IP Layer: IP Routing:
ARP and Broadcast Domains

ECE 50863 – Computer Network Systems

LAN Addresses and ARP

32-bit IP address:

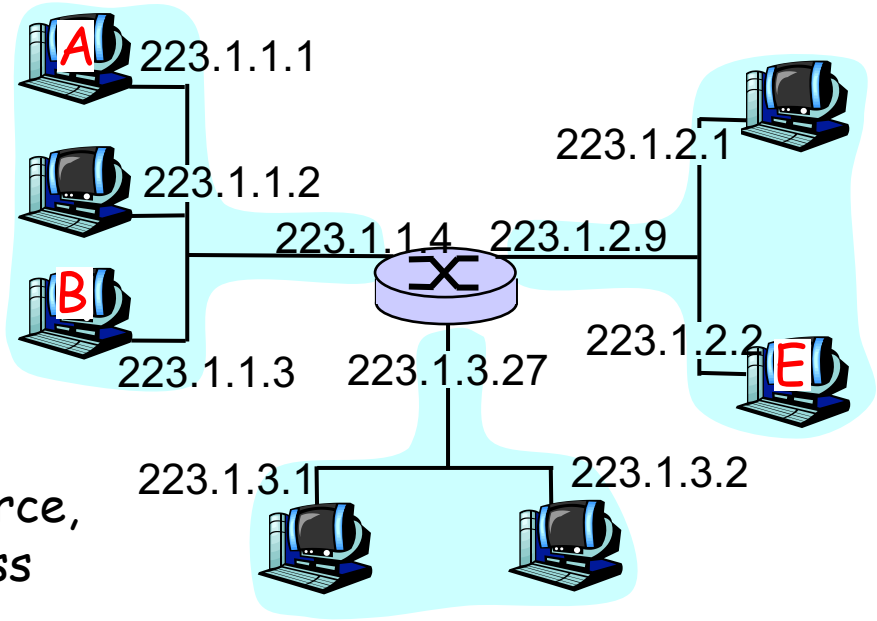
- *network-layer* address
- used to get datagram to destination network

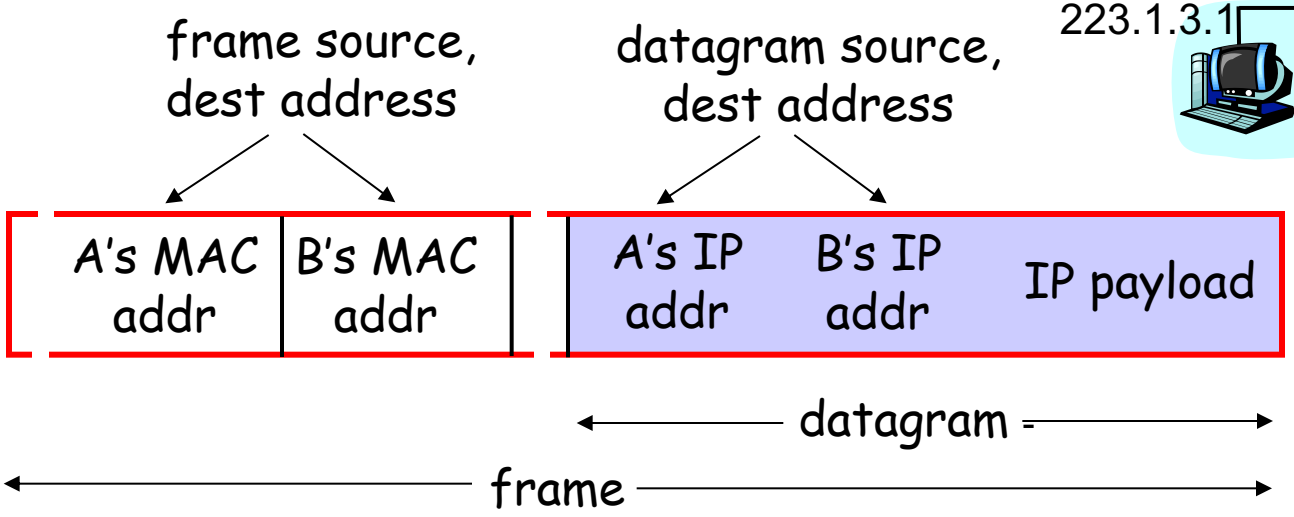
LAN (or MAC or physical) address:

- used to get datagram from one interface to another physically-connected interface (same network)
- 48 bit MAC address

LAN addresses (more)

Question: how to determine MAC address of B given B's IP address?

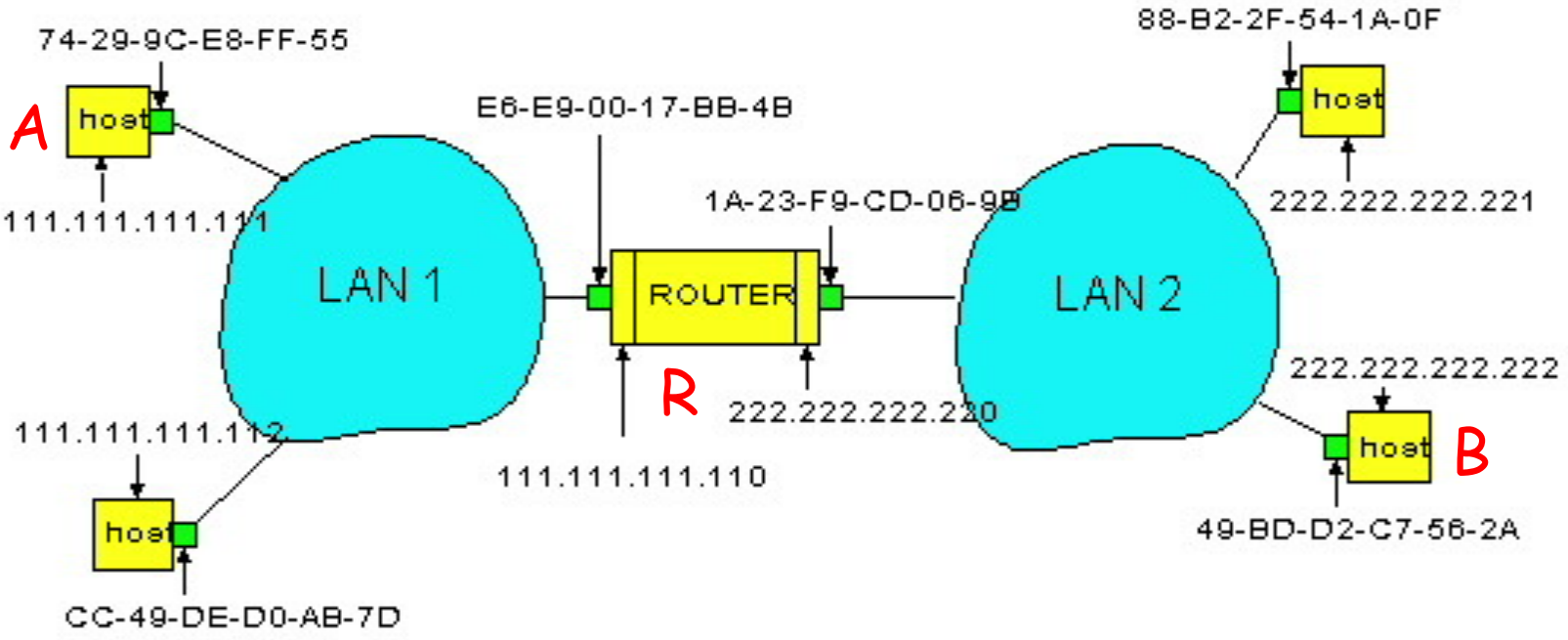




ARP protocol

- A first determines if B on the same interface of the router
- A knows B's IP address, wants to learn physical address of B
- A broadcasts ARP query pkt, containing B's IP address
  - all machines on LAN receive ARP query
- B receives ARP packet, replies (unicast) to A with its (B's) physical layer address
- A caches (saves) IP-to-physical address pairs until information becomes old (times out)
- ARP Table: IP/MAC address mappings for some LAN nodes
  - < IP address; MAC address; TTL>
  - TTL (Time To Live): time after which address mapping will be forgotten (typically 20 min)

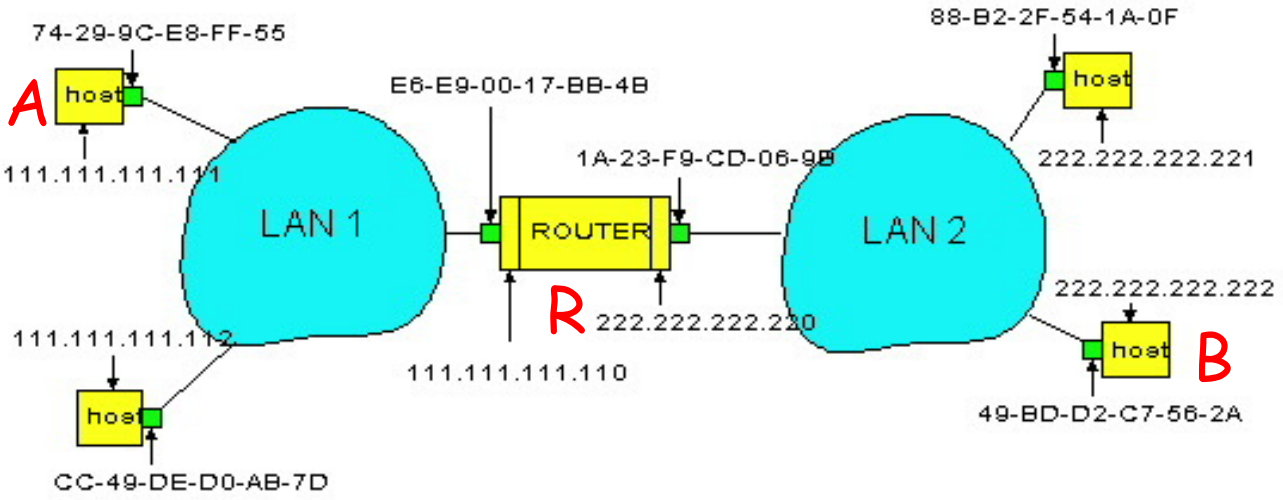
Transfer across Networks



- A creates IP packet with source A, destination B
- A uses ARP to get R's physical layer address for 111.111.111.110
- A transmits Ethernet frame with R's physical address as dest
- R removes IP datagram from Ethernet frame, sees IP destination is B
- R uses ARP to get B's physical layer address
- R creates frame containing A-to-B IP datagram with MAC source and destination being R and B respectively.

A's MAC	R's MAC	A's IP	B's IP	IP payload

R's MAC	B's MAC	A's IP	B's IP	IP payload

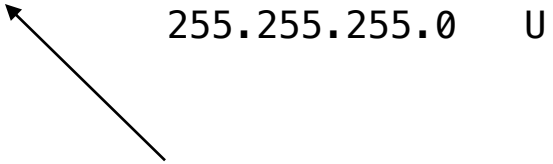


How to determine if destination is on the same interface?

```
netstat –rn

Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0         128.46.4.1      0.0.0.0         UG        0 0          0 p3p1
128.46.4.0      0.0.0.0         255.255.255.0   U         0 0          0 p3p1
```

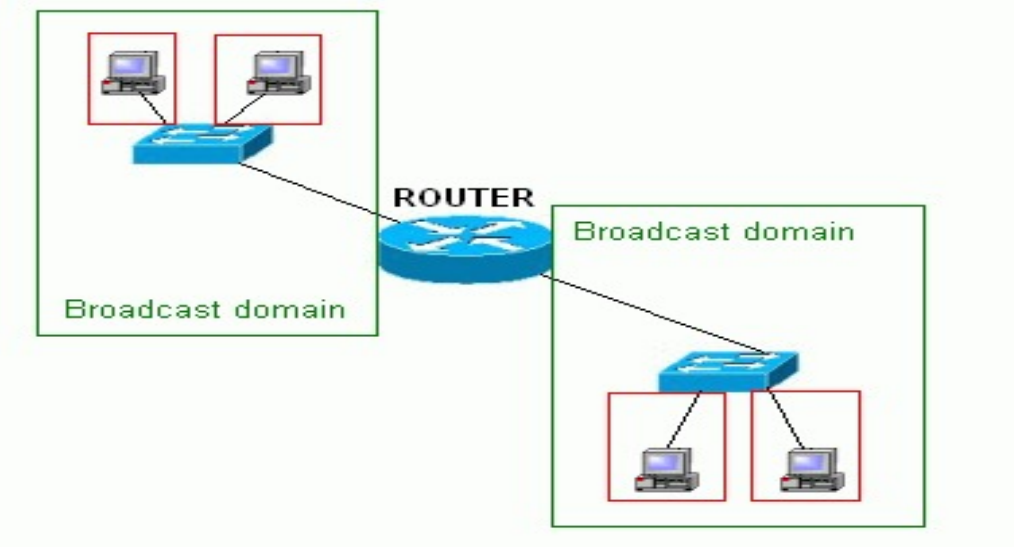
Destinations 128.46.4.*
are on the same interface



All other destinations
are reachable via Gateway
128.46.4.1

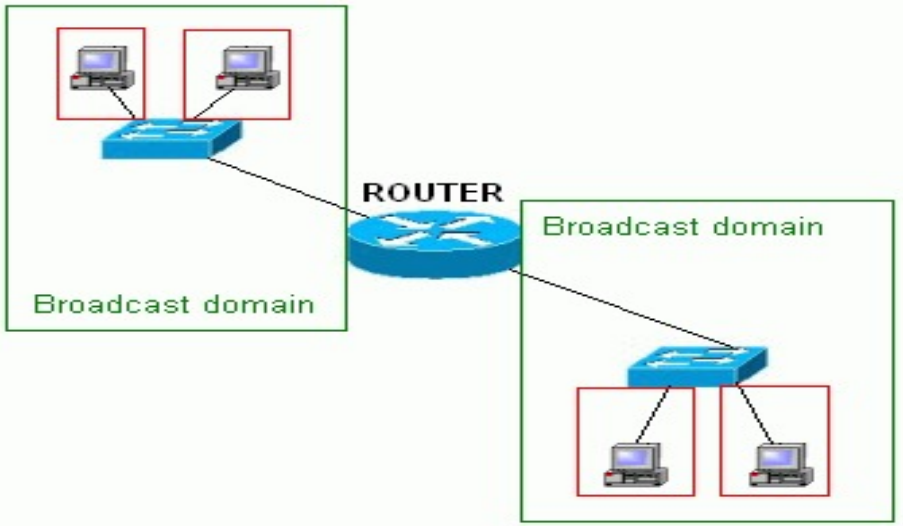
Example routing table on a Purdue computer

Broadcast Domain



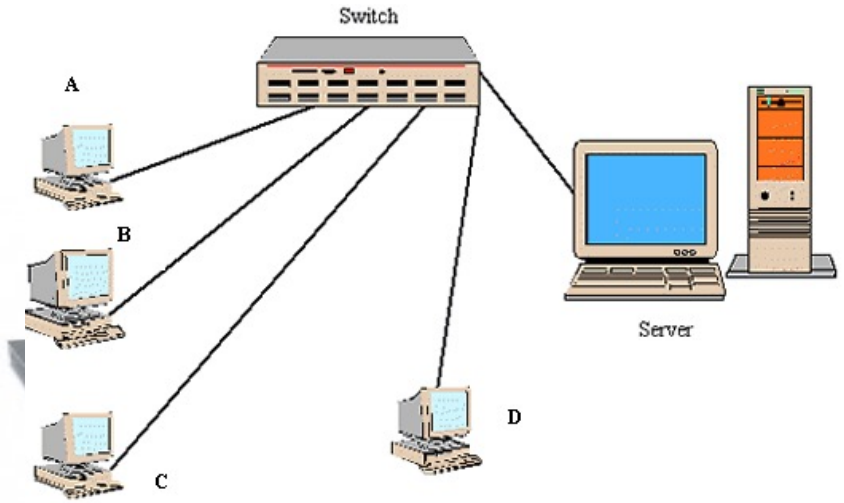
- Broadcast Domain: 2 hosts in same broadcast domain if a broadcast packet (e.g. ARP packet) sent by one of the hosts will also reach the other host.
- Different than “Collision Domain”.
- Collision Domain: logical network segment where data packets can "collide" with one another for being sent on a shared medium at the same time.

What is a Router?



- Router: networking device - forwards data packets across an inter-network.
- Routers operate on Layer 3 of OSI model and use IP address information of the destination to forward the packet.
- Will not propagate broadcast packets (ARP)
- Are not Plug-and-play devices, hosts connected to the routers need their IP addresses to be configured.
  - Router must be configured to indicate packets of certain subnet must be directed on particular interface.
  - IP address of host must be carefully configured to match subnet it is on.
  - Host also configured with router information (typically)

Contrast: Switch



- Switch: Networking device that operate on Ethernet frames – Layer 2 devices
- Forward pkts to the destination's MAC address.
- Plug-and-Play devices - Self-configuring without hardware or software changes.
- Will propagate broadcast packets (ARP)
- Will not show up in output of "traceroute"

- Example:
  - Host A can have arbitrary MAC address. No "rule" dictating what it should be.
  - Switch will learn address of A over time.
  - A need not be configured with information about the switch.

Physical View of a LAN