COMPUTER NETWORKS

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Unit – 5 Link Layer and LAN Roadmap

- Introduction
- Error detection, correction
- Multiple access protocols
- LANs
  - Addressing, ARP
  - Ethernet
  - Switches
- A day in the life of a web request
- Physical layer
- Wireless LANs: IEEE 802.11

Class 51 : Link Layer Switches : Learning Objectives

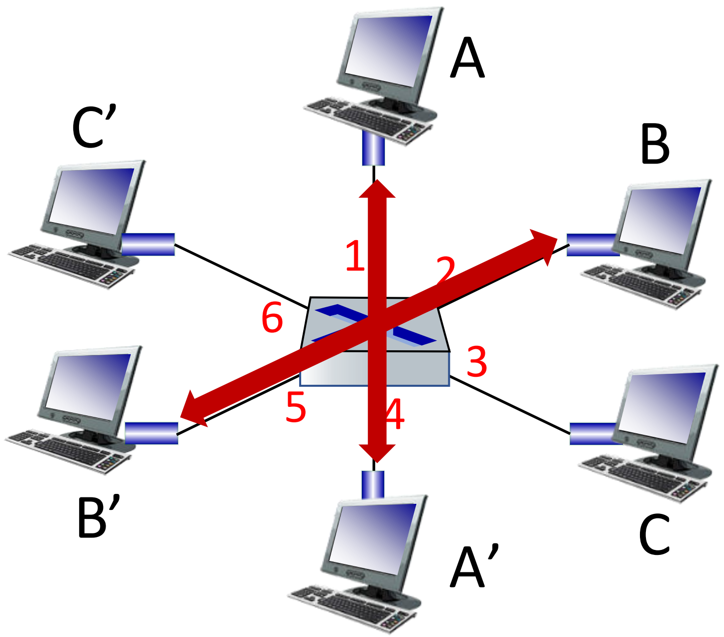
- Multiple Simultaneous Transmissions
- Frame Forwarding and Filtering

Ethernet switch

- Switch is a link-layer device: takes an *active* role
  - Store, forward Ethernet frames
  - Examine incoming frame's MAC address,
  - *selectively* forward frame to one-or-more outgoing links,
  - uses CSMA/CD to access segment
- Transparent: hosts *unaware* of presence of switches
- Plug-and-play, self-learning
  - Switches do not need to be configured

Switch : Multiple Simultaneous Transmissions

- Hosts have dedicated, direct connection to switch
- Switches buffer packets
- Ethernet protocol used on *each* incoming link, so:
  - no collisions; full duplex
  - each link is its own collision domain
- Switching: A-to-A' and B-to-B' can transmit simultaneously, without collisions



switch with six interfaces (1,2,3,4,5,6)

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  - No collisions; full duplex
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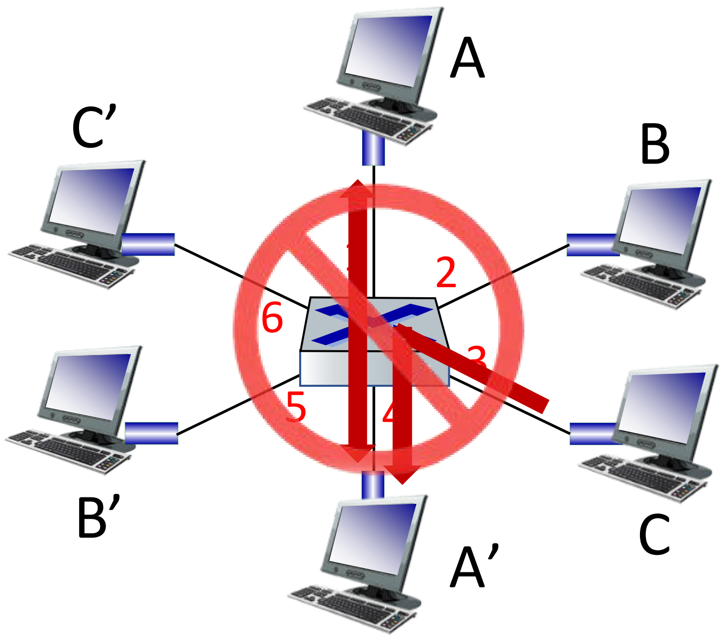
- Switching: A-to-A' and B-to-B' can transmit simultaneously, without collisions
  - but A-to-A' and C to A' can *not* happen simultaneously



switch with six interfaces (1,2,3,4,5,6)

Switch Forwarding Table

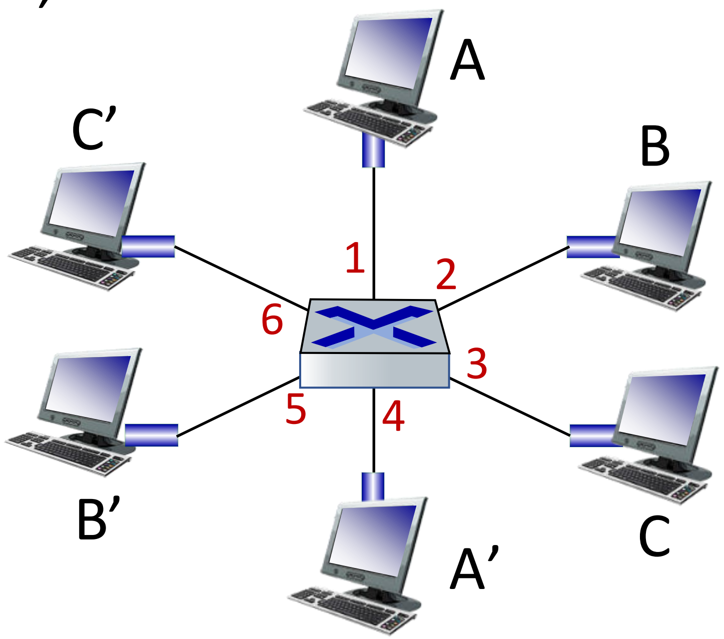
Q: How does switch know A’ reachable via interface 4, B’ reachable via interface 5?

A: Each switch has a switch table, each entry:

- (MAC address of host, interface to reach host, time stamp)
- looks like a routing table!

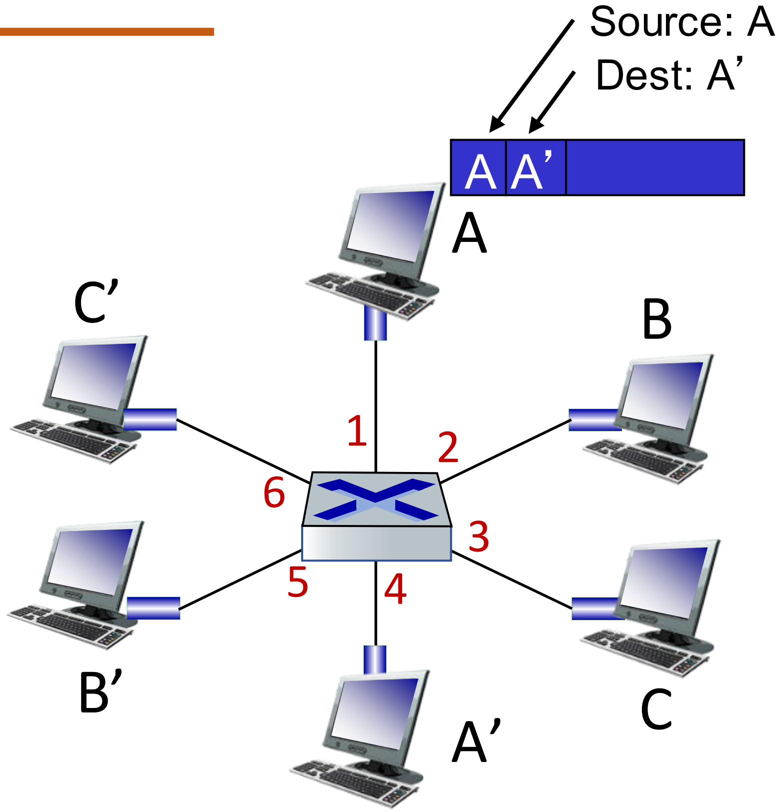
Q: How are entries created, maintained in switch table?

- something like a routing protocol?



Switch : Self - learning

- Switch *learns* which hosts can be reached through which interfaces
  - When frame received, switch "learns" location of sender: incoming LAN segment
  - Records sender/location pair in switch table



Switch table (initially empty)

MAC addr	interface	TTL
A	*1*	*60*

Switch : Frame Filtering / Forwarding

When frame received at switch:

```
1. Record incoming link, MAC address of sending host
2. Index switch table using MAC destination address
3. If entry found for destination
     then {
      If destination on segment from which frame arrived
         then drop frame
         else forward frame on interface indicated by entry
      }
      else flood  /* forward on all interfaces except arriving interface
    */
```

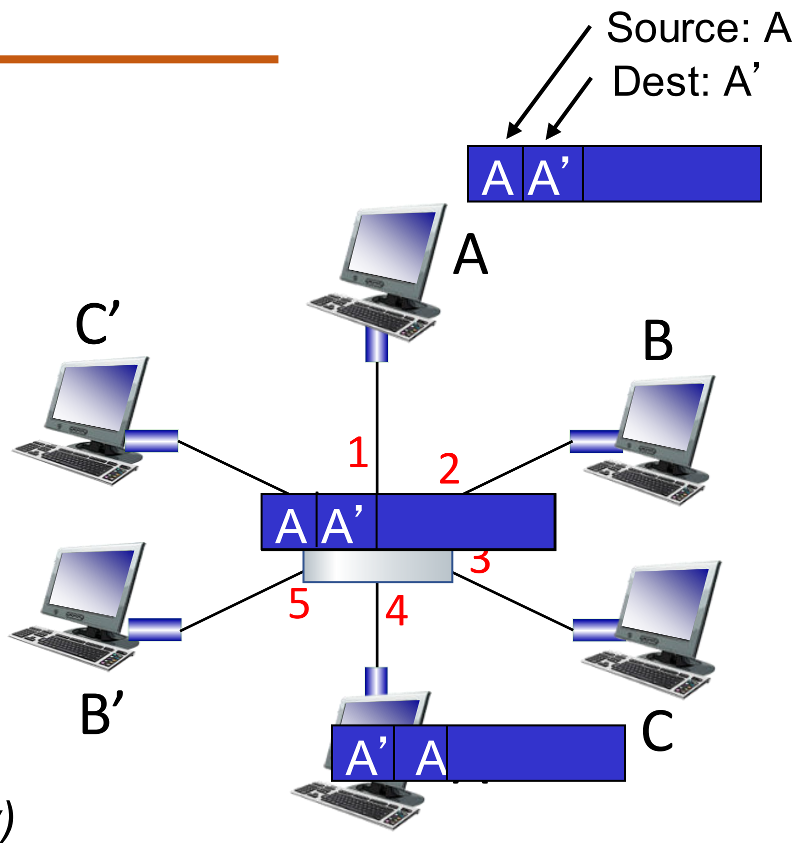
Self-learning, Forwarding : Example

- Frame destination, A', location unknown: Flood

- Destination A location known: Selectively send on just one link

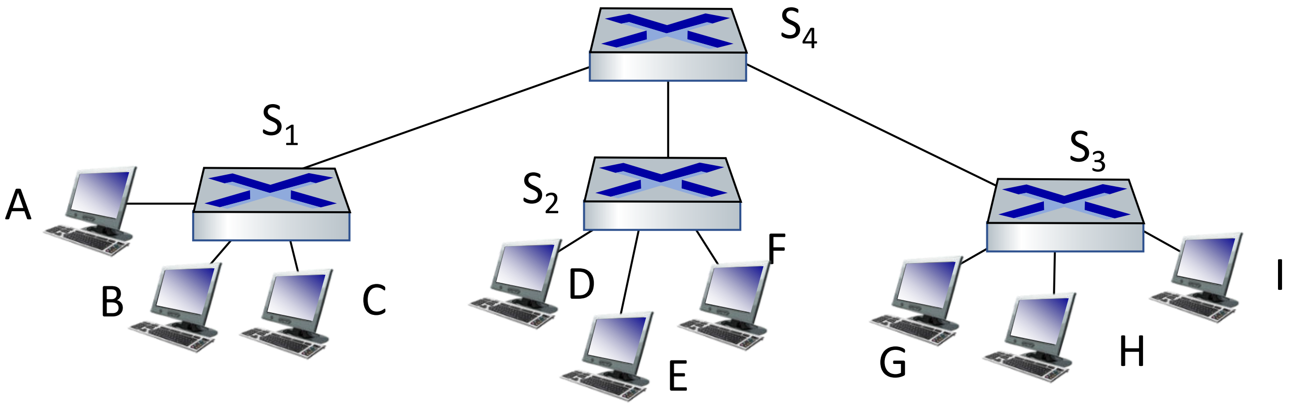
MAC addr	interface	TTL
A	*1*	*60*
A'	*4*	*60*

switch table (initially empty)



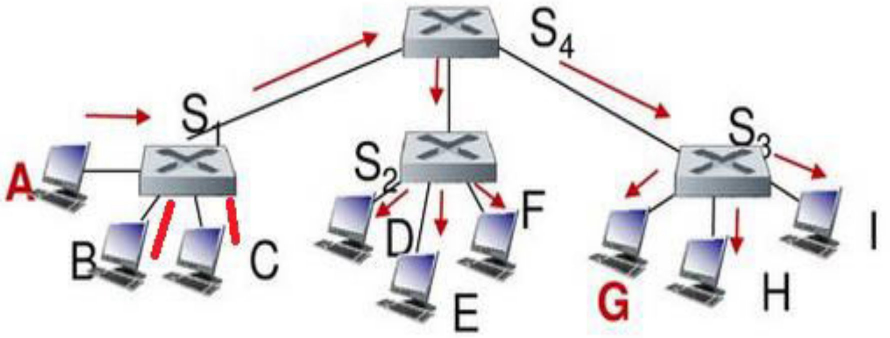
Interconnecting Switches

Self-learning switches can be connected together:



Q:

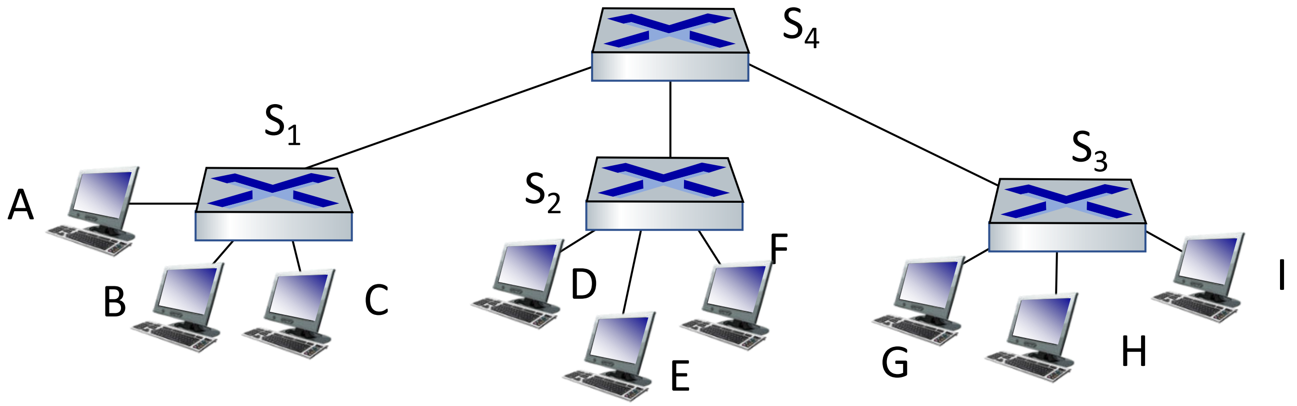
*S*ending from A to G – how does S_1 know to forward frame destined to G via S_4 and S_3?



- *A:* self learning! (works exactly the same as in single-switch case!)

Self-learning Multi-switch Example

Suppose C sends frame to I, I responds to C



Q: show switch tables and packet forwarding in S_1, S_2, S_3, S_4

Self-learning Multi-switch Example

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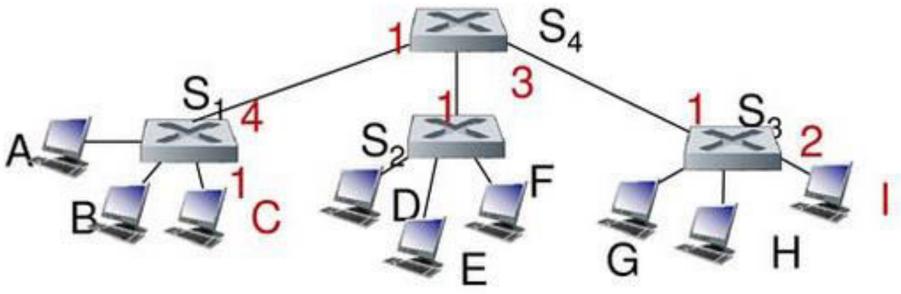


- Q: show switch tables and packet forwarding in S_1, S_2, S_3, S_4

S1

Address	Port
C	1
I	4

S4

Address	Port
C	1
I	3

S3

Address	Port
C	1
I	2

S2

Address	Port
C	1

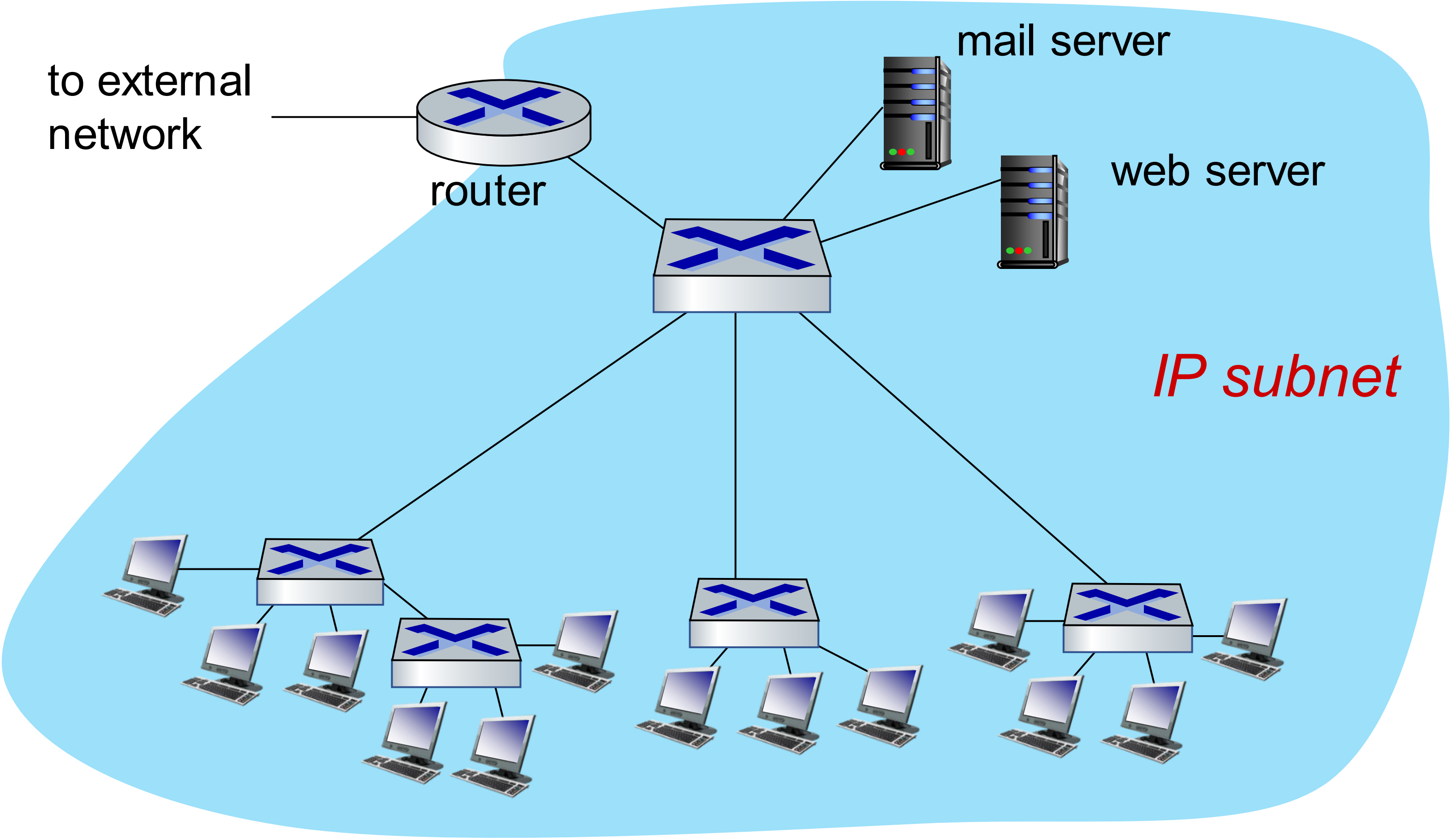
Properties of Link Layer Switching

- *Elimination of collisions*
  - In a LAN built from switches (and without hubs), there is no wasted bandwidth due to collisions!
  - buffer frames and never transmit more than one frame on a segment at any one time.
  - As with a router, the maximum aggregate throughput of a switch is the sum of all the switch interface rates.
  - provide a significant performance improvement over LANs with broadcast links.
- *Heterogeneous links*
  - Because a switch isolates one link from another, the different links in the LAN can operate at different speeds and can run over different media.
  - Example, three1 Gbps 1000BASE-T copper links, two 100 Mbps 100BASE-FX fiber links, and one 100BASE-T copper link.

Properties of Link Layer Switching

- *Management*
  - providing enhanced security,
  - eases network management
    - Example,
    - If an adapter malfunctions and continually sends Ethernet frames (called a jabbering adapter),
      - a switch can detect the problem and internally disconnect the malfunctioning adapter.
    - Similarly, a cable cut disconnects only that host that was using the cut cable to connect to the switch.
    - Gather statistics on bandwidth usage, collision rates, and traffic types, and make this information available to the network manager.
    - Used to debug and correct problems, and to plan future LAN

Small Institutional Network



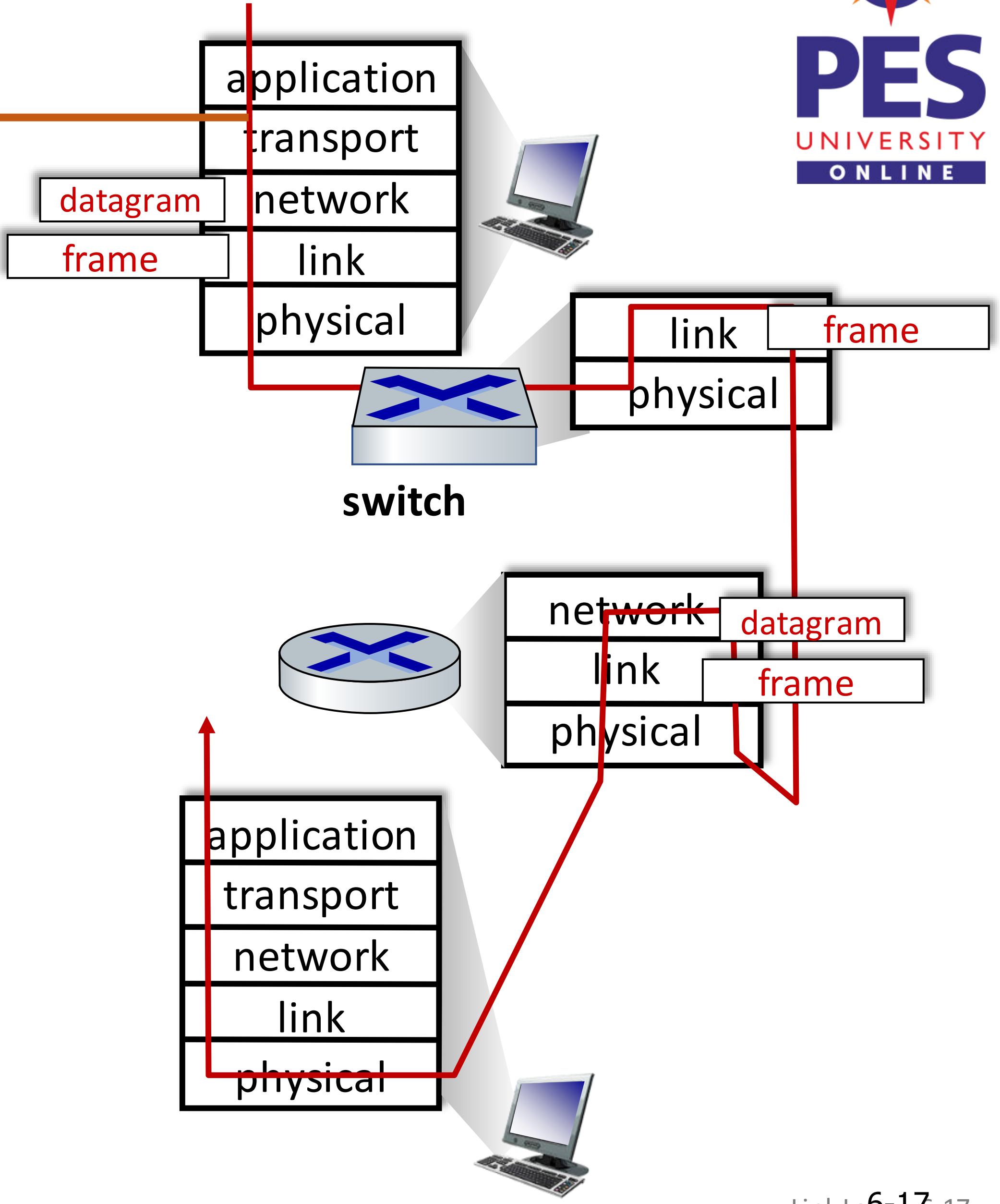
Switches Vs Routers

Both are store-and-forward:

- *Routers*: network-layer devices (examine network-layer headers)
- *Switches:* link-layer devices (examine link-layer headers)

Both have forwarding tables:

- *Routers:* compute tables using routing algorithms, IP addresses
- *Switches:* learn forwarding table using flooding, learning, MAC addresses



Switches Vs Routers

Switches

Pros

- plug-and-play
- relatively high filtering and forwarding rates
- prevent the cycling of broadcast frames, the active topology of a switched network is restricted to a spanning tree.

Cons

- large switched network would require large ARP tables in the hosts and routers and generate substantial ARP traffic and processing.
- susceptible to broadcast storms
- if one host goes haywire and transmits an endless stream of Ethernet broadcast frames, the switches will forward all of these frames, causing the entire network to collapse

Switches Vs Routers

Routers

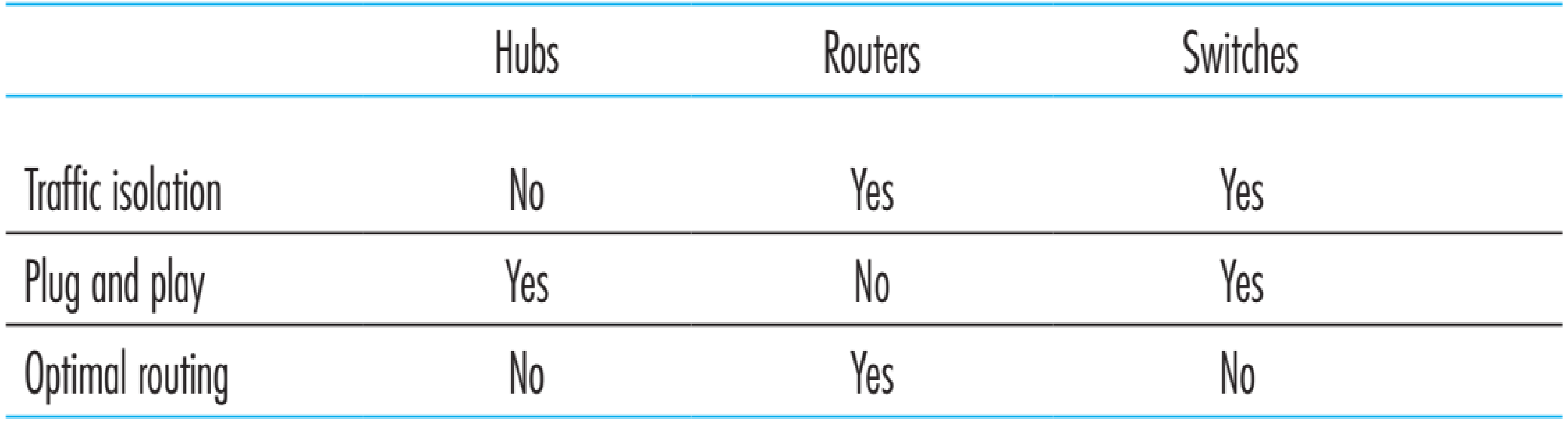
Pros

- Because network addressing is hierarchical, packets do not normally cycle through routers even when the network has redundant paths.
- packets can cycle when router tables are misconfigured;
- IP uses a special datagram header field to limit the cycling.
- packets are not restricted to a spanning tree and can use the best path between source and destination.
- allowed the Internet to be built with a rich topology. Ex: multiple active links between Europe and North America.
- provide firewall protection against layer-2 broadcast storms.

Cons

- not plug-and-play—they and the hosts that connect to them need their IP addresses to be configured.
- Larger per-packet processing time than switches

Hubs Vs Switches Vs Routers



	Hubs	Routers	Switches
Traffic isolation	No	Yes	Yes
Plug and play	Yes	No	Yes
Optimal routing	No	Yes	No

Table 6.1 ♦ Comparison of the typical features of popular interconnection devices

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THANK YOU

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