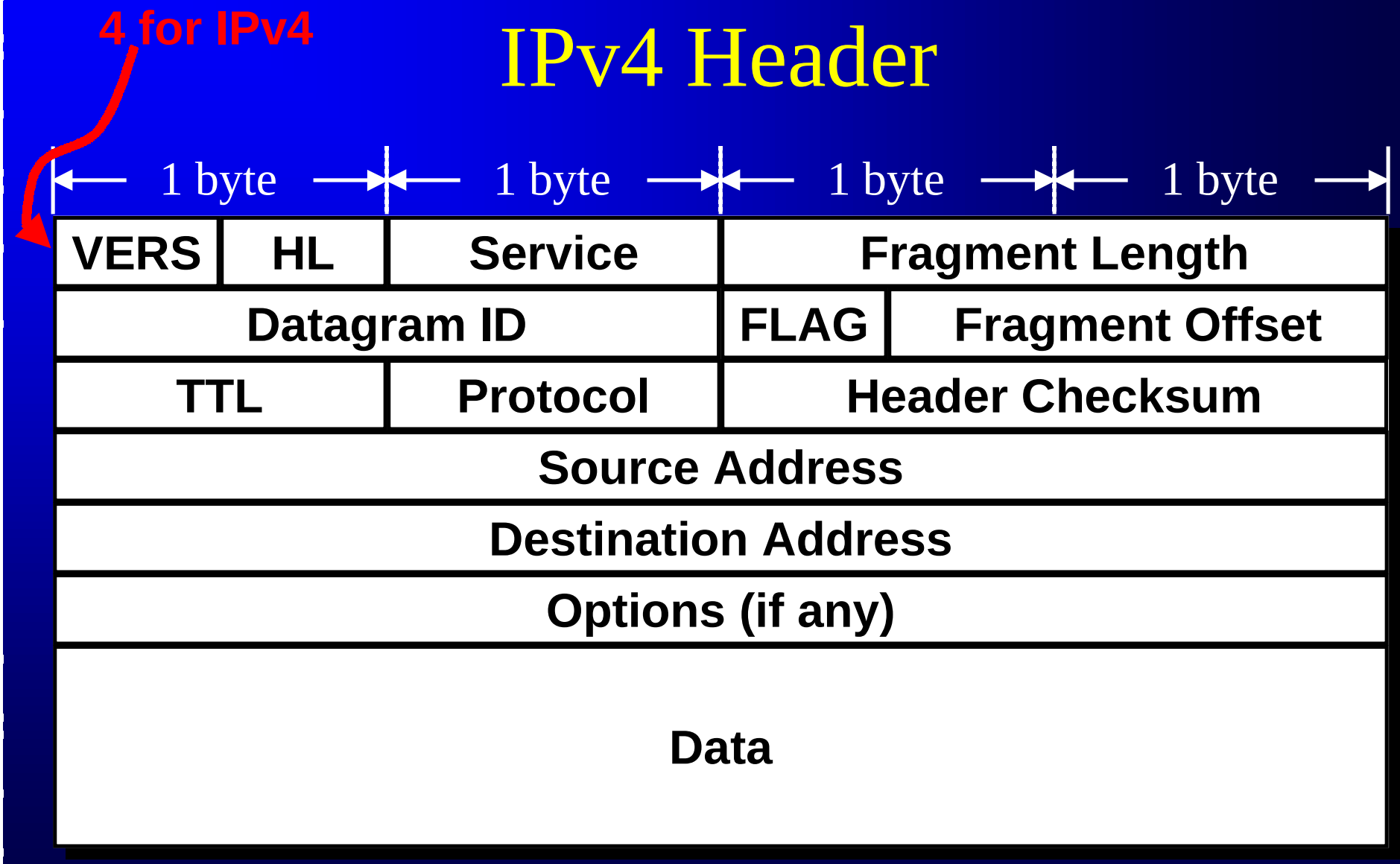
IPv6 Design Issues

- Overcome IPv4 scaling problem (lack of address space)
- Flexible transition mechanism.
- New routing capabilities.
- Quality of service
- Security
- Ability to add features in the future.

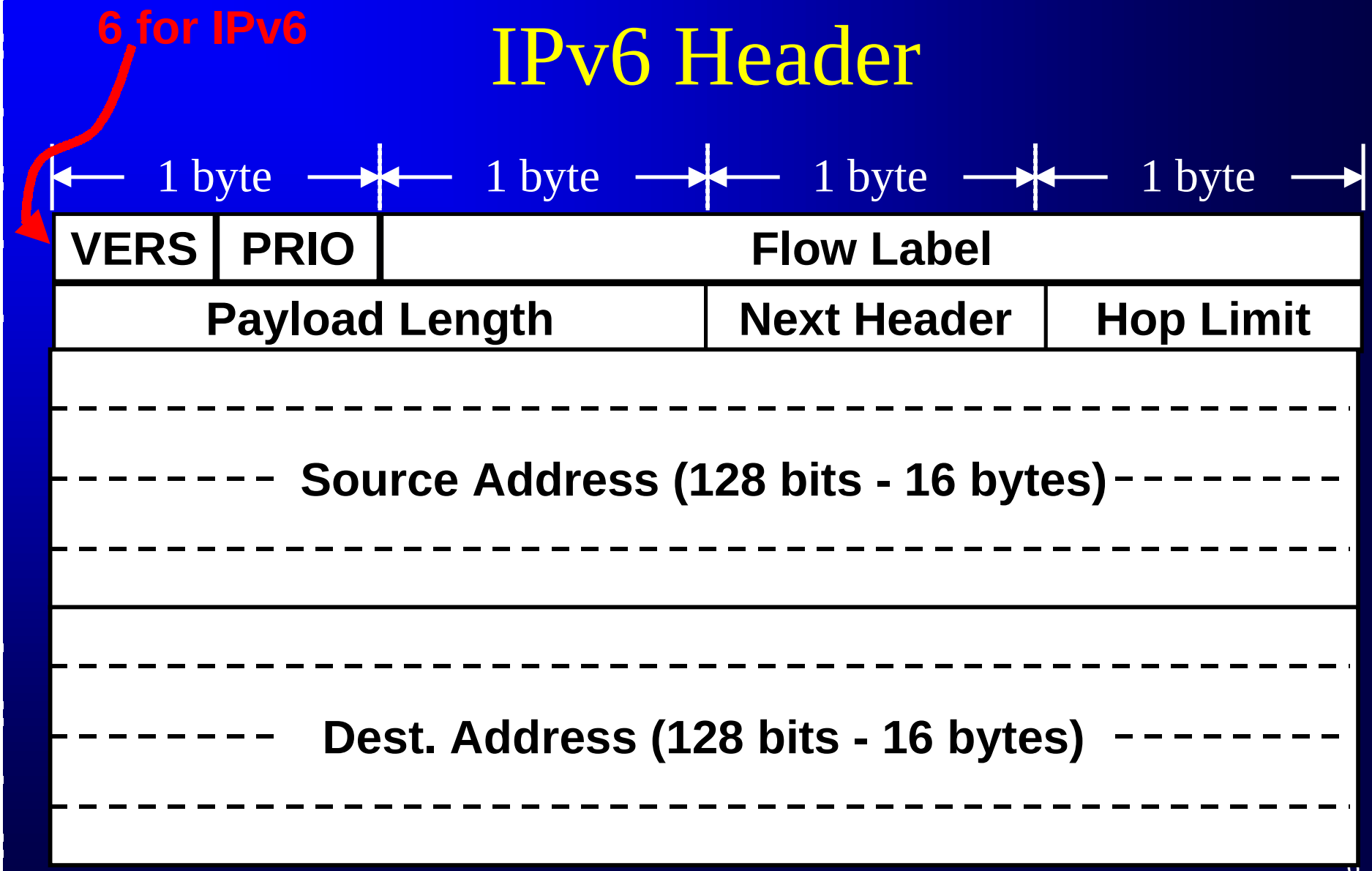
IPv6 Headers

- Simpler header - faster processing by routers.
  - No optional fields - fixed size (40 bytes)
  - No fragmentation fields.
  - No checksum
- Support for multiple headers
  - more flexible than simple “protocol” field.

IPv4 Header


4 for IPv4
1 byte
1 byte
1 byte
1 byte
VERS
HL
Service
Fragment Length
Datagram ID
FLAG
Fragment Offset
TTL
Protocol
Header Checksum
Source Address
Destination Address
Options (if any)
Data

IPv6 Header


6 for IPv6
1 byte
1 byte
1 byte
1 byte
VERS
PRIO
Flow Label
Payload Length
Next Header
Hop Limit
Source Address (128 bits - 16 bytes)
Dest. Address (128 bits - 16 bytes)

IPv6 Header Fields

- VERS: 6 (IP version number)
- Priority: will be used in congestion control
- Flow Label: experimental - sender can label a sequence of packets as being in the same flow.
- Payload Length: number of bytes in everything following the 40 byte header, or 0 for a *Jumbogram*.

IPv6 Header Fields

- Next Header is similar to the IPv4 “protocol” field - indicates what type of header follows the IPv6 header.
- Hop Limit is similar to the IPv4 TTL field (but now it really means hops, not time).

Extension Headers

- Routing Header - source routing
- Fragmentation Header - supports fragmentation of Ipv6 datagrams.
- Authentication Header
- Encapsulating Security Payload Header

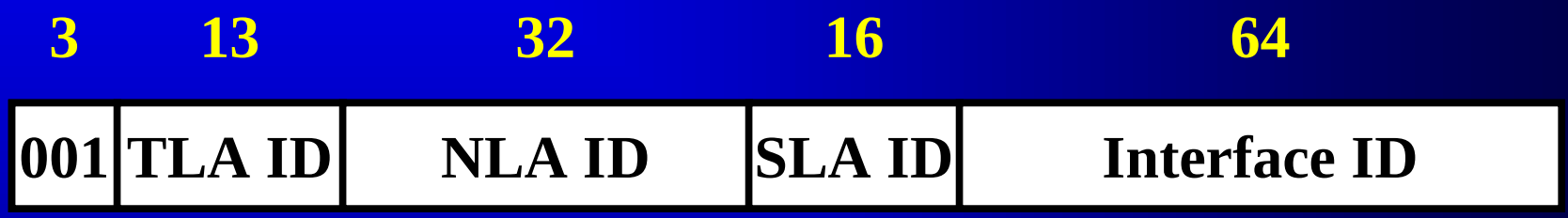
IPv6 Addresses

- 128 bits - written as eight 16-bit hex numbers.

  `5f1b:df00:ce3e:e200:0020:0800:2078:e3e3`

- High order bits determine the *type* of address. The book shows the breakdown of address types.

IPv6
Aggregate Global Unicast Address



TLA: top-level aggregation
NLA: next-level
SLA: site-level

Interface ID is based on hardware MAC address

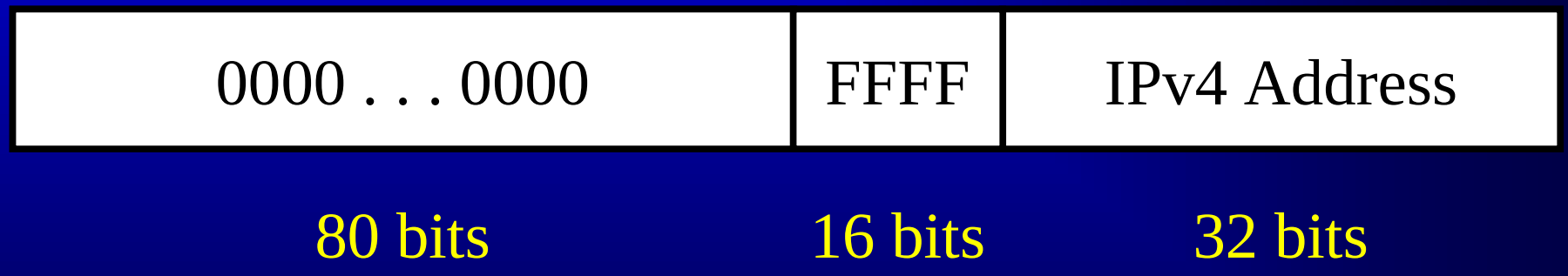
IPv4-Mapped IPv6 Address

- IPv4-Mapped addresses allow a host that support both IPv4 and IPv6 to communicate with a host that supports only IPv4.

- The IPv6 address is based completely on the IPv4 address.

IPv4-Mapped IPv6 Address

- 80 bits of 0s followed by 16 bits of ones, followed by a 32 bit IPv4 Address:



IPv4-Compatible IPv6 Address

- An IPv4 compatible address allows a host supporting IPv6 to talk IPv6 even if the local router(s) don’t talk IPv6.
- IPv4 compatible addresses tell endpoint software to create a tunnel by encapsulating the IPv6 packet in an IPv4 packet.

IPv6 Sockets programming

- New address family: `AF_INET6`
- New address data type: `in6_addr`
- New address structure: `sockaddr_in6`

in6_addr

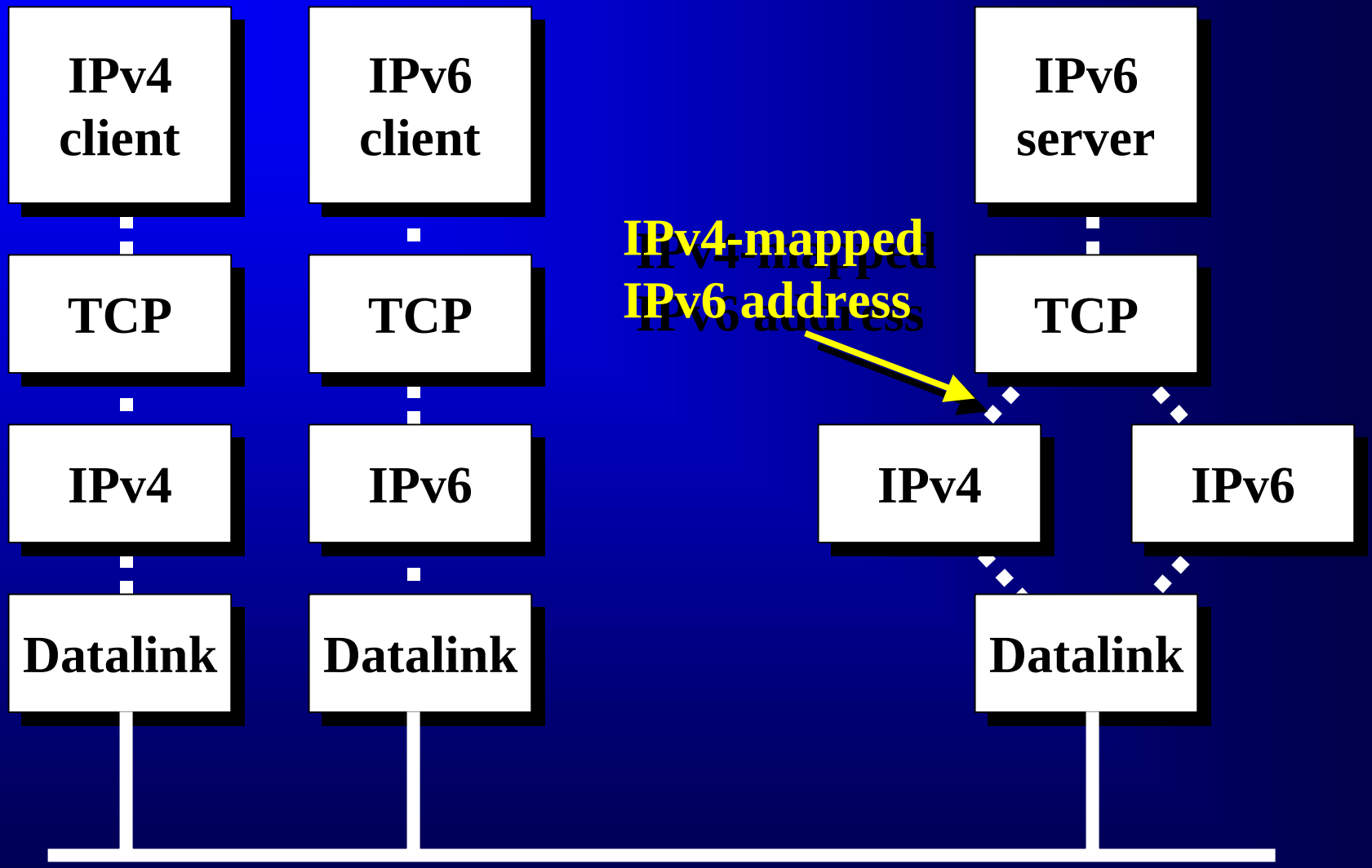
```
struct in6_addr {
    uint8_t s6_addr[16];
};
```

sockaddr_in6

```
struct sockaddr_in6 {
  uint8_t          sin6_len;
  sa_family_t      sin6_family;
  in_port_t        sin6_port;
  uint32_t         sin6_flowinfo;
  struct in6_addr  sin6_addr;
};
```

Dual Server

- In the future it will be important to create servers that handle both IPv4 and IPv6.
- The work is handled by the O.S. (which contains protocol stacks for both v4 and v6):
  - automatic creation of IPv6 address from an IPv4 client (IPv4-mapped IPv6 address).


IPv4
client
IPv6
client
IPv6
server
IPv4-mapped
IPv6 address
TCP
TCP
TCP
IPv4
IPv6
IPv4
IPv6
Datalink
Datalink
Datalink

IPv6 Clients

- If an IPv6 client specifies an IPv4 address for the server, the kernel detects and talks IPv4 to the server.
- DNS support for IPv6 addresses can make everything work.
  - `gethostbyname()` returns an IPv4 mapped IPv6 address for hosts that only support IPv4.

IPv6 - IPv4 Programming

- The kernel does the work, we can assume we are talking IPv6 to everyone!
- In case we really want to know, there are some macros that determine the type of an IPv6 address.
  - We can find out if we are talking to an IPv4 client or server by checking whether the address is an IPv4 mapped address.