COMP202-08B
Computer Communications
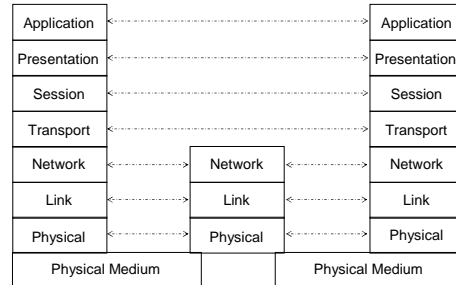
Lecture 7 – Ethernet

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Open Systems Interconnection (OSI)

| Application |
| Presentation |
| Session |
| Transport |
Network	Network	Network
Link	Link	Link
Physical	Physical	Physical
Physical Medium	Physical Medium

Encapsulation

Application		Information	Application
Presentation	PH	Information	Presentation
Session	SH	Information	Session
Transport	TH	Information	Transport
Network	NH	Information	Network
Link	DLH	Information DLT	Link
Physical		Information Frame	Physical

- Information is encapsulated inside of headers
- Kind of like how a sub-class extends features of another class by adding something to the class
- Product is a 'Frame'

OSI Layers and the Internet

- Application
- Presentation
- Session
- Transport   TCP
- Network   IP
- Data Link   Ethernet ← Today's focus
- Physical   Ethernet

Today's Lecture: Ethernet Part 2
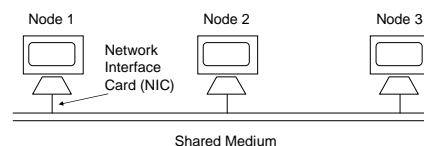
- Ethernet Link Layer
  - Information to transmit
  - Addresses
  - Protocol types
  - Error checking code
  - Synchronisation
- Frames

Ethernet Addressing

Node 1   Node 2   Node 3

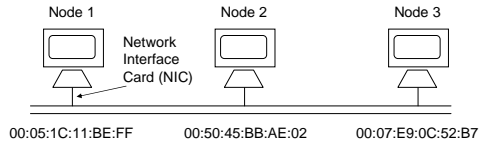Network Interface Card (NIC)

Shared Medium

Ethernet systems use a shared medium to communicate.
We require the ability to distinguish between nodes when sending messages.
We do so using addresses.

Ethernet Addresses

Node 1 Node 2 Node 3

Network Interface Card (NIC)

00:05:1C:11:BE:FF   00:50:45:BB:AE:02   00:07:E9:0C:52:B7

- Ethernet addresses
  - known as Ethernet MAC addresses (Medium Access Control)
  - are 48-bits in size. (6 bytes)
  - are unique (barring errors)
  - are assigned by the NIC manufacturer
  - are usually written as six pairs of hexadecimal characters, each pair separated by a colon

Ethernet Addresses

- 00:05:1C:11:BE:FF

- 6 pairs of hexadecimal digits
- each pair separated by a colon
- Hexadecimal digits (base 16) are thought to be more convenient to use than base 10 in this scenario

Hexadecimal numbers

- Base 10
  - 1234_{10}
  - 4 + 3 lots of ten + 2 lots of one hundred + one thousand
  - 4 + 3 lots of ten + 2 lots of ten squared + one lot of ten qubed
  - $(4 \times 10^0) + (3 \times 10^1) + (2 \times 10^2) + (1 \times 10^3)$

Hexadecimal numbers

- Base 16: need 16 digits instead of 10
  - 10   A
  - 11   B
  - 12   C
  - 13   D
  - 14   E
  - 15   F
- Base 16
  - $4D2_{16}$
  - 2 + 13 lots of 16 + 4 lots of 16 squared
  - $(2 \times 16^0) + (13 \times 16^1) + (4 \times 16^2)$

Kinds of communication

- One to one (normal case)
  - Only the addressee uses the message
- Broadcast
  - Sender addresses all machines on the network
- Multicast
  - Sender addresses all machines who want to listen
- Promiscuous
  - Receiver looks at every passing message

Ethernet addressing

- Broadcast messages
  - FF:FF:FF:FF:FF:FF
- Multicast addresses
  - Reserved
  - [1bbb]x:xx:xx:xx:xx

Network interfaces

- Can receive, by default
  - All messages for its own address
  - All messages broadcast
- Can be programmed to receive multicast messages
- Can be programmed to receive all messages (promiscuous)

Ethernet addresses

```
cms-r1-17:[101]~>/sbin/ifconfig
eth0      Link encap:Ethernet  HWaddr
          00:19:B9:19:2A:9E
          inet addr:130.217.252.17
```
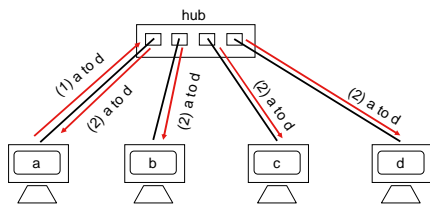
Ethernet hubs

- Ethernet hubs forward messages out all ports

Ethernet switches

- Ethernet switches usually only forward messages out the appropriate port
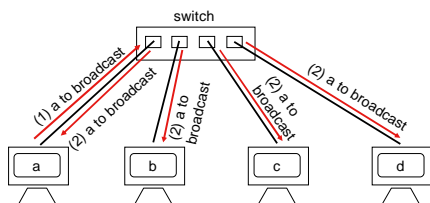 - Interfaces in promiscuous mode won't see messages that the switch does not forward
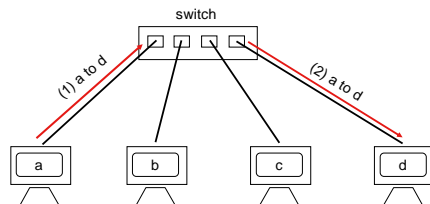
Ethernet switches

- Ethernet switches will forward broadcast messages out all ports
  - Interfaces in promiscuous mode won't see messages that the switch does not forward
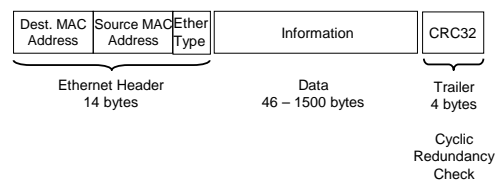
Ethernet Frames

Link	DLH	Information	DLT	Link
Physical		Information Frame		Physical

Dest. MAC Address	Source MAC Address	Ether Type	Information	CRC32
Ethernet Header 14 bytes			Data 46 – 1500 bytes	Trailer 4 bytes

Cyclic Redundancy Check
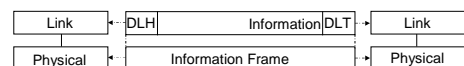
Ethernet Frames

- Destination MAC Address: destination!
- Source MAC Address: source!

- EtherType: protocol type
  - Allows multiple types of Network protocols to be carried in Ethernet frames
  - IPv4   0x0800
  - IPv6   0x86DD

- CRC32:   error checking field
  - Fairly strong technique to detect (but not correct) errors in received message

Ethernet Frames on the wire

- Ethernet also specifies how the frame should be transmitted on the physical medium
  - 8 byte preamble before transmission of frame:
    - 7 bytes of   10101010
    - 1 byte of   10101011
    - Used to allow receiver to synchronise its clock
  - 12 byte (96 bit) delay after transmitting frame before node can send again
  - Information must be at least 46 bytes
    - 46 + 14 + 4 = 64 bytes
    - Required to allow receiver to detect collision

So far

- Specified physical characteristics of Ethernet
- Specified Ethernet link layer

- We've now encountered multiple types of addresses
  - DNS names   sorcerer.cs.waikato.ac.nz
  - IPv4 addresses   130.217.250.39
  - Ethernet MAC addresses   00:05:1C:11:BE:FF
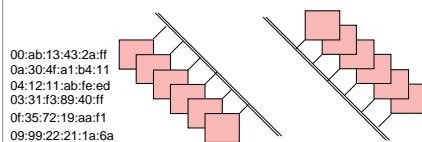- Why are there multiple addressing schemes?

So far

- Ethernet
  - 48 bit MAC address
  - Flat addressing scheme
  - Connect machines in small network
- Internet Protocol v4 (IPv4)
  - 32 bit IP addresses
  - Structured addressing scheme
  - Internet-wide addressing

Networks

00:ab:13:43:2a:ff
0a:30:4f:a1:b4:11
04:12:11:ab:fe:ed
03:31:f3:89:40:ff
0f:35:72:19:aa:f1
09:99:22:21:1a:6a

MAC addresses are wired in (flat)

Networks

Router

192.168.1.254

192.168.1.1
192.168.1.2
192.168.1.3
192.168.1.4
192.168.1.5
192.168.1.6

192.168.2.1
192.168.2.2
192.168.2.3
192.168.2.4
192.168.2.5
192.168.2.6

192.168.2.254
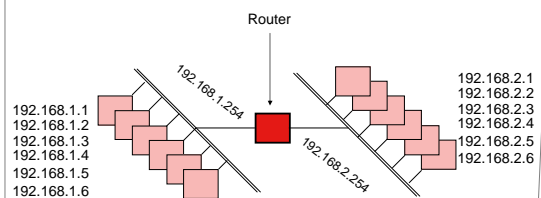
MAC addresses are wired in (flat)
IP addresses are chosen (structured)

OSI

- Physical, Link: Ethernet
- Network: IPv4

Network		Network		Network
Link		Link		Link
Physical		Physical		Physical
Physical Medium			Physical Medium	

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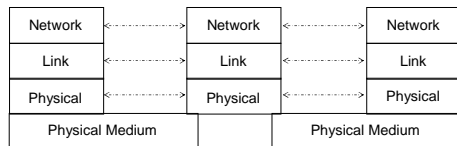
Summary

- Ethernet
  - Frames
  - MAC addresses
  - Network Interface Cards
  - Hubs, switches
- IP
  - Packets
  - IPv4 addresses
  - Routers

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