CS 716: Introduction to communication networks

- 14th class; 21st Sept 2011

Instructor: Sridhar Iyer
IIT Bombay

Think-Pair-Share: IP addressing

- What is the need for IP addresses?
  - Why not have only MAC addresses?

- Given that IP addresses are required, come up with a suitable way of structuring them.
  - What are the pros and cons of your solution?
  - Analogy: Think about a post-office.
    - What information needs to be maintained by each post-office in order to route a letter from here to anywhere?

IP Addressing

- Addresses need to be globally unique, so they are hierarchical
- Another reason for hierarchy: *aggregation*
  - reduces size of routing tables
  - at the expense of longer routes

Network layer

- Need:
  - Hide type of subnet
  - Ethernet, Token Ring, FDDI ...
  - Hide topology of subnets

- Provides:
  - Uniform addressing
  - Packet delivery

IP characteristics

- IP can run on
  - Ethernet (CSMA/CD)
  - FDDI (token ring)
  - telephone trunks (SONET or PDH)
  - wireless links (CSMA/CA)
  - satellite links (ALOHA)
  - other technologies like X.25, ISDN
- underlying technology can be upgraded without affecting TCP/IP

Network layer functions

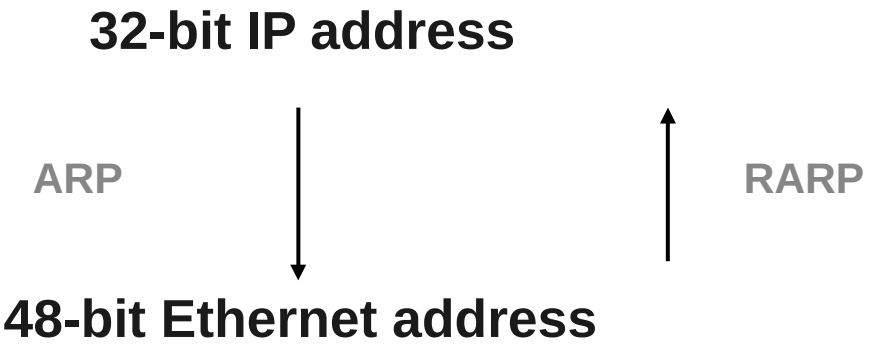
- Internetworking
  - uniform addressing scheme
- Routing
  - choice of appropriate paths from source to destination
- Congestion Control
  - avoid overload on links/routers

Addressing

- Address: byte-string that identifies a node; usually unique
  - physical address: device level
    - Ethernet HWaddr 00:1c:c0:ae:a7:65
  - network address: network level
    - inet addr:10.129.5.151
  - logical address: application level
    - www addr: www.cse.iitb.ac.in

Address Resolution Protocol (ARP) RFC 1010

- Address resolution provides mapping between IP addresses and datalink layer addresses
- point-to-point links don’t use ARP, have to be configured manually



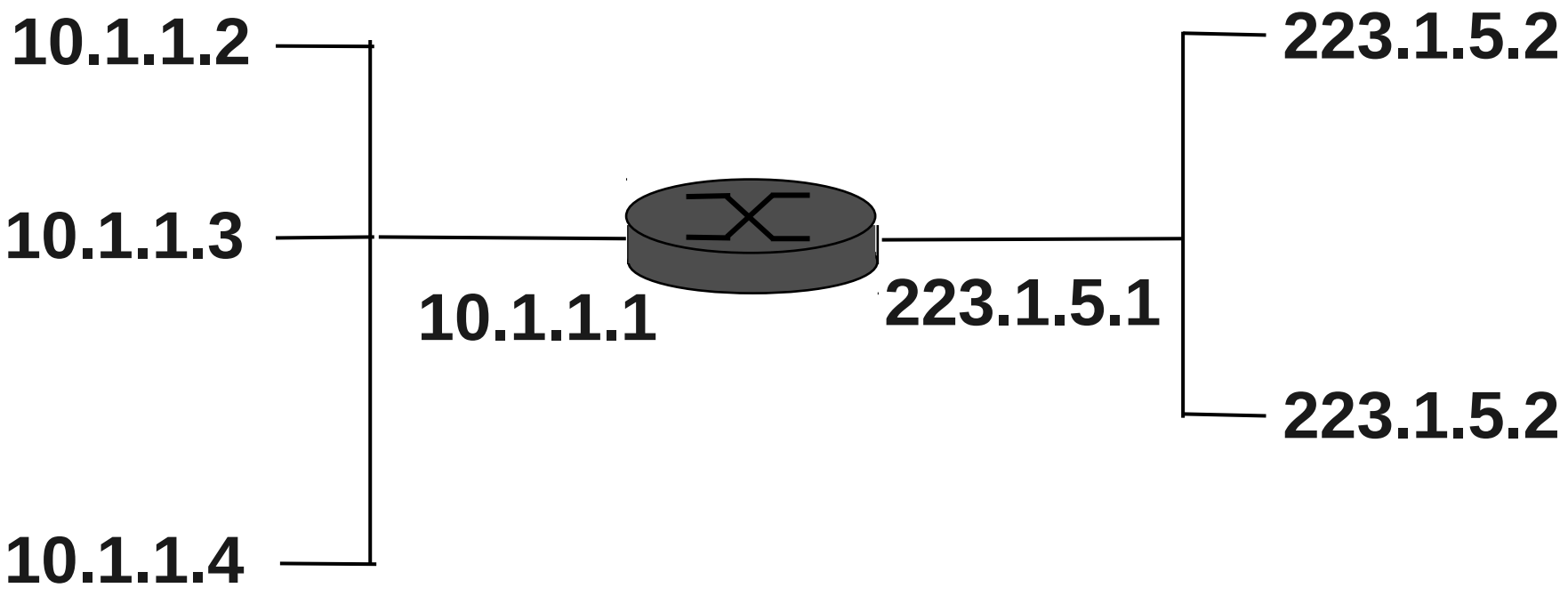
ARP request/reply; cache

- ARP requests are broadcasts
  - “Who owns IP address x.x.x.x.?”.
- ARP reply is unicast
- ARP cache is created and updated dynamically
  - arp –a displays entries in cache
- Every machine broadcasts its mapping when it boots

IP addressing

- Internet Protocol (IP)
  - connectionless packet delivery and “best-effort” quality of service
- Every host interface has its own IP address
- Routers have multiple interfaces, each with its own IP address

IP addressing example



11011111 00000001 00000101 00000010

223 1 5 2

IP forwarding

At a host:

- Destination on my net?
  - If yes, use ARP and deliver directly.
  - If not, give to default gateway.

At a gateway:

- Am I the destination IP?
  - If yes, deliver packet to higher layer.
  - If not, which interface to forward on?
    - consult Routing Tables to decide.

Think-Pair-Share: Address space

- Why 32 bit address space?
- How many bits should be allocated for network number and host number?
- How does a router know which bits to consider for network number and which ones for host number?

IPv4 addresses

- Logical address at network layer
- 32 bit address space
  - Network number, Host number
  - boundary identified by a *subnet m*ask
  - can aggregate addresses within subnets
- Machines on the same "network" have same network number

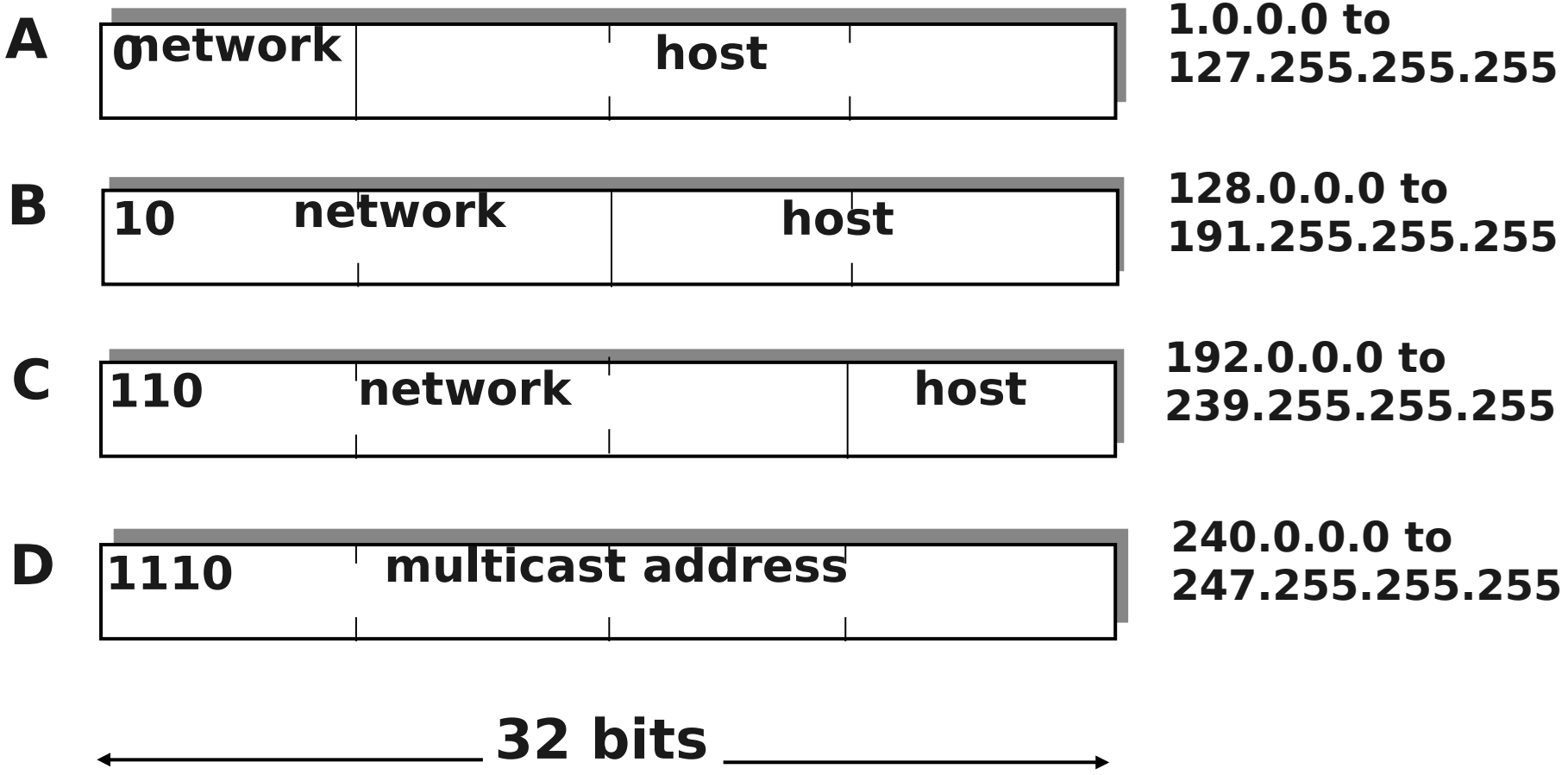
Address classes

- Class A addresses - 8 bits network number
- Class B addresses - 16 bits network number
- Class C addresses - 24 bits network number

- Distinguished by leading bits of address
  - leading 0 => class A (first byte < 128)
  - leading 10 => class B (first byte in the range 128-191)
  - leading 110 => class C (first byte in range 192-223)

IPv4 addresses

class



IPv4 address issues

- Inefficient: wasted addresses
- Inflexible: fixed interpretation
- Not scalable:
  - Number of networks is growing
  - Not enough network numbers

Group Activity – IP addressing

- IPv4 addressing is inefficient due to wasted addresses in class A and class B networks.
- It is also not scalable to growing number of networks.

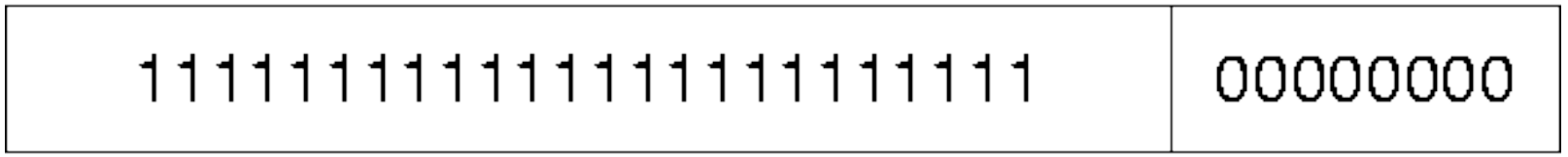
- Design a solution to fix the above IP address inefficiency problems.
  - What are the pros and cons of your solution?

IP addressing schemes

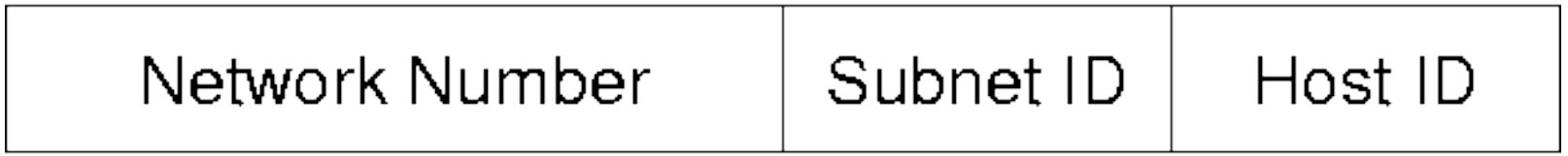
- Sub-netting: Subnet Masks
  - Create sub networks within an address space.
- CIDR: Classless InterDomain Routing
  - Variable interpretations for the network number.
- DHCP: Dynamic Host Configuration Protocol
  - Assign addresses dynamically from a pool.
- NAT: Network Address Translation
  - Private IP addresses within intranet; Translate to a public IP address at gateway before internet access. So reuse is possible.
- Ipv6: 128 bit address space

Subnet mask

Class B address



Subnet Mask (255.255.255.0)



Subnetted Address

Subnet addressing

- Internal routers & hosts use subnet mask to identify “subnet ID” and route packets between “subnets” within the “network”
- Subnet mask can end on any bit
- Mask must have contiguous 1s followed by contiguous zeros. Routers do not support other types of masks.

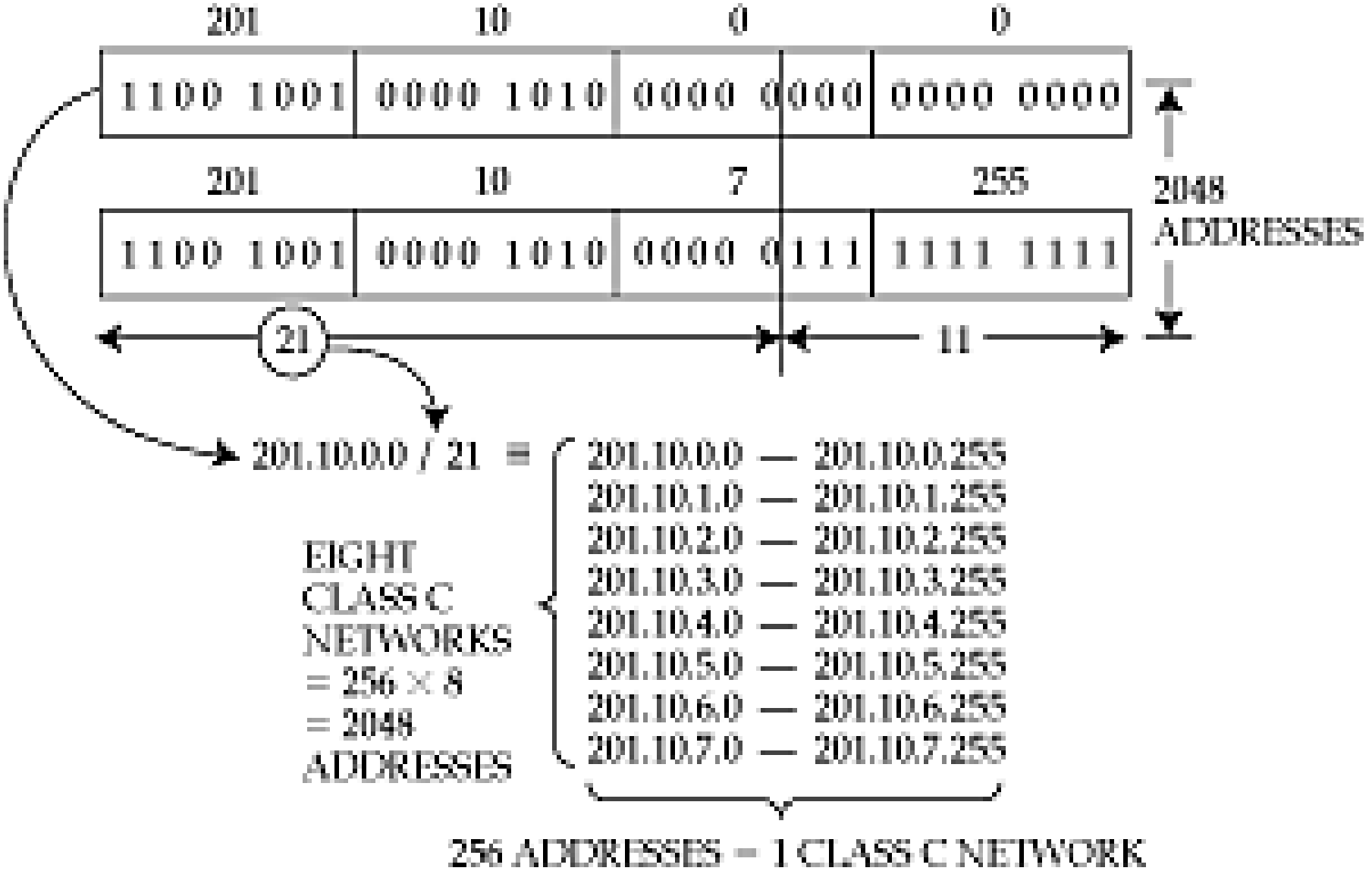
VLSM: variable length subnet mask

- Multiple different masks possible in a single class address space
  - Eg: 255.255.255.0 and 255.255.254.0 could be used to subnet a single class B address space
  - Allows more efficient use of address space

Classless Inter Domain Routing (CIDR)

- Medium sized networks choose class B addresses, leading to wasted space
  - allow ways to represent a set of class C addresses as a block, so that class C space can be used
  - use a CIDR mask

CIDR


201
10
0
0
1100 1001
0000 1010
0000 0000
0000 0000
201
10
7
255
1100 1001
0000 1010
0000 0111
1111 1111
2048
ADDRESSES
21
11
201.10.0.0 / 21 =
201.10.0.0 — 201.10.0.255
201.10.1.0 — 201.10.1.255
201.10.2.0 — 201.10.2.255
201.10.3.0 — 201.10.3.255
201.10.4.0 — 201.10.4.255
201.10.5.0 — 201.10.5.255
201.10.6.0 — 201.10.6.255
201.10.7.0 — 201.10.7.255
EIGHT
CLASS C
NETWORKS
= 256 × 8
= 2048
ADDRESSES
256 ADDRESSES = 1 CLASS C NETWORK

Closure

- Self-study:
  - Read about CIDR (Classless Interdomain Routing).
- Tutorial question:
  - Given an IP address 144.16.116.2 and subnet mask 255.255.255.192. Identify the Net:Subnet and the Host parts of the IP address.