Network Layer

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COMP nologies

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IP Addresses (1)

- IP address (IPv4) is 32-bit long, written in dotted decimal notation

128.18.3.11

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7	6	5	4	3	2	1	0
0	0	0	1	0			

range: 0-255

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- Addresses are **hierarchical** and c d in **blocks**

  e.g. 256 addresses in the block 128.18.3.0 – 128.18.3.255
- Overall, IP allocation is managed by Internet Corporation for Assigned Names and Numbers (ICANN)

IP Addresses (2)

- network portion + host portion
- **Prefix:** determined by the network portion, all hosts on a single network has the same network portion.
  prefix is written as: lowest address/bit-length
- **Subnet mask**:
- **Extract** prefix: ANDed the IP a the subnet mask

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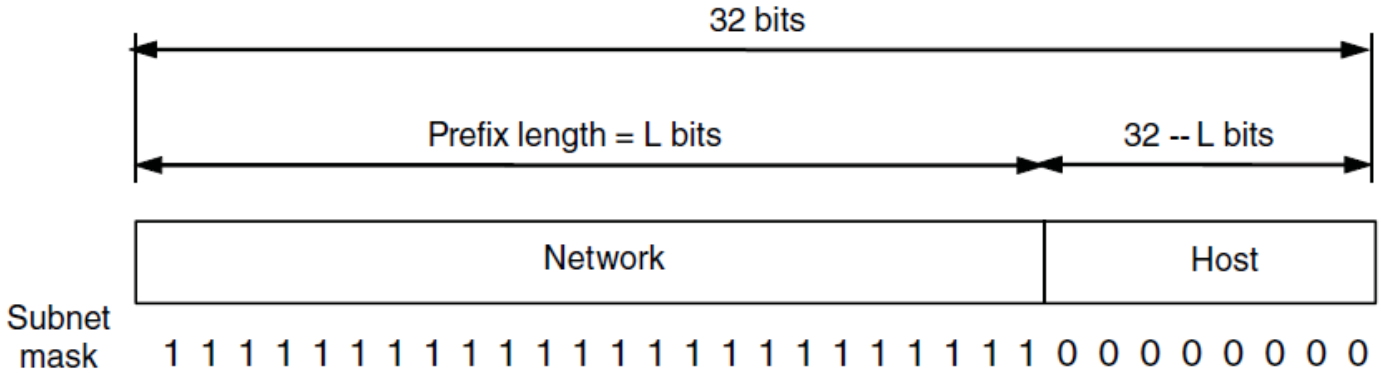

IP Addressing and Routing Tables

- Routing tables are typically built on a triplet:
  - Prefix Address
  - Subnet Mask
  - Outgoing Line
- Example: a ro

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Prefix	Subnet	nterface
128.18.3.0/24	255.255.255.0	Eth 0

Subnets (1)

- Subnetting allows networks to be split into several parts for internal uses whilst acting like a single network for external use

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ISP gives Melbourne Uni a single prefix

Network is divided into subnets internally, but looks like a single prefix outside the network

Subnets (2)

128.208.0.0/16 → number of addresses 2^{16}

block	128.208.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2^{16}
																		=
CS	128.208.	**1**	x									x	x	x	x	x	x	2^{15}
																		+
EE	128.208.	**0**	**0**	x	x	x	x	x	x					x	x	x	x	2^{14}
																		+
Art	128.208.	**0**	**1**	**1**	x	x	x	x	x	x	x	x	x	x	x	x	x	2^{13}
																		+
Left	128.208.	**0**	**1**	**0**	x	x	x	x	x	x	x	x	x	x	x	x	x	2^{13}

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Classless Inter-Domain Routing (1)

- Routing table explosion? Backbone router connecting networks around the world → 300k networks
- Aggregation: process of joining multiple IP prefixes into a single larger prefix to reduce size of routing table

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Classless Inter-Domain Routing (2)

- Packets are forwarded to the entry with the **longest matching prefix** (i.e. smallest address block)
- Complicates forwarding process but adds flexibility

  1) Check address whether matches the longest prefix → /22

  2) If not, then see if it matches /19

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↑ **Except for this part!**

↑ **Main prefix goes this way**

Prefix Address	Subnet Mask	Interface
192.24.12.0/22	255.255.252.0	Eth 0 (to SF)
192.24.0.0/19	255.255.224.0	Eth 1 (to London)

Classless Inter-Domain Routing (3)

192.24.0.0/19 → number of addresses 2^{13} (8192)

London	192.24.	**0**	**0**	**0**	x	x	x	x	x	x	x	x	x	x	x	x	x	2^{13}
																		=
London Cambridge	192.24.	**0**	**0**									x	x	x	x	x	x	2^{11}
																		+
London Edinburgh	192.24.	**0**	**0**	**0**	**0**	**1**	**0**	x	x					x	x	x	x	2^{10}
																		+
San Francisco	192.24.	**0**	**0**	**0**	**0**	**1**	**1**	x	x	x	x	x	x	x	x	x	x	2^{10}
																		+
London Oxford	192.24.	**0**	**0**	**0**	**1**	x	x	x	x	x	x	x	x	x	x	x	x	2^{12}

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Classful Addressing

- Old design: addresses came in blocks of fixed size (Class A, B, C, D, E)
  - Carries size as part of address, but lacks flexibility

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Private IP Ranges

- Range of IP addresses that CANNOT appear on the Internet
- Reserved only for private networks
  - 10.0.0.0/8 (2 [illegible] s)
  - 172.16.0.0/1[illegible]
  - 192.168.0.0 /16 (2^{16} = 65,5[illegible]

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Network Address Translation (NAT)

- NAT box maps one external IP address to many internal IP addresses
  - Uses TCP/UDP port to distinguish connections
  - Violates layering; popular tool in conserving global address space

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IPv6 (1)

- Larger address space: 128-bit address using hexadecimal colon notation

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- Support for more security: encryption and authentication
- Transition: dual stack, tunneling, header translation

IPv6 (2)

- Required fields in IPv6 header (40 bytes)

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Internet Control Protocols

- IP works with the help of several control protocols:
  - **ICMP** (Internet Control Message Protocol) is a companion to IP that returns error info
    - Required, a traceroute, ping
  - **ARP** (Addre finds MAC address of a local IP addre
    - Host queries an address and plies
  - **DHCP** (Dynamic Host Control Protocol) assigns a local IP address to a host
    - Gets host started by automatically configuring it
    - Host sends request to server, which grants a lease

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ICMP

- Used for testing and monitoring ambient conditions between hosts and routers

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