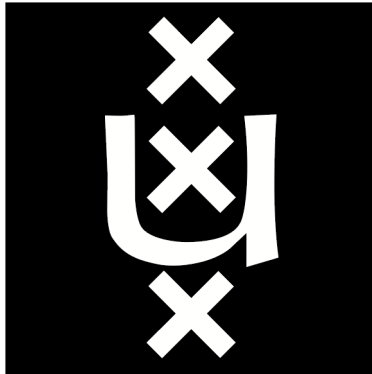


UNIVERSITY OF AMSTERDAM

INTERNETWORKING AND ROUTING



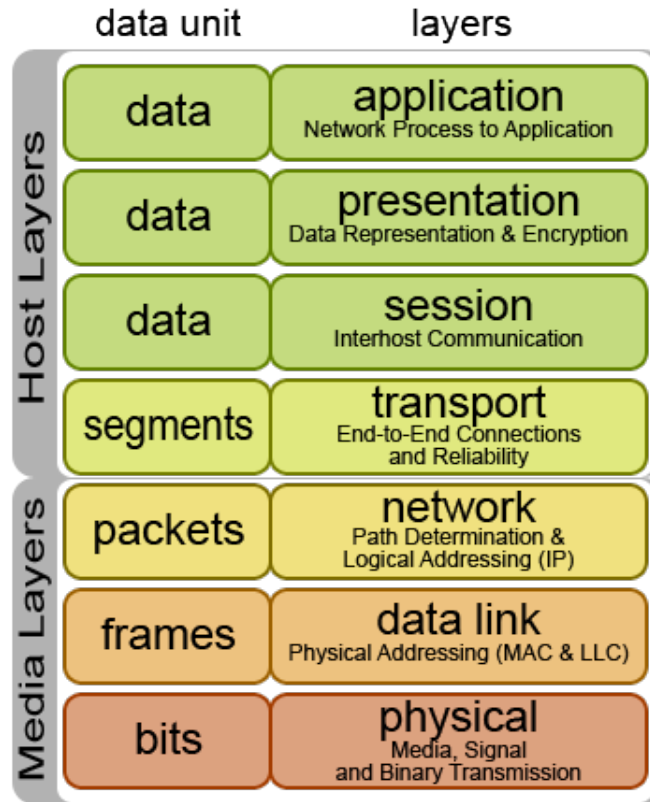
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March 12, 2015

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# 1 Overview

## 1.1 OSI Model



## 1.2 Interfaces and Protocols

**Interfaces** Interfaces connect different layers on the same computer. Uses Protocol Data Units (PDU).

**Protocols** Protocols are used to communicate between parties data on a specific layer. Uses Service Data Units (SDU) inside Service Access Points (SAP).

## 1.3 Encapsulation and Multiplexing

**Encapsulation** When data units go down one level in the layer model, headers are added to add information regarding the current layer.

**Multiplexing** Multiple protocols can coexist on the same layer. However,

when going down the layer model, these protocols should be treated equally. For example, TCP and UDP are multiplexed down at the IP level, and demultiplexed back when reading the information of IP packets.<sup>1</sup>

## 1.4 ES Models: Strong vs Weak

**Strong ES Model** Hosts suppress packets with a destination address that references another of its interfaces.

**Weak ES Model** Hosts accept packets that match with one of its interfaces addresses, even if it does not receive it on that interface.

## 1.5 IP Addressing (IPv4)

- 32-bit addresses
- Decimal-dotted notation (a.b.c.d,  $0 \leq a, b, c, d \leq 255$ ).
- Special addresses:
  - 0.0.0.0** IP address unknown.
  - 127.0.0.1** Loopback address.
  - Host part all 0** Subnet identifier.
  - Host part all 1** Directed broadcast.
  - 255.255.255.255** Local subnet broadcast.
- Private addresses:
  - 10.0.0.0/8**
  - 172.16.0.0/12**
  - 192.168.0.0/16**
  - 169.254.0.0/16**

## 1.6 Subnetting

- Originally classful subnetting (subnets in A/B/C ranges, with 24, 16 and 8 bits of network addresses respectively; D range for multicast and an unused E range).<sup>2</sup>
- Classless Inter-Domain Routing (CIDR), with network masks to mark the difference between network address and host address. Routing done by selecting most specific match.

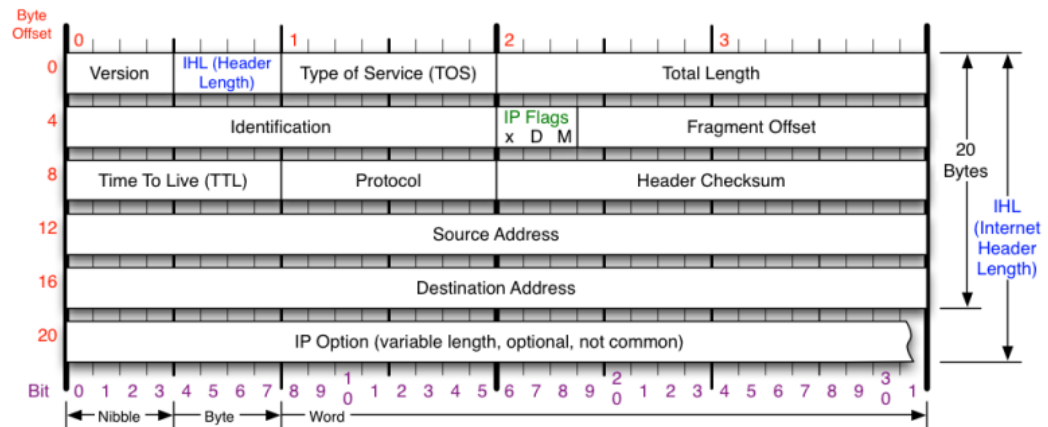
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<sup>1</sup>[http://www.tcpipguide.com/free/t\\_TCPIPProcessesMultiplexingandClientServerApplicati-2.htm](http://www.tcpipguide.com/free/t_TCPIPProcessesMultiplexingandClientServerApplicati-2.htm)

<sup>2</sup>[http://en.wikipedia.org/wiki/Classful\\_network#Introduction\\_of\\_address\\_classes](http://en.wikipedia.org/wiki/Classful_network#Introduction_of_address_classes)

- Variable Length Subnet Masks (VLSM) to use different subnets that do not have the requirement of having the same size. Add the possibility of subnets inside subnets. This was not possible in RIPv1.
- A "link" is defined as the topological area in which a packet with  $TTL = 1$  can be delivered (aka. not being forwarded).
- A "subnet" is the topological area in which the interfaces receive the same network prefix.

## 1.7 IP Packet Format



<b>Version</b> Version of IP Protocol. 4 and 6 are valid. This diagram represents version 4 structure only.	<b>Protocol</b> IP Protocol ID. Including (but not limited to): 1 ICMP 17 UDP 57 SKIP 2 IGMP 47 GRE 88 EIGRP 6 TCP 50 ESP 89 OSPF 9 IGRP 51 AH 115 L2TP	<b>Fragment Offset</b> Fragment offset from start of IP datagram. Measured in 8 byte (2 words, 64 bits) increments. If IP datagram is fragmented, fragment size (Total Length) must be a multiple of 8 bytes.	<b>IP Flags</b> x D M x 0x80 reserved (evil bit) D 0x40 Do Not Fragment M 0x20 More Fragments follow
<b>Header Length</b> Number of 32-bit words in TCP header, minimum value of 5. Multiply by 4 to get byte count.	<b>Total Length</b> Total length of IP datagram, or IP fragment if fragmented. Measured in Bytes.	<b>Header Checksum</b> Checksum of entire IP header	<b>RFC 791</b> Please refer to RFC 791 for the complete Internet Protocol (IP) Specification.

## 2 CLEAN: Calculating, Legacy, Endianness, Addressing, Networks

### 2.1 Calculating: Counting

**Counting** Process that starts with  $n = 0$  as the initial count. Every counted object is labeled with the actual  $n$  value, and  $n$  is updated to  $n = n + 1$ . Process ends when all objects have been counted.

### 2.2 Legacy

- Everybody knows what Karst thinks of legacy.

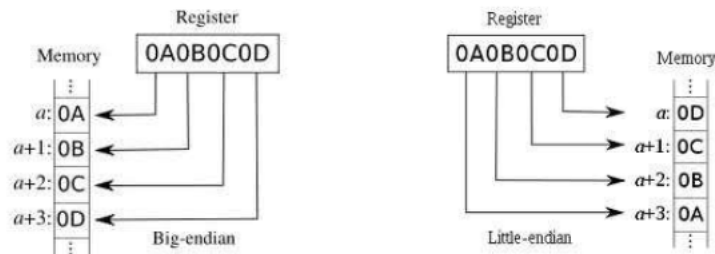
### 2.3 2-adic vs Binary

2-adic	Binary	2-adic to base-10	Binary to base-10
1	0	1	0
2	1	2	1
11	00	3	0
12	01	4	1
21	10	5	2
22	11	6	3
111	000	7	0

- The whole point is that binary resets at every range increase.

### 2.4 Big-endian and Little-endian

#### Big Endian vs. Little Endian



### 2.5 Addressing

- <http://www.exploringbinary.com/binary-converter/>

## 3 IPv6

### 3.1 Rationale

- $4x$  address space size increase =  $2^{96}$  address number increase.
- Headers have a fixed size of 40 bytes. Supports extended headers for additional functionality.
- NATs no longer needed due the vast amount of addresses.

### 3.2 Addressing

- 128-bit addresses.
- 8 blocks of 4 nibbles ( $8x4x4 = 128$  bits)
- Consecutive blocks of all-zeroes can be replaced by `::` once.
- No broadcasts, no subnet masks.
- <http://www.iana.nl/assignments/ipv6-address-space/ipv6-address-space.xhtml>

#### Reserved addresses

<code>::/8</code>	Special-purpose
<code>100::/8</code>	Special-purpose
<code>2000::/3</code>	Global unicast
<code>fc00::/7</code>	Unique local unicast
<code>fe80::/10</code>	Link-local (Link-scoped) unicast
<code>ff00::/8</code>	Multicast

#### Special-purpose addresses

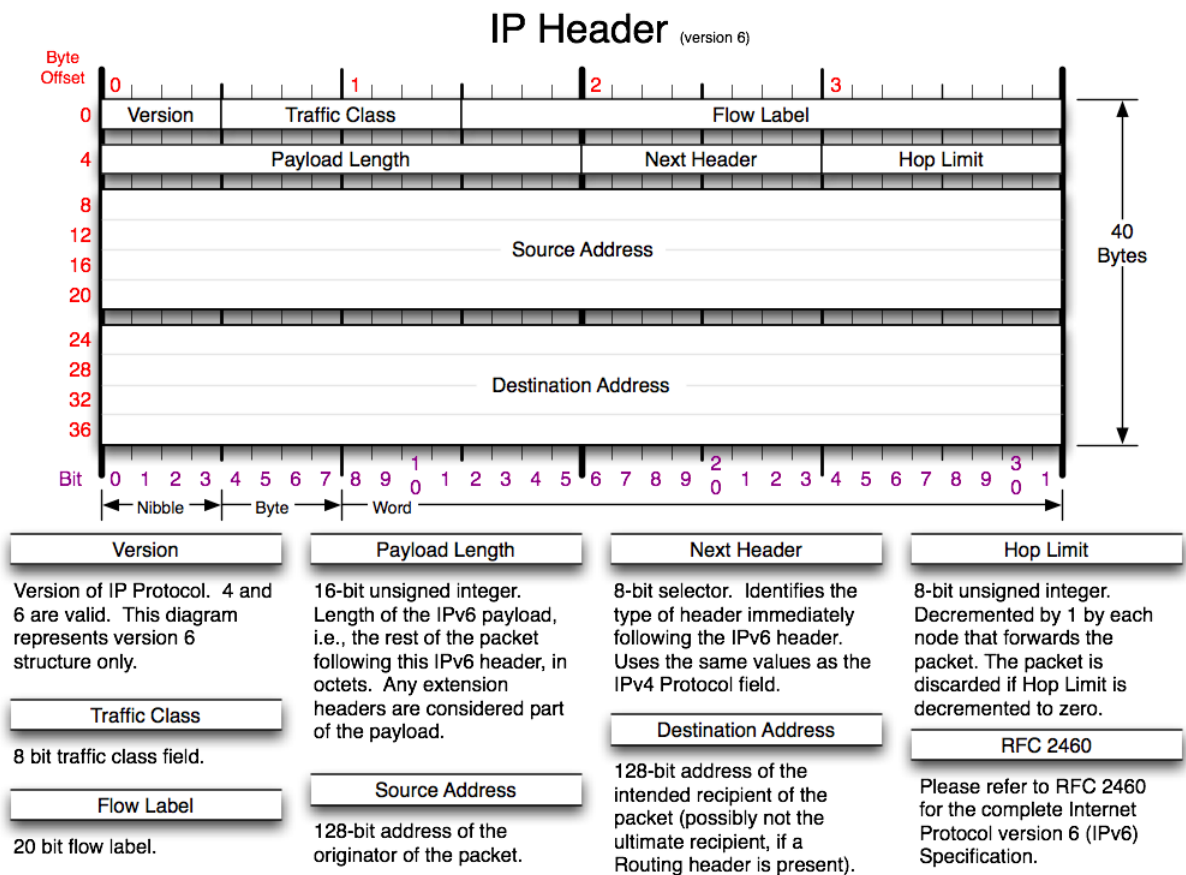
<code>::/128</code>	Unspecified address
<code>::1/128</code>	Localhost address
<code>::a.b.c.d/128</code> (from <code>::/96</code> )	IPv4-compatible addresses
<code>::ffff:a.b.c.d/128</code> (from <code>::ffff:0:0/96</code> )	IPv4-mapped addresses
<code>64:ff9b::/96</code>	Well-known prefix
<code>100::/64</code>	Discard-only address block

### 3.3 Neighbour Discovery Protocol (NDP)

- IPv6 does not use ARP. Uses ICMPv6 instead.
- ICMPv6 types for NDP:

133	Router Solicitation
134	Router Advertisement
135	Neighbor Solicitation
136	Neighbor Advertisement
137	Redirect Message

### 3.4 IPv6 Header



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