

# Linux Networking: IP addresses

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## IP addresses

- 32 bit numbers
  - 11000000 10101000 00000100 00000001
- Expressed as “dot quads”
  - 192.168.4.1
- Called “IP”s

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## IP addresses - subnet masks

- Given: a pool of address numbers of fixed quantity
- Expresses internal breakdown within an address number to
  - identify a subgroup, and
  - identify a “subaddress” pinpointing the machine within its group

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## IP addresses - subnet groupings

- Decimal: what is 1000 (i.e., one thousand)?
  - 1 group of a thousand?
  - 10 groups of a hundred?
  - 100 groups of ten?
- Binary: what is 1000 (i.e., eight)?
  - 1 group of eight?
  - 2 groups of four?
  - 4 groups of two?

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## IP addresses - subnet groupings

- Decimal: consider address “729”
  - If there is 1 group of a thousand
    - 729 -> 729<sup>th</sup> member of the 1<sup>st</sup> (and only) group
  - If there are 10 groups of a hundred
    - 729 -> 29<sup>th</sup> member of the 7<sup>th</sup> group
  - If there are 100 groups of ten
    - 729 -> 9<sup>th</sup> member of the 72<sup>nd</sup> group

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## The Set of IP addresses

- Is a pool of addresses of fixed quantity
- That quantity is
  - 1 00000000 00000000 00000000 00000000
  - or, about 4 billion
- Is it regarded as a single group of 4 billion?
- No

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## IP addresses - subnet masks

- Applied to IP addresses
  - demarcates “network” and “host” portions
  - by binary and’ing
  - solid 1’s followed by solid 0’s
- 255.255.0.0, or
  - 11111111 11111111 00000000 00000000
- 255.255.255.0, or
  - 11111111 11111111 11111111 00000000
- 255.255.255.248, or
  - 11111111 11111111 11111111 11111000

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## IP AND mask = IP’s network

binary: 11000000 10101000 00000100 00000001  
11111111 11111111 11111111 00000000

dot quad: 192.168. 4. 1  
255.255.255.0

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## Binary AND operation

- ANDing with 1 preserves the input bit
- ANDing with 0 nullifies the input bit

ANDing with **1**:

1 AND **1** is 1

0 AND **1** is 0

ANDing with **0**:

1 AND **0** is 0

0 AND **0** is 0

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## A bit of culture

- 1 is the preserver



Vishnu the Preserver

- 0 is the destroyer



Shiva the Destroyer

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## IP AND mask = IP's network

binary: 11000000 10101000 00000100 00000001  
11111111 11111111 11111111 00000000  
  ↓ 1s' effect    0s' effect ↓  
11000000 10101000 00000100 00000000

dot quad: 192.168. 4. 1  
255.255.255.0

192.168. 4. 0

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## IP AND mask = IP's network

binary: 11000000 10101000 00000100 00000001  
11111111 11111111 11111111 00000000

11000000 10101000 00000100 00000000

dot quad: 192.168. 4. 1 <-- the IP address  
255.255.255.0

192.168. 4. 0 <-- the network thereof

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## Mask subdivision - network|host

- 11000000 10101000 00000100 00000001
- with mask 11111111 11111111 11111111 00000000
  - 11000000 10101000 00000100|00000001
- with mask 11111111 11111111 00000000 00000000
  - 11000000 10101000|00000100 00000001

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## Mask subdivision - network|host

- 192.168.4.1
- with mask 255.255.255.0
  - 192.168.4.0 (designates the network, of 256 addresses)
  - 192.168.4.1 (1<sup>st</sup> of the 256)
- with mask 255.255.0.0
  - 192.168.0.0 (designates the network, of 65536 addresses)
  - 192.168.4.1 (1025<sup>th</sup> of the 65536)

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## Mask notations

- Dot-quad mask
  - 192.168.4.1/255.255.255.0
  - 192.168.4.1/255.255.0.0
- Bitcount mask
  - 192.168.4.1/24
  - 192.168.4.1/16

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## “Class” Addressing (obsolete)

- Allowed only 3 mask values
  - Class A: 11111111 00000000 00000000 00000000
  - Class B: 11111111 11111111 00000000 00000000
  - Class C: 11111111 11111111 11111111 00000000
- Implying only 3 network sizes
  - 16 million
  - 65536
  - 256

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## CIDR – Classless Interdomain Routing (current)

- Allows mask values for any bit boundary, e.g.
  - 11111111 11111111 11100000 00000000, or
  - 11111111 11111111 11111100 00000000, or
  - 11111111 11111111 11111111 11100000, or
  - 11111111 11111111 11111111 11111000, or
- Implying corresponding network sizes of, e.g.
  - 8192
  - 1024
  - 32
  - 8

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## Common netmasks, small LANs

- For groups of 128 (126 machines)
  - 11111111 11111111 11111111 10000000 - 255.255.255.128
- For groups of 64 (62 machines)
  - 11111111 11111111 11111111 11000000 - 255.255.255.192
- For groups of 32 (30 machines)
  - 11111111 11111111 11111111 11100000 - 255.255.255.224
- For groups of 16 (14 machines)
  - 11111111 11111111 11111111 11110000 - 255.255.255.240
- For groups of 8 (6 machines)
  - 11111111 11111111 11111111 11111000 - 255.255.255.248
- For groups of 4 (2 machines)
  - 11111111 11111111 11111111 11111100 - 255.255.255.252

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## Defining a subnet

- A subnet mask
  - Legal “solid-1’s then solid-0’s” number
  - Implies a certain network size
- A network address
  - Boundaried on a multiple of the network size

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## Defining a subnet - example

- Subnet mask 255.255.255.248
  - Legal: 29 1’s followed by 3 0’s
  - Implies network size of 8
  - Illegal examples: 255.255.255.247, 255.255.255.249
- Network address 209.220.186.24
  - Legal: boundaried on 24, a multiple of 8
  - Illegal examples: 209.220.186.23, 209.220.186.25

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## Our example subnet

- 209.220.186.24 – reserved, network's address
- 209.220.186.25 - available for assignment
- 209.220.186.26 - available for assignment
- 209.220.186.27 - available for assignment
- 209.220.186.28 - available for assignment
- 209.220.186.29 - available for assignment
- 209.220.186.30 - available for assignment
- 209.220.186.31 – reserved, network's broadcast address

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## IP addresses - private IPs

- Certain ranges are reserved
  - 10.x.x.x
  - 172.16.x.x ... 172.31.x.x
  - 192.168.0.x ... 192.168.255.x
- Commercial routers refuse to handle them
- For non-internet/intraLAN (private) purposes

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