

IPv4 addressing and routing

Tecnologie e Servizi di Rete

Computer Network Technologies and Services

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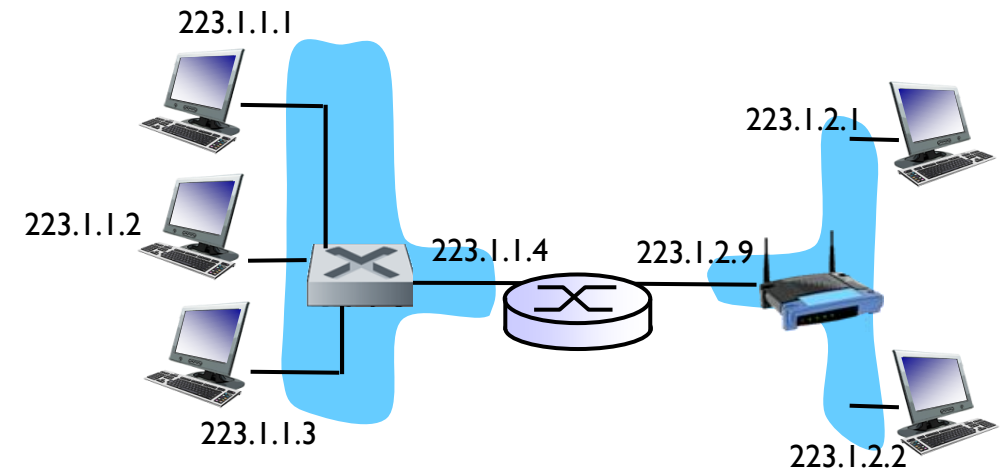
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IP addressing: terminology

- **IP address**: 32-bit identifier for host, router interfaces
- **Network part**: high order bits of the IP address
- **Host part**: low order bits of the IP address
- **IP network**: set of IP devices whose interfaces
 - Have the same network part of the IP address
 - Are connected to the same physical (link-layer) network



IP addressing: special addresses

| | |
|------------|--------------------|
| Some value | All 0s |
| All 1s | |
| Some value | All 1s |
| 127 | Anything (often 1) |

the (sub)network ID

limited broadcast (local net)

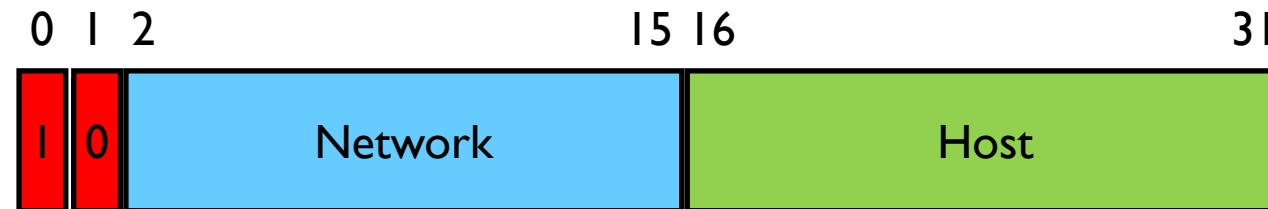
directed broadcast for net

loopback

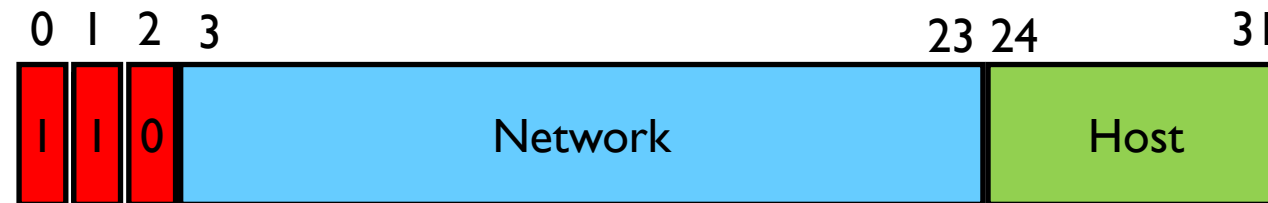
IP addressing classes



Class A – 128 networks – 1st byte: 0-127



Class B – 16K networks – 1st byte: 128-191

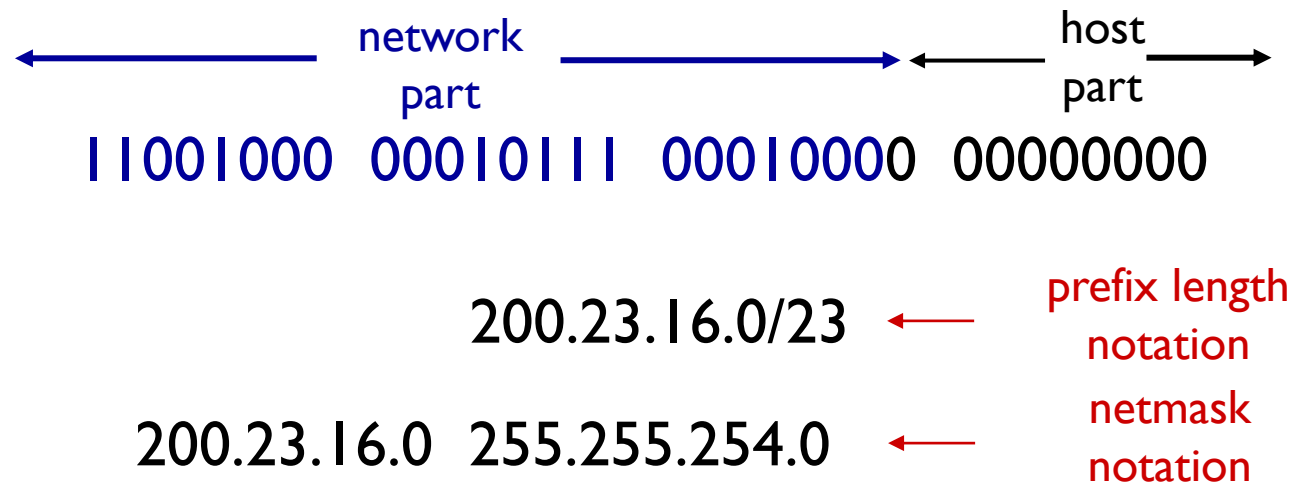


Class C – 2M networks – 1st byte: 192-223

IP addressing: CIDR

■ CIDR: Classless InterDomain Routing

- network portion of address of arbitrary length
- address format: *network ID* + *prefix length* or *netmask*
 - *prefix length*: /x, where x is # bits in network portion of address
 - *netmask*: all '1s' in the network part, all '0s' in the host part



IP addressing: CIDR

- *Valid netmasks*: possible values in the 4 bytes composing the address

| | | | | |
|-----|------|------|-------|------------------------------|
| 0 | 0000 | 0000 | (256) | |
| 128 | 1000 | 0000 | (128) | |
| 192 | 1100 | 0000 | (64) | |
| 224 | 1110 | 0000 | (32) | |
| 240 | 1111 | 0000 | (16) | |
| 248 | 1111 | 1000 | (8) | |
| 252 | 1111 | 1100 | (4) | smaller usable netmask |
| 254 | 1111 | 1110 | (2) | not valid in the 4° byte |
| 255 | 1111 | 1111 | (1) | represents the single device |

IP addressing: CIDR

■ *Some examples*

- 130.192.0.0/16 – 130.192.0.0 255.255.0.0
- 130.192.0.0/24 – 130.192.0.0 255.255.255.0
- 130.192.0.0/25 – 130.192.0.0 255.255.255.128
- 130.192.2.0/23 – 130.192.2.0 255.255.254.0
- 130.192.1.4/30 – 130.192.1.4 255.255.255.252
- ~~130.192.1.0/31 – 130.192.1.0 255.255.255.254~~

Each IP network *must* contain at least the network ID and the broadcast address!

IP addressing: CIDR

■ Valid Network ID

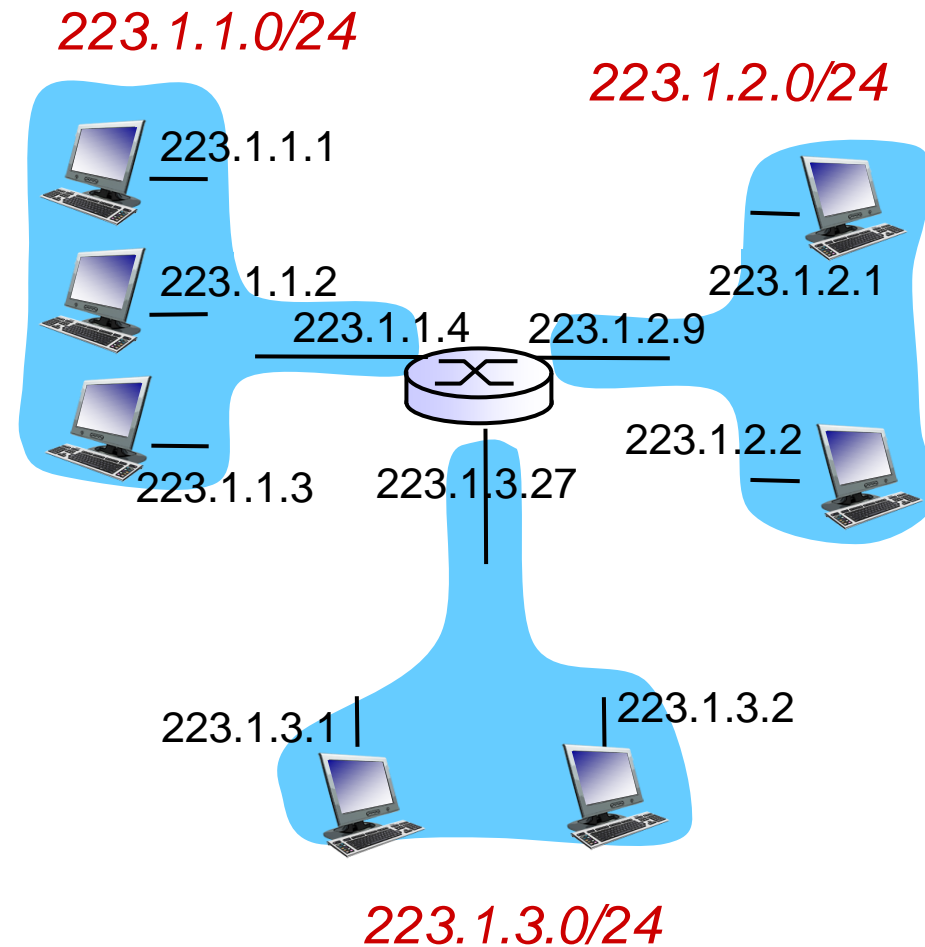
- 130.192.1.4/30
- 130.192.1.16/30
- 130.192.1.16/29

■ Invalid Network ID

- 130.192.1.1/30
- 130.192.1.4/29
- 130.192.1.24/28



IP addressing: a real example



netmask: 255.255.255.0



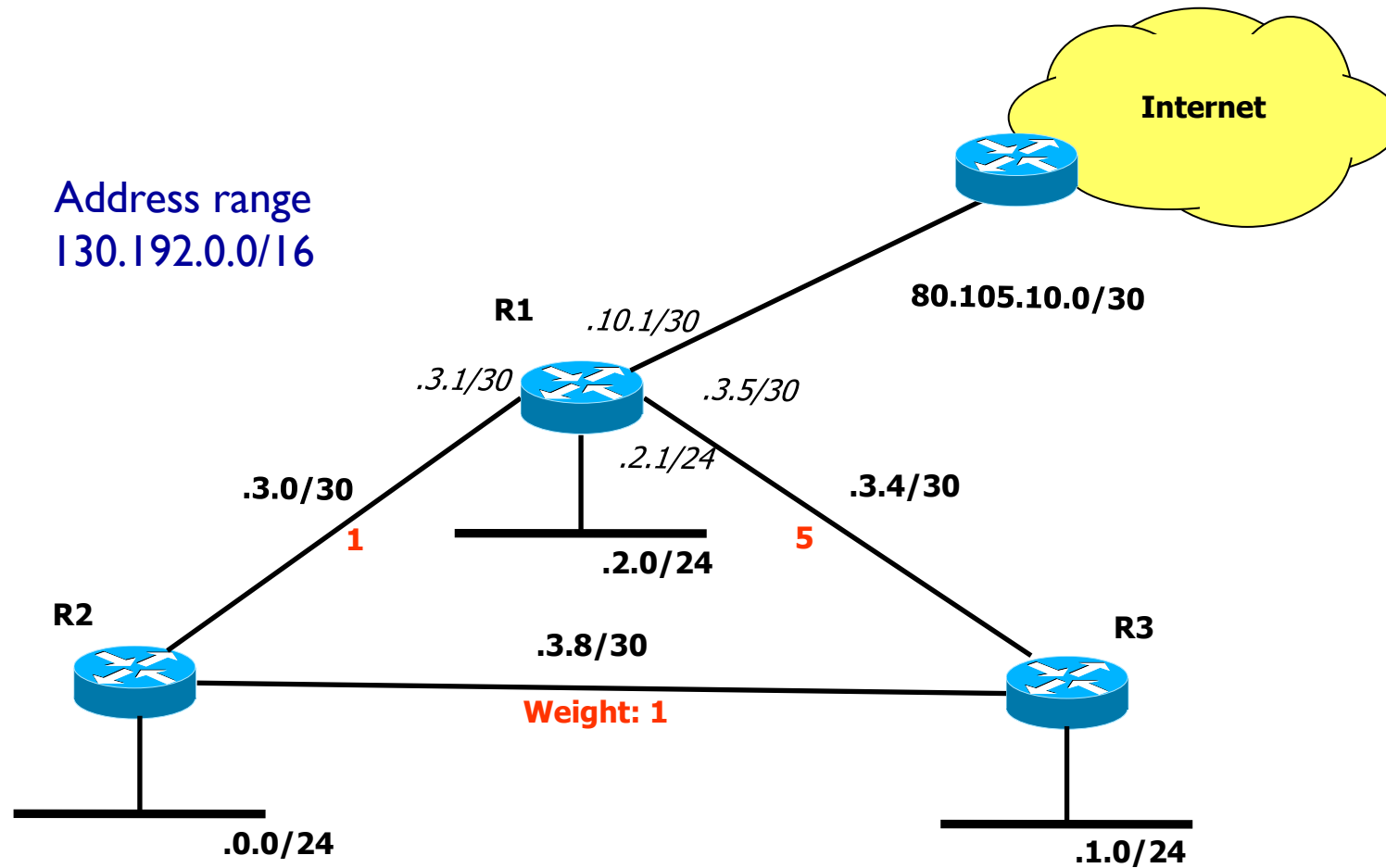
IP routing

- *The general rules:*

- Given a destination IP address to reach, an IP device search its own routing table, looking for a *match*
- In case of multiple matches, it selects the most specific one (*longest prefix matching*)

| routing table | |
|----------------|-------------|
| destination | output link |
| 200.23.16.0/20 | 1 |
| 200.23.18.0/23 | 2 |
| 199.31.0.0/16 | 2 |

IP routing: an example



IP routing: an example

R1 routing table

| <i>Type</i> | <i>Destination</i> | <i>Next-hop</i> | <i>Cost</i> |
|-------------|--------------------|-----------------|-------------|
| S | 130.192.0.0/24 | 130.192.3.2 | 2 |
| S | 130.192.1.0/24 | 130.192.3.2 | 2 |
| S | 130.192.3.8/30 | 130.192.3.2 | 2 |
| S | 0.0.0.0/0 | 80.105.10.2 | 2 |
| D | 130.192.2.0/24 | 130.192.2.1 | 1 |
| D | 130.192.3.0/30 | 130.192.3.1 | 1 |
| D | 130.192.3.4/30 | 130.192.3.5 | 1 |
| D | 80.105.10.0/30 | 80.105.0.1 | 1 |

remote
interface!!

local
interface!!

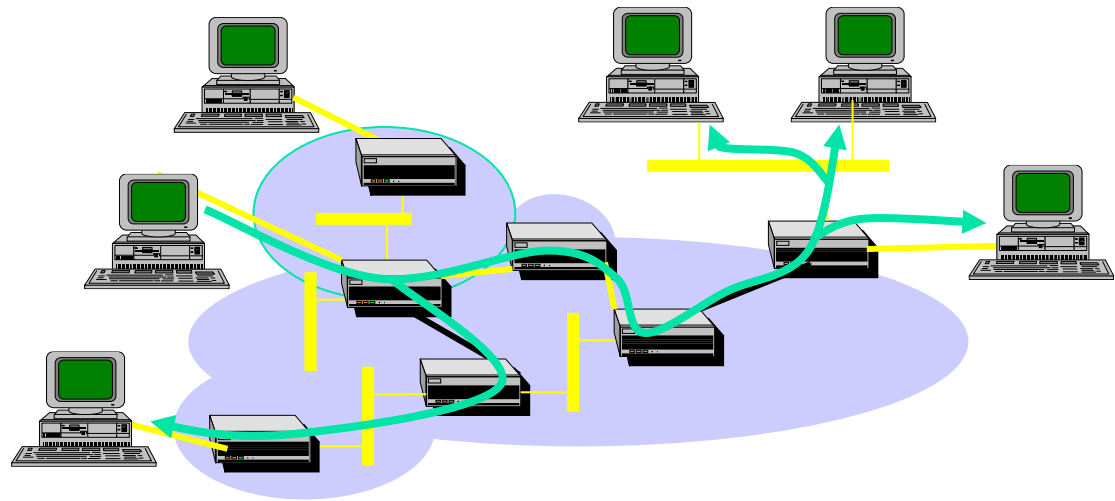


IPv4 Multicast



Underlying Concept

- Packets routed from source to multiple destinations
 - Key for group communication
 - e.g., videoconferencing, video broadcasting
- Address identifies a group



Multicast addressing

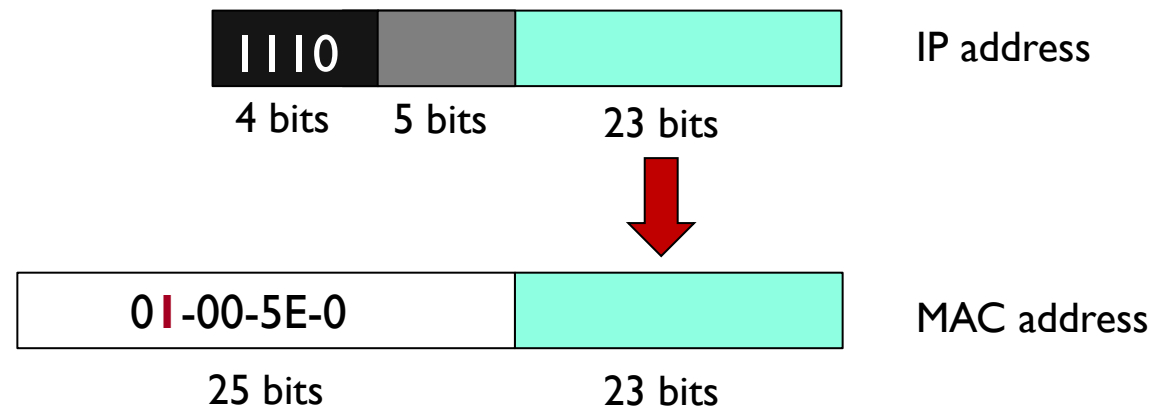
- Class D addresses
 - Begin with 1110
 - 224.0.0.0 - 239.255.255.255
- Address identifies a host group
 - Packet is delivered to all hosts in the group
 - Anywhere in the network

Host Group

- Hosts join and leave dynamically
- Recipients establish which hosts receive a packet
 - In unicast it is the source
 - Controlling traffic reach is more difficult

Within an IEEE 802 Network

- Group delivery delegated to lower level (MAC)
- IP multicast address mapped to a MAC multicast address
 - 0|-00-5E-0 ← 1 bit
 - 23 least significant bits of IP address



Within an IEEE 802 Network

- Interface card configured to receive that MAC multicast
- Recipient-initiated group join

Beyond single networks

- Routers discover host groups on each LAN
 - Internet Group Management Protocol (IGMP)
- Routers announce host groups to others
 - Multicast routing protocols
- Routers build a distribution tree for each host group
 - To all LANs with at least a member

Deployment status

- Not widely supported
- Not fit to common traffic control/engineering practice
- Mostly limited to controlled environments
 - e.g., video broadcasting over IP solutions