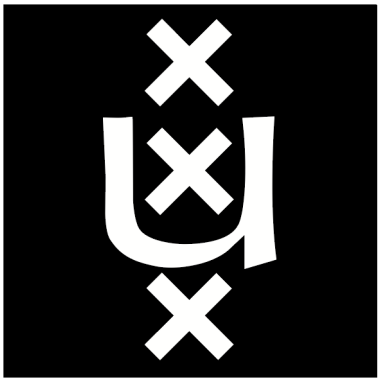
University of Amsterdam

InterNetworking and Routing



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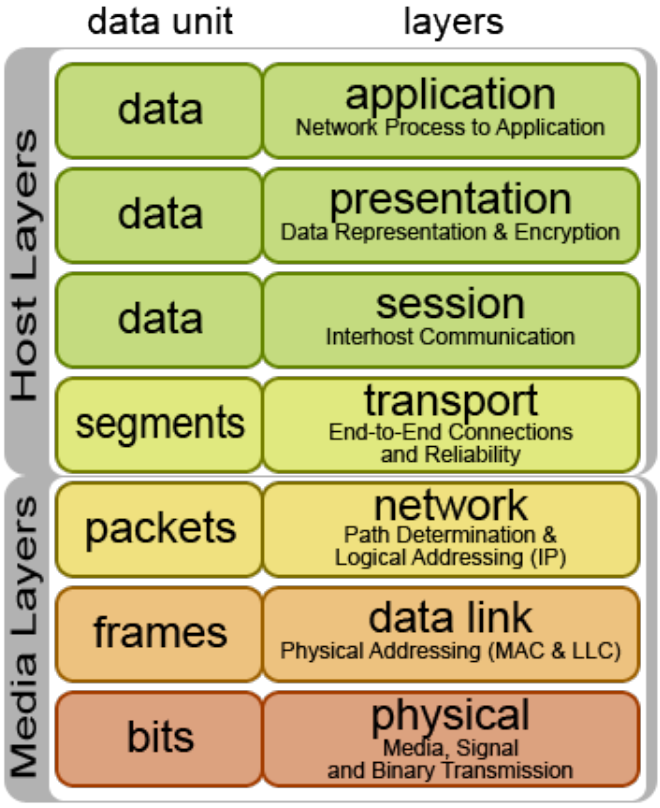
1 Overview

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.[1]

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 =< a,b,c,d =< 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

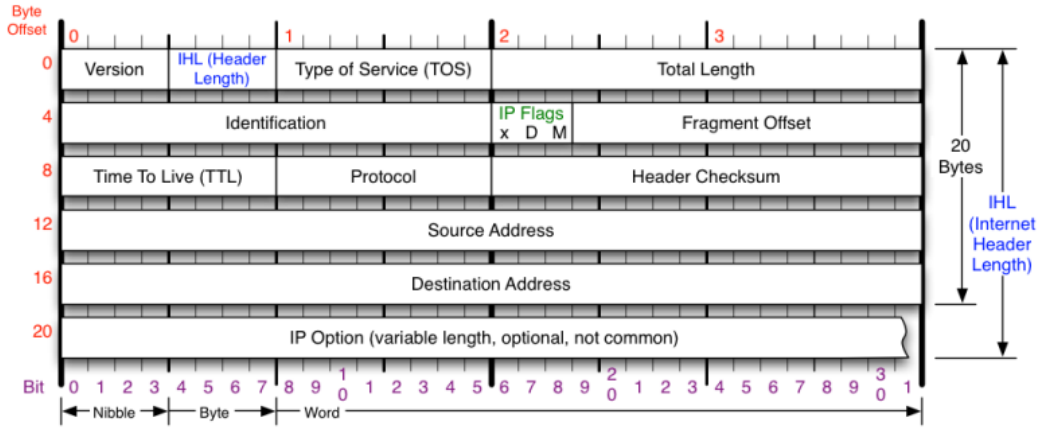
- Originally classful subnetting (subnets in A/B/C ranges, with 24, 16 and 8 bits of network addresses respectively; D range for multicast and an unused E range).[2]
- Classless Inter-Domain Routing (CIDR), with network masks to mark the difference between network address and host address. Routing done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

[1] `http://www.tcpipguide.com/free/t_TCPIPProcessesMultiplexingandClientServerApplicati-2.htm`

[2] `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



Version

Version of IP Protocol. 4 and 6 are valid. This diagram represents version 4 structure only.

Header Length

Number of 32-bit words in TCP header, minimum value of 5. Multiply by 4 to get byte count.

Protocol

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

Total Length

Total length of IP datagram, or IP fragment if fragmented. Measured in Bytes.

Fragment Offset

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.

Header Checksum

Checksum of entire IP header

IP Flags

x D M

x 0x80 reserved (evil bit)
D 0x40 Do Not Fragment
M 0x20 More Fragments follow

RFC 791

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

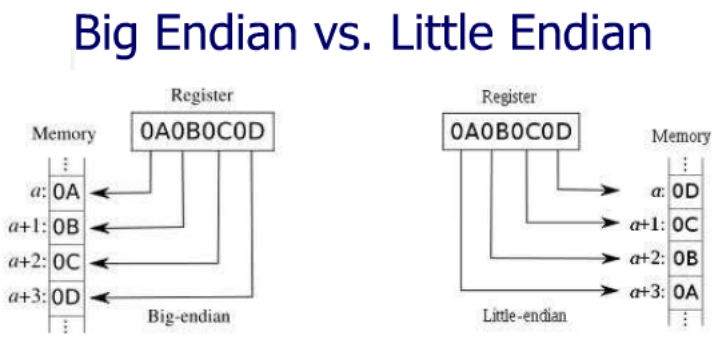
- Everybody knows what Karst thinks of legacy.

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



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`