Date 30:04:2024

CSE421 - Computer Networks - SEQ

Lecture 15 — Data link layer

1. Nodes - hosts + routers
2. Links - wired / wireless links
3. PDU - Frame (H + Data + T)

Where is this layer implemented? [H/W]

↳ Network interface card (NIC)

↳ MAC address is set here.

IP Address	MAC Address
* 32 bits (8×4)	* 48 bits (8×6)
* Decimal notation	* 12 Hex digits (6 blocks)
* Network layer	* data link layer
* Hierarchal (tree structure)	* Flat
↳ has levels	↳ has no levels
* Not portable	* Portable
↳ cannot take your network IP wf you	↳ can carry your device to anywhere [same regardless of the network]

cannot derive multiple MAC from one MAC device ↳ no branching

MAC Address

00-10-65-C0-00-01

OUI — Organizationally unique identifier

NIC — Network Interface Controller

1st octet last bit → 0 : unicast, 1 : multicast

2nd last bit → 0 : globally unique (given by org)

1 : locally administered (changed according to your use)

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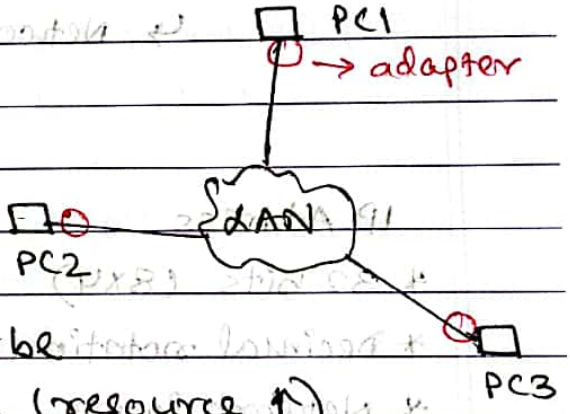
Types of MAC Addresses – (I) Unicast
(II) Multicast – ["01-00-5E" in an IPv4 multicast packet]
(III) Broadcast – [FF-FF-FF-FF-FF-FF] (all devices)
↳ destn MAC

LAN addresses and ARP –

* each adapter on LAN has unique addresses.
* ARP – address resn protocol
* Both IP + MAC are needed.
  - ↙ Identify host
  - ↘ identify device



* MAC of so many devices cannot be stored due to storage issues (resource ↑)
* Packet sent wf IP but also needs MAC; the MAC is resolved using ARP.
* ARP matches the IP of the device wf the given IP wf the packet. The response is the MAC Address.

Example – ARP (same network)
↳ Destn IP ✓
ARP packet → Broadcast MAC (all F) | Destn IP | } Destn

↳ sends to all devices and matches IP → reply → unicast to S.
↳ not matched; ARP packet dropped

ARP response (unicast) to Sender → source MAC = Receiver

ARP table – maintains TTL
↳ storage

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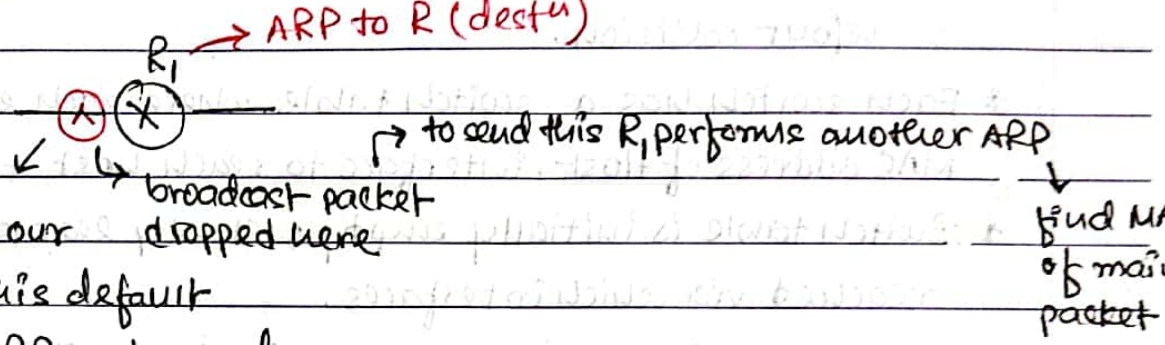
Example – ARP (different network)

ARP Protocol is broadcasted – dropped at router; cannot leave network
So ARP is done step by step.
Router performs ARP in this case.



We will send our packet till this default gateway. ARP performed to find MAC of default gateway and so can send the packet there.

↳ contains IP address of receiver.

Then, R has destn IP and MAC both. → forwards the actual packet to the destination (Receiver).

If there were more routers, then each router would perform an ARP to find the destn MAC address.

Switching –

* data link layer device; stores and forwards Ethernet frames
* examine incoming frame's MAC address + selectively forward frame to one/more outgoing links when frame is to be forwarded on segment, uses CSMA/CD to access segment.
* Switches are transparent → hosts are unaware of their presence
* Plug-and-play + self-learning → switches do not need to be configured. ↳ just give connection; learns MAC address when frame passes through the switch and can find out the paths to destn w/out configuration.

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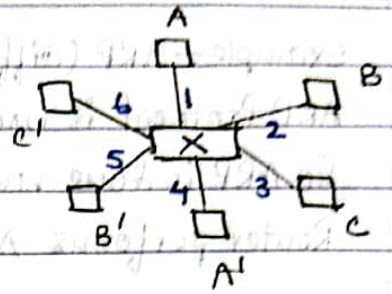
* Hosts have dedicated DC w/ switch
* full duplex; Ethernet protocol on each incoming link w/no collisions
* each link is its own collision domain.

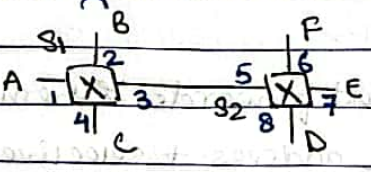


Ex. A → A' B → B' at the same time w/out collision.

* Each switch has a switch table where each entry contains MAC address of Host, interface to reach host + time stamp.
* Switch table is initially empty; slowly learns which hosts can be reached via which interfaces.
* whenever switch receives a frame, it checks if it has an entry of this frame in its table or else it stores the entry.
* Does not have entry of the Receiver so switch broadcasts it to all the devices → devices that do not match w/ Dest^n IP + MAC will drop the packet; device that matches, if sends a reply then the entry is stored in switching table.
* For known host mappings, unicast is used instead of broadcast.
* Switch also has memory and TTL for entries.

filtering - you have entries forwarding - send

(*) Interconnecting Switches —



A → D : does not know so flood. (both S1 + S2)

S1 →

MAC	Port
A	1

S2 →

MAC	Port
A	5
D	8

(*) Comparison betn Switches + Routers —

Switch	Routers
* Data link layer	* Network layer
* learns forwarding table using flooding + learning + MAC addresses	* compute tables using R. Algorithms and IP addresses

Similarity → store + forward → have forwarding tables