Computer Science CSCI 251

Systems and Networks

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Internet Protocols

- the Internet is a *packet switching* network
  (as opposed to *circuit switching*)

- two computing systems communicate by
  sending *messages*

- messages are split into *packets*

- packets are viewed as a sequence of *fields*

- depending on the protocol, a packet is re-termed
  as a *frame*, a *datagram* or a *segment*

TCP/IP Terminology

Applications
- FTP
- SSH   (message)
- Echo Client/Server

messages

packets

Transport
- UDP   (datagram)
- TCP   (segment)

Network
- IP   (datagram)

Link
- Ethernet (frame)

Packet Headers

- `https://www.sans.org/security-resources/tcpip.pdf`

Application · | Message |

UDP Payload

Transport (UDP) · | UDP Header | Message |

IP Payload

Network (IP) · | IP Header | UDP Header | Message |

Ethernet Payload

Link (Ethernet) · | Ethernet Header | IP Header | UDP Header | Message |
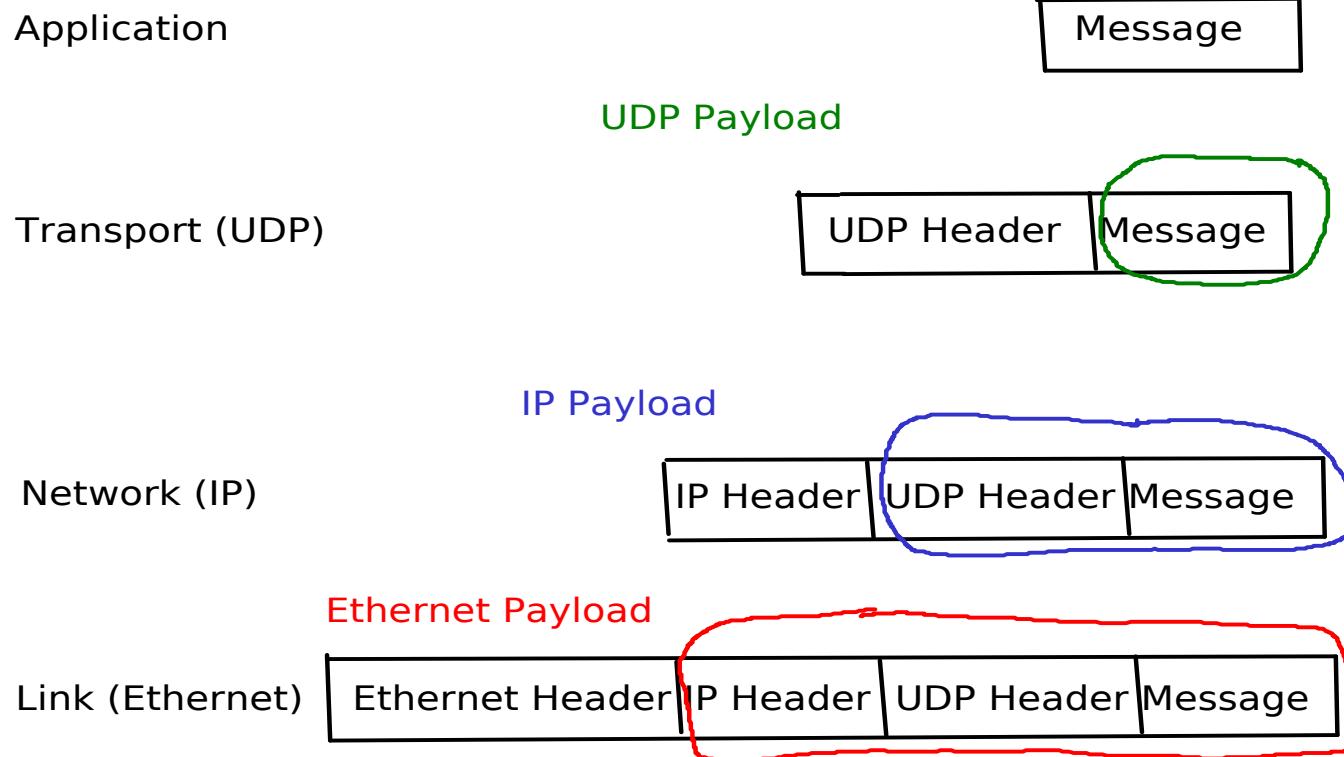
Internet Addresses

○ MAC (media access control)
  - Ethernet, 48 bits (6 octets, 6x8 or 12x4 bits)
  - e.g. `8c:c1:21:a7:52:33`

○ IP (internet protocol v4)
  - 32 bits (4 octets, 4x8 bits)
    e.g., `192.168.0.12`
  - CIDR (Classless Inter-Domain Routing)
    address divided into network prefix and host
    identifier e.g., `192.168.0.12/24`
    leftmost 24 bits correspond to network prefix
    rightmost 8 bits correspond to host identifier

○ Port
  - 16 bits for UDP applications
 - 16 bits for TCP applications

Network Connecting Devices

○ Router

- knows about IP addresses

○ Switch

- knows about MAC addresses

○ Hub

- knows nothing!!

LAN Broadcast Communication

- Hosts A and C attempt to transmit a packet

Collision Domain

Host A

Host B

Collision

Host C

Coaxial Cable
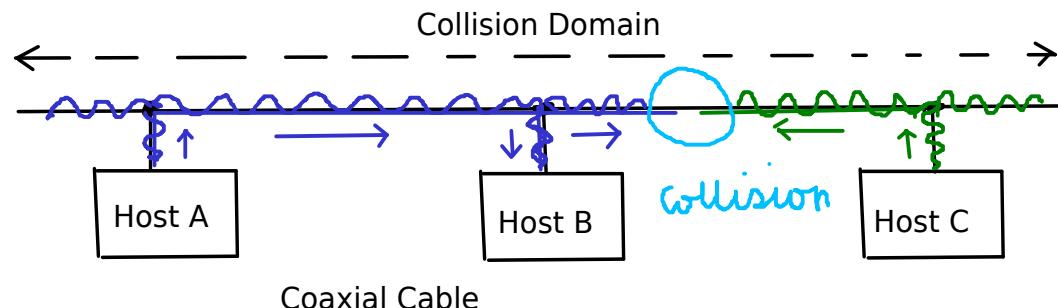
CSMA/CD Carrier Sense Multiple Access/Collision Detection
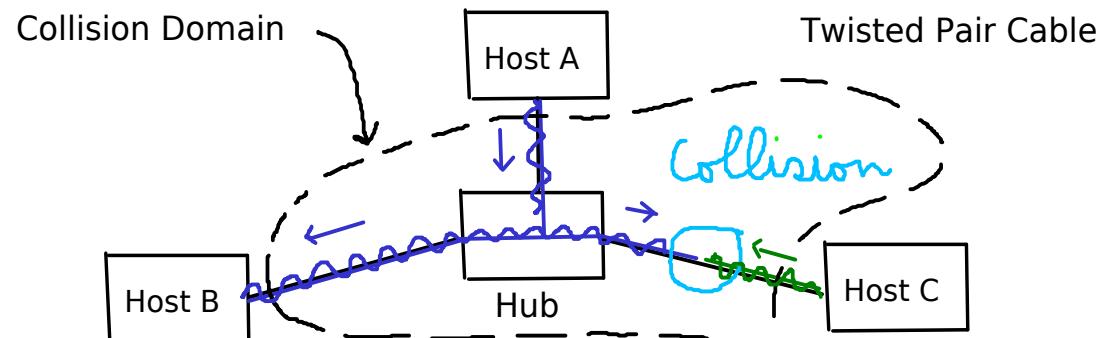
Collision Domain

Host A

Twisted Pair Cable

Collision

Host B

Hub

Host C

LAN Switched Communication

- Hosts A and C communicate (abstraction)

Host A   MAC=3

Port 0

Switch

Host B   Port1   Port 2   Host C

MAC=4
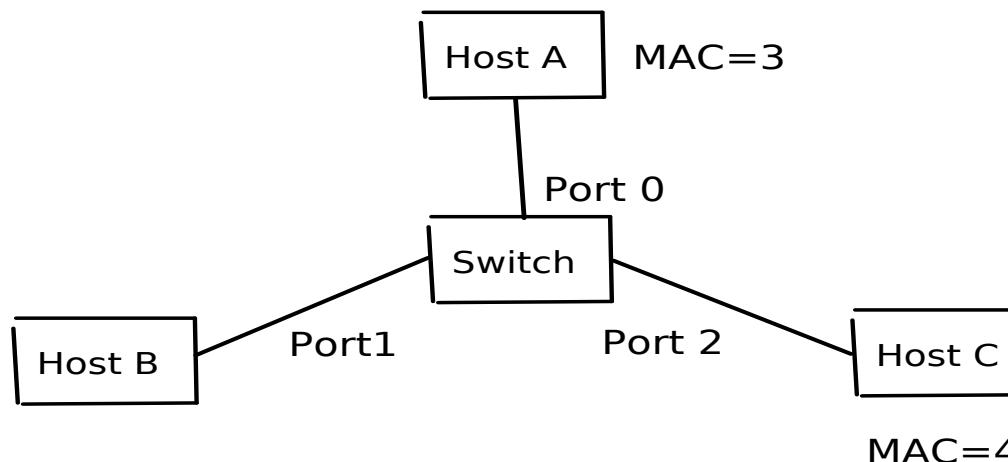
Full Duplix
No collisions

Switch Data Structure

MAC   PORT

LAN Switched Communication cont.

- Hosts A and C communicate (abstraction)

Host A MAC=3

Port 0

Switch

Host B Port1 Port 2 Host C

MAC=4
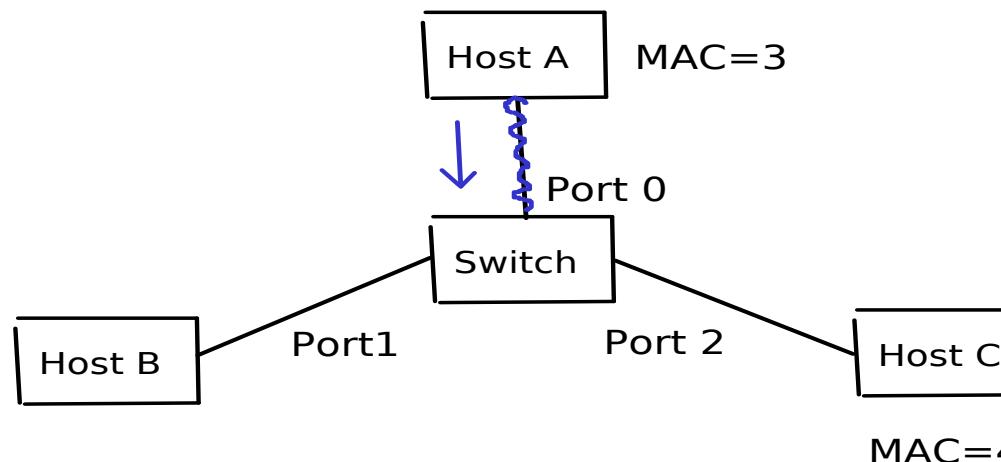
Full Duplix
No collisions

Switch Data Structure

MAC PORT

3	0

LAN Switched Communication cont.

- Hosts A and C communicate (abstraction)

| Host A | MAC=3

Port 0

| Switch |

| Host B | Port1   Port 2 | Host C |

MAC=4

Switch Data Structure

Full Duplix
No collisions

MAC	PORT
3	0

LAN Switched Communication cont.

- Hosts A and C communicate (abstraction)

Host A   MAC=3

Port 0

Switch

Host B   Port1   Port 2   Host C

MAC=4
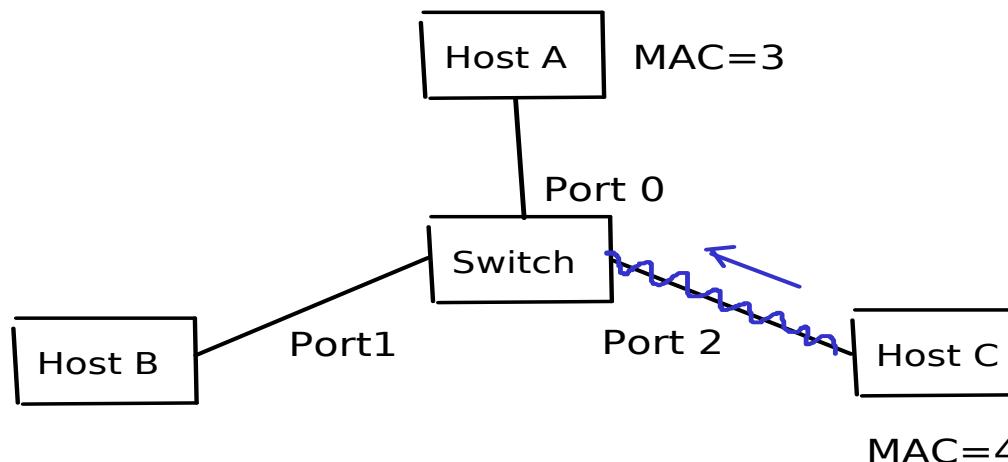
Full Duplix
No collisions

Switch Data Structure

MAC	PORT
3	0
4	2

LAN Switched Communication cont.

- Hosts A and C communicate (abstraction)

Host A   MAC=3

Port 0

Switch

Host B   Port1   Port 2   Host C

MAC=4
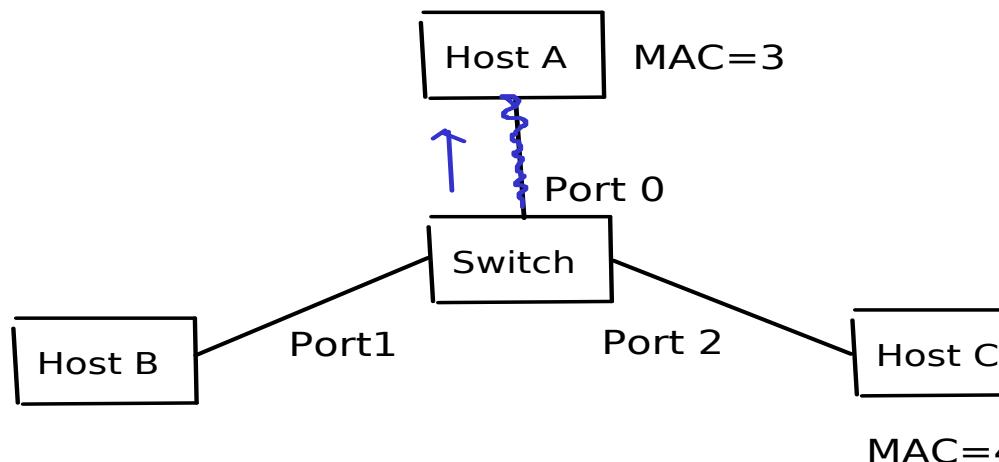
Full Duplix
No collisions

Switch Data Structure

MAC	PORT
3	0
4	2

Routers

Uplink

Switch

Router

0　1　2　3

Host A

Host B

Router

Host A

Host B
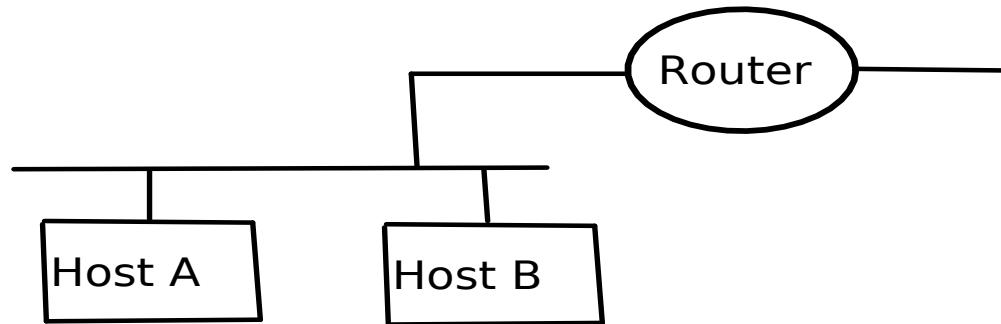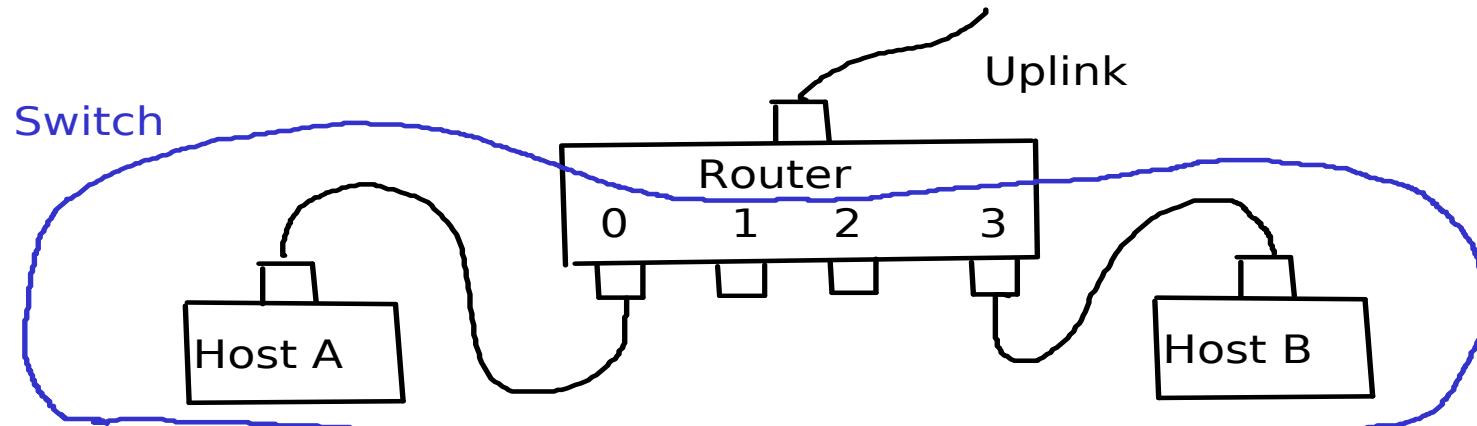
Internet Communication

- Hosts A and C communicate (abstraction)

```
                                    a.b.c.d    Internet
                                    eth2
        192.168.1.0/24                          192.168.2.0/24
                            eth0   Router  eth1
                            192.168.1.100      192.168.2.100
                                 mac=81     mac=3

   eth0              eth0                              eth0
 Host A           Host B                            Host C

192.168.1.7    192.168.1.12              192.168.2.44
mac=34          mac= 92                    mac=104
```

Host A's Routing Table		
Network	Gateway	Interface
192.168.1.7	0.0.0.0	lo
192.168.1	0.0.0.0	eth0
0.0.0.0	192.168.1.100	eth0

Router R's Routing Table		
Network	Gateway	Interface
192.168.1.100	0.0.0.0	lo
192.168.2.100	0.0.0.0	lo
192.168.1	0.0.0.0	eth0
192.168.2	0.0.0.0	eth1
0.0.0.0	a.b.c.d	eth2

Home Office

- poor wifi signal in basement

Internet

Telus Router

Top Floor

Powerline Adaptor

Main Floor

Cisco Switch

Basement
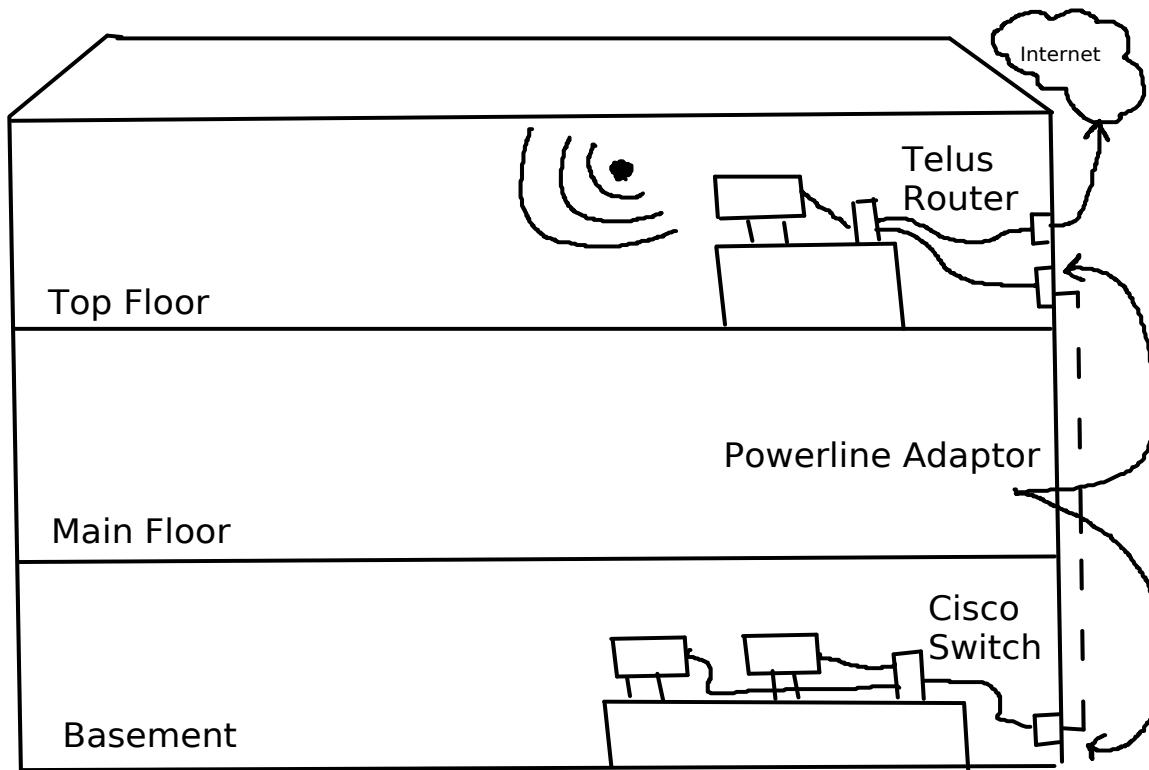
Home Office cont.

- one LAN architecture

C\

Internet

Telus Router — C\

192.168.1/24

Cisco Switch

cobra:

192.168.1.74

walcol: