NTNU | Kunnskap for en bedre verden

TTM4175 – Week 35

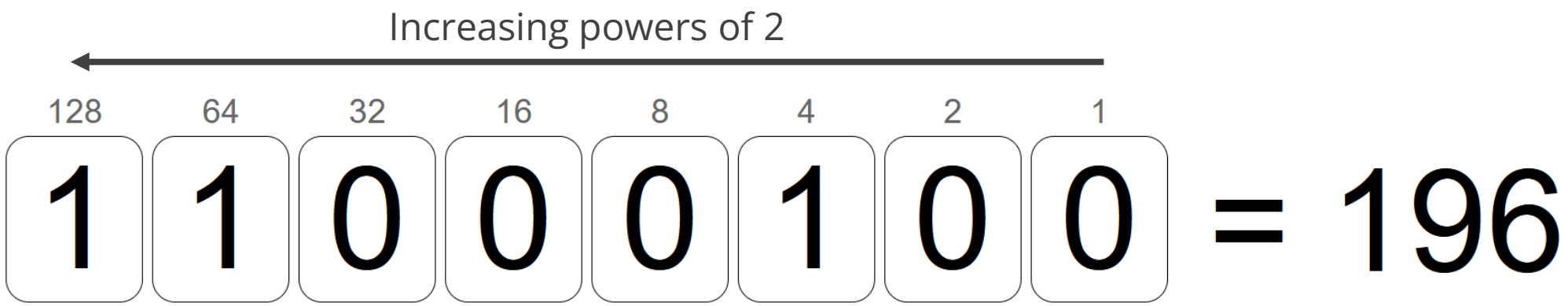
Net 1 – IP Addresses and Binary Representation, Routing

Goals – Week 35

- Understand and apply basic **binary arithmetic**
- Understand **IP addresses** and **subnets**
- Create and configure **Local Area Networks (LANs)**
- Use basic **Linux commands** for managing
  - IP addresses (IPv4 and IPv6)
  - IP subnets and masks

Recap – Binary

- Number system that uses only **bi**nary digi**ts** 0 and 1
- Common grouping: 8 bits = 1 octet = 1 byte
  - Possible values from 0 (0000 0000) to 255 (1111 1111)
- Given n bits, we can represent 2^n numbers
  - 8 bits → 256 numbers, 32 bits → 4 294 967 296 numbers



https://www.advanced-ict.info/interactive/binary.html

Binary Arithmetic – AND Operator

- Defined via **truth table**

a	b	a AND b
0	0	0
0	1	0
1	0	0
1	1	1

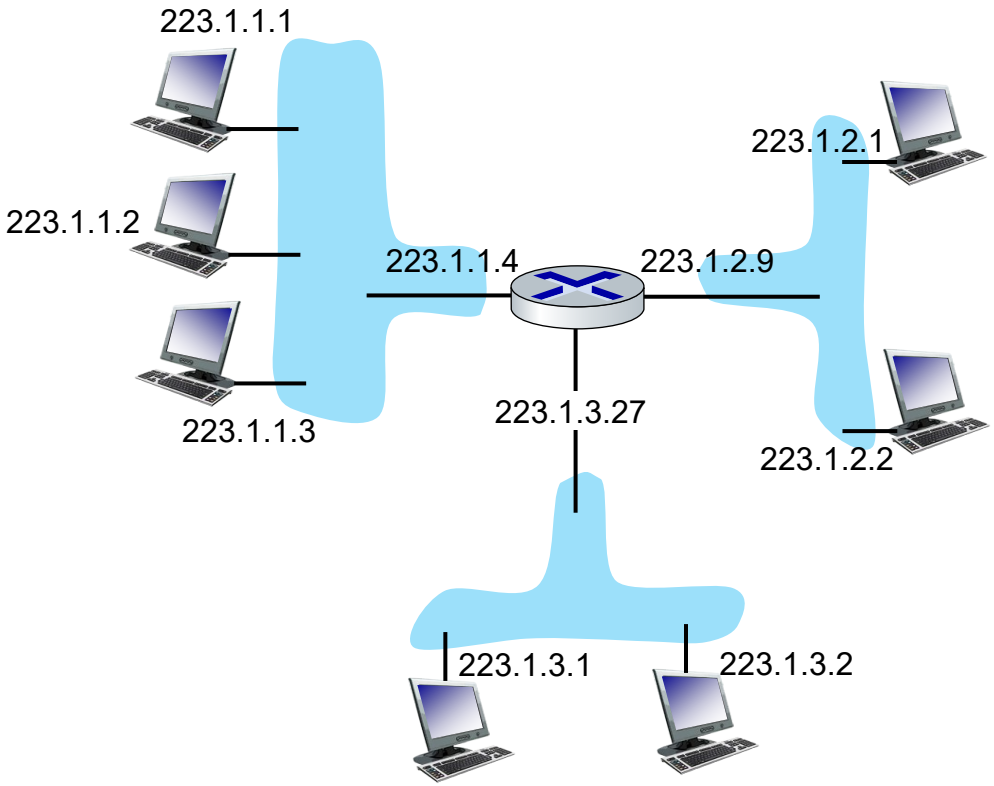
Expression	Value
x_1	1011 0111
x_2	1111 1100
$x_1\ AND\ x_2$	1011 0100

Bit-mask to extract first 6 bits of x_1

- Often used in programming to check multiple conditions
- Bit-wise application to a pair of same-length bit strings allows extracting sub-strings

IP Addressing

- IP address: 32-bit identifier associated with each host or router *interface*
- Interface: connection between host/router and physical link
  - Routers typically have multiple interfaces
  - Host typically has one or two interfaces (e.g., wired, wireless)



Dotted-decimal IP address notation

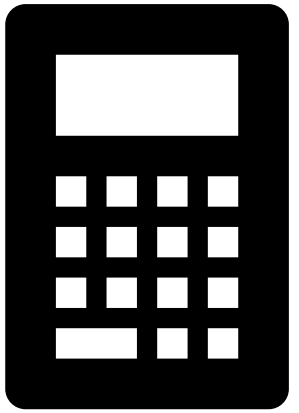
223.1.1.1 = 11011111 00000001 00000001 00000001

223 1 1 1

Binary, IP – Exercise

1. Convert `172.16.254.35` to binary
2. Construct a bit mask to extract the **first 24** bits from the result
3. Apply the mask to the address in 1.
4. Convert the bit mask and the result back to dotted decimal

Check slide 11



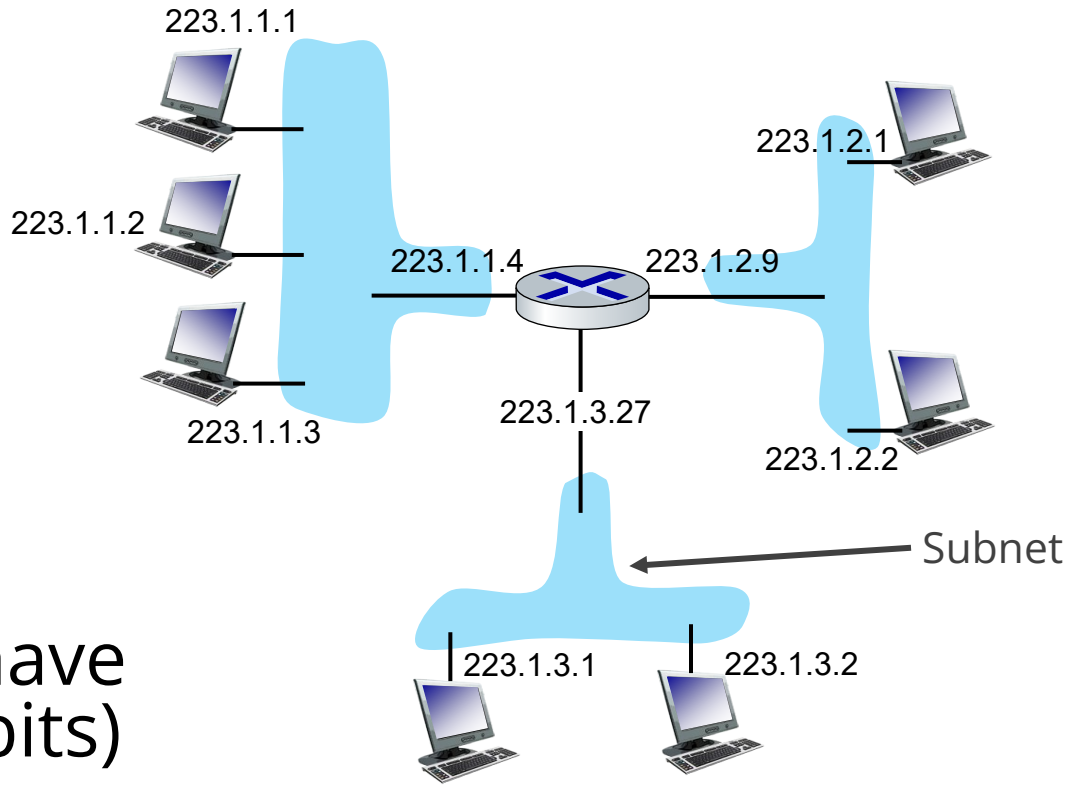
10:00

https://www.advanced-ict.info/interactive/binary.html
https://www.rapidtables.com/calc/math/binary-calculator.html - ! note: use and(&) and not add(+) !

Subnets

- *What's a subnet?*
  - Device interfaces that can physically reach each other without passing through an intervening router
- IP addresses have structure
  - Subnet part: devices in a subnet have common high order bits (=first n bits)
  - Host part: remaining low order bits (=remaining $32 - n$ bits)

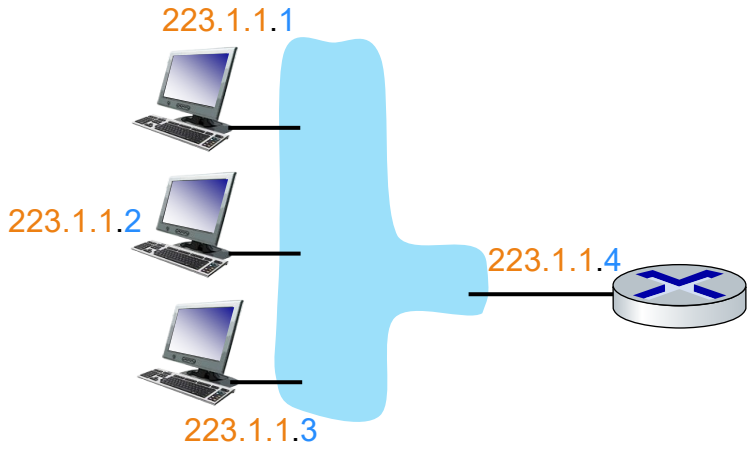
➔ Organization, security, manageability



Network with 3 subnets

Subnets

- IP addresses have structure
  - Subnet part: devices in a subnet have common high order bits (=first n bits)
  - Host part: remaining low order bits (=remaining $32 - n$ bits)



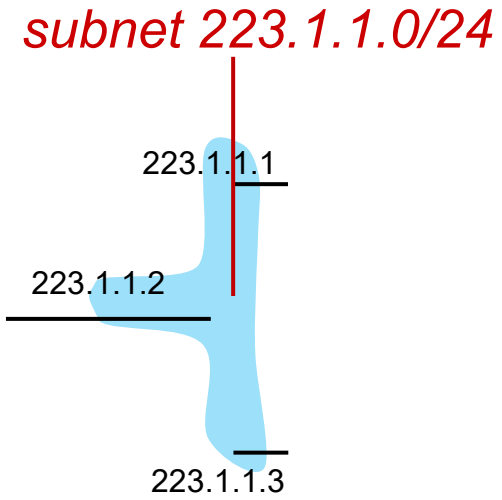
- Subnet mask defines a subnet, determining the size and IP address range of the subnet
  - Here: IP 223.1.1.1 and mask 255.255.255.0
  - Common notation
    - 223.1.1.0/24 to refer to the subnet
    - 223.1.1.1/24 to refer to the IP address

First 24 bits are ones

Subnets – Example

Length of subnet part

- 223.1.1.0/24
- 11011111 00000001 00000001 00000000
- Subnet part, host part
- Available addresses in subnet
  - 11011111 00000001 00000001 00000000
  - 11011111 00000001 00000001 00000001
  - …
  - 11011111 00000001 00000001 11111110
  - 11011111 00000001 00000001 11111111



Special reserved addresses (network address, broadcast address) that **can't** be assigned to an interface

Subnets – Exercise

10:00

- Given the subnet `172.31.207.109/24`,
  1. Determine the first / last address in the subnet
  2. Determine the number of addresses in the subnet
  3. How do the answers to 1 and 2 change in case of a /20 subnet?

https://jodies.de/ipcalc

Private Subnets

- Best practice to use subnets from these ranges when setting up local networks – RFC 1918 https://datatracker.ietf.org/doc/html/rfc1918
  - 10.0.0.0
    - Subnet Mask 255.0.0.0 (/8)
  - 172.16.0.0
    - Subnet Mask 255.240.0.0 (/12)
  - 192.168.0.0
    - Subnet Mask 255.255.0.0 (/16)
- Longer masks commonly used, e.g., 192.168.1.0/24

Remember: The first and last address of a subnet are reserved!

https://www.gns3.com/assets/custom/gns3/images/logo-colour.png

Lab Program Today

- Create your own local network in GNS3
- Learn how to use the CLI to
  - Get interface information
  - Set IP addresses
  - Check connectivity using `ping`
- Explore subnet masks

Next Week: Networking Lab II

- Topics: ports, layers, client-server arch., web servers
- Goals
  - Recognize the importance of ports in networking
  - Understand how computer networking is organized into protocol layers
  - Get familiar with the popular client-server architecture for network-based services and see it applied with a web server
- Preparation material & BB announcement on Monday
- ! Remember the reflections after the lab