

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 -> 729th member of the 1st (and only) group
 - If there are 10 groups of a hundred
 - 729 -> 29th member of the 7th group
 - If there are 100 groups of ten
 - 729 -> 9th member of the 72nd 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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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 (1st of the 256)
- with mask 255.255.0.0
 - 192.168.0.0 (designates the network, of 65536 addresses)
 - 192.168.4.1 (1025th 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: bounded 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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