IPv4 addressing and routing

Tecnologie e Servizi di Rete

Computer Network Technologies and Services

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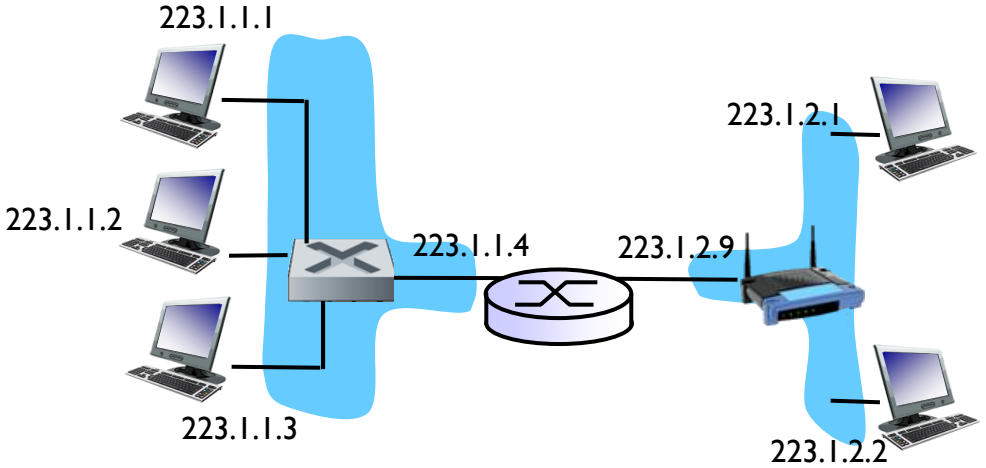
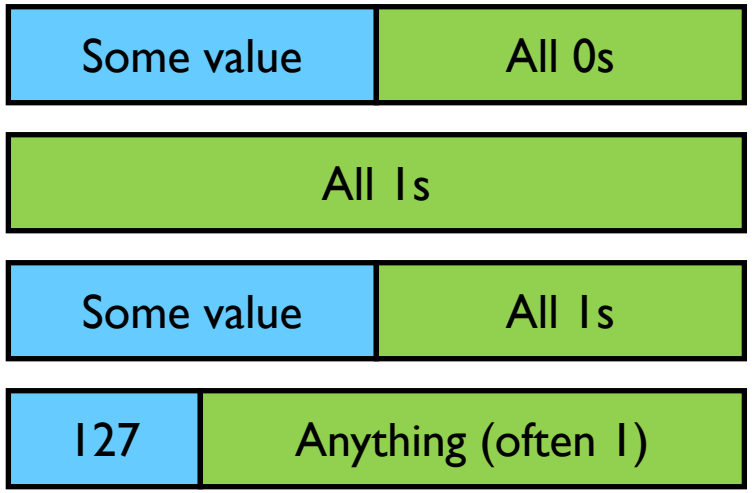
IP addressing: terminology

- *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



the (sub)network ID

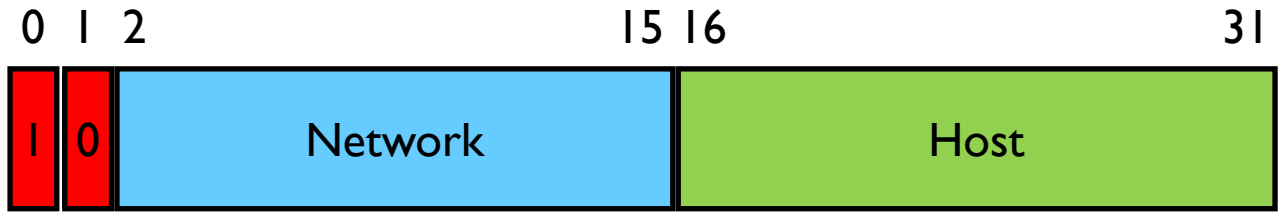
limited broadcast (local net)

directed broadcast for net

loopback

IP addressing classes

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

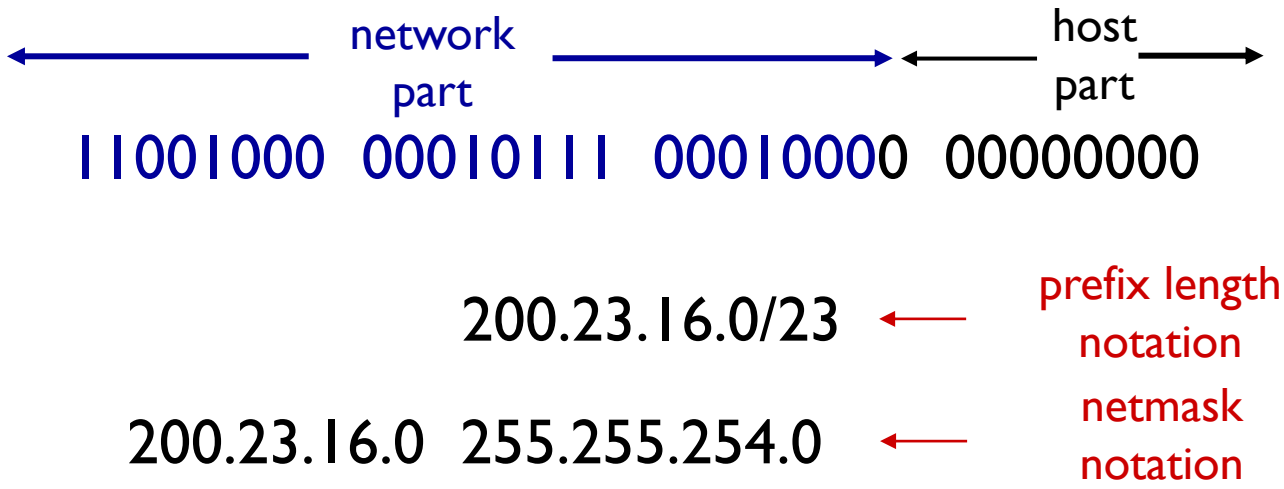


Class B – 16K networks – 1° byte: 128-191

Class C – 2M networks - 1° 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~~

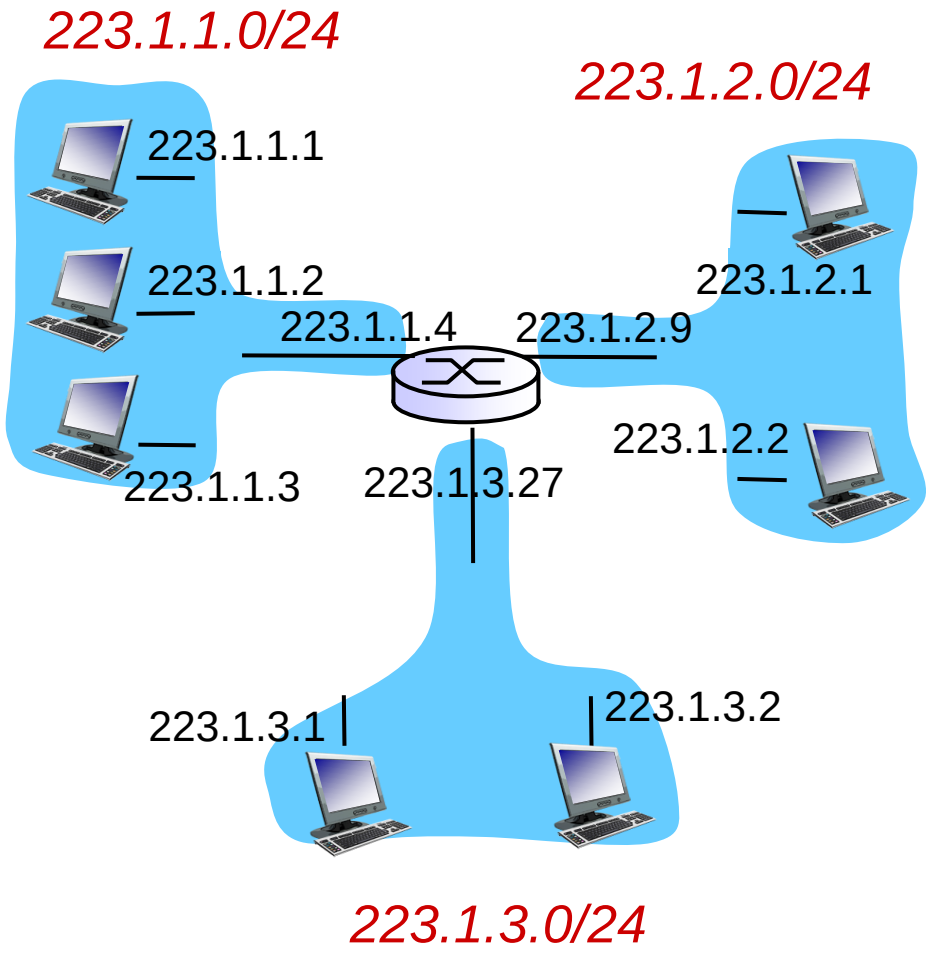
  Each IP network *must* contain at least the network ID and the broadcast address!

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



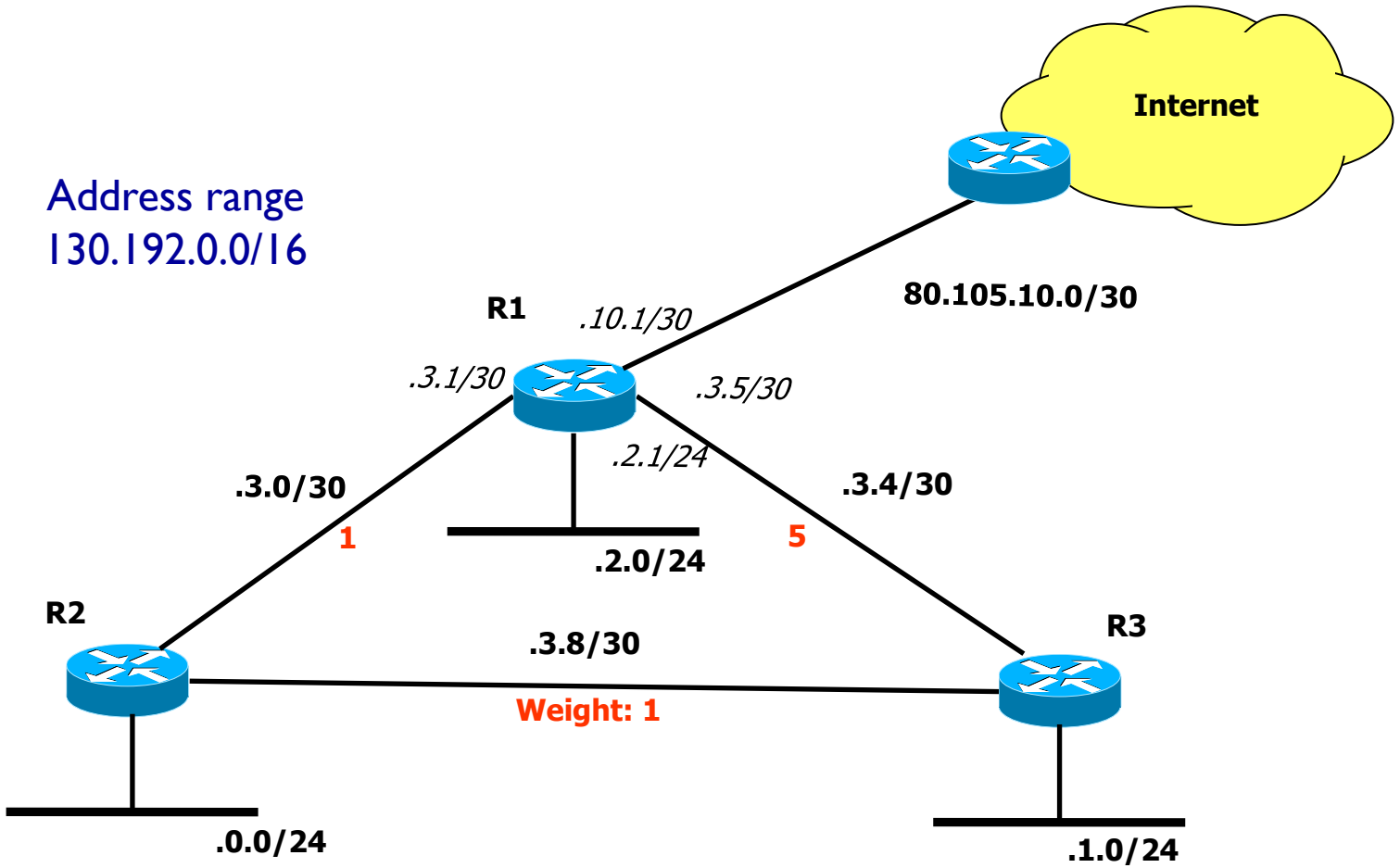
netmask: 255.255.255.0

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

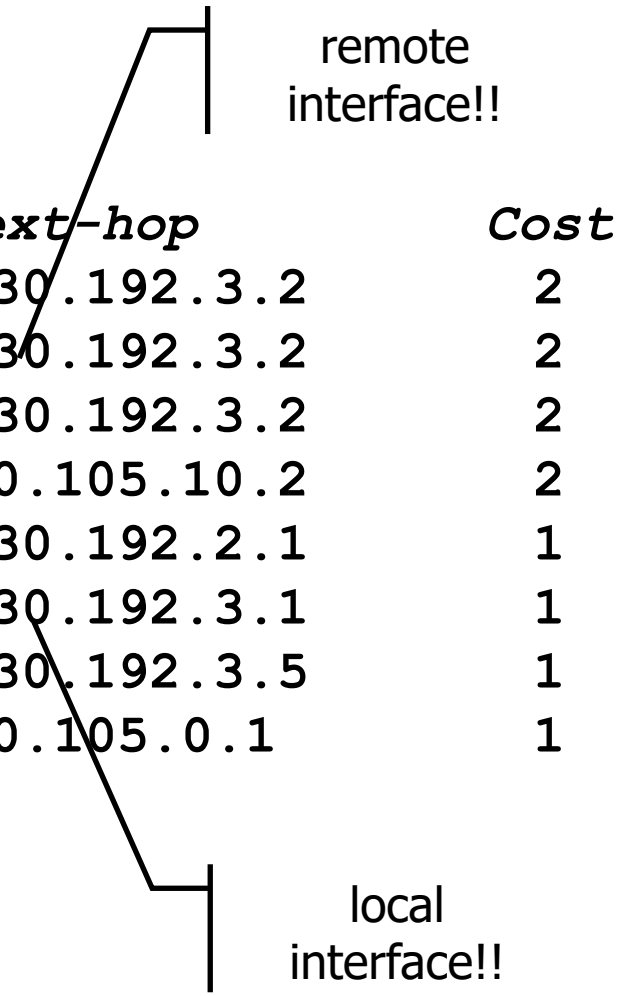
IP routing: an example



IP routing: an example

R1 routing table

Type	*Destination*	*Next-hop*	*Cost*
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

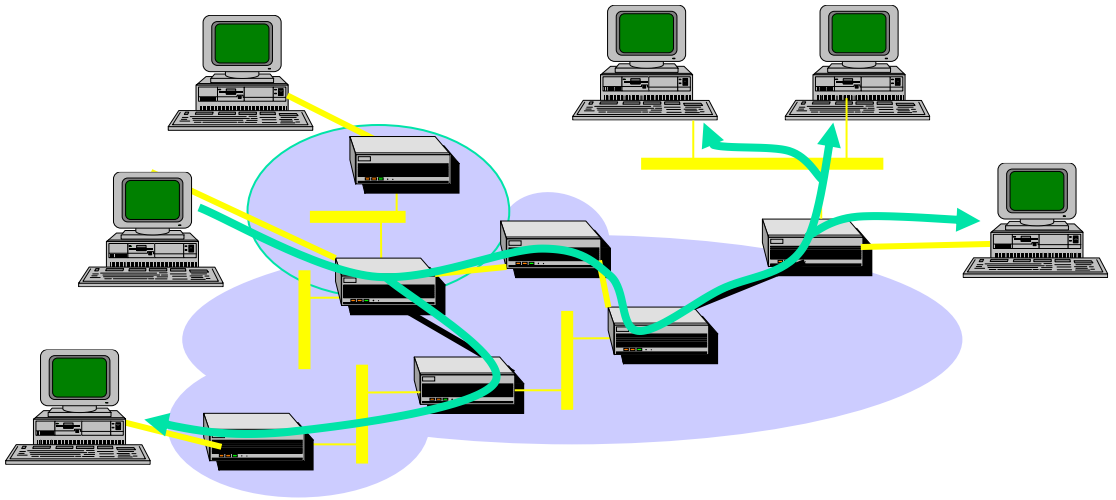


IPv4 Multicast

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

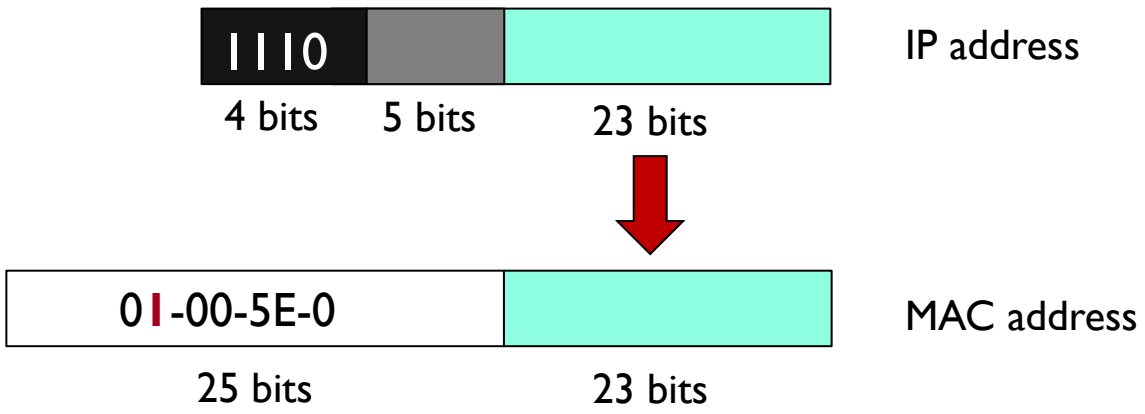
Host Group

- 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
  - 01-00-5E-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