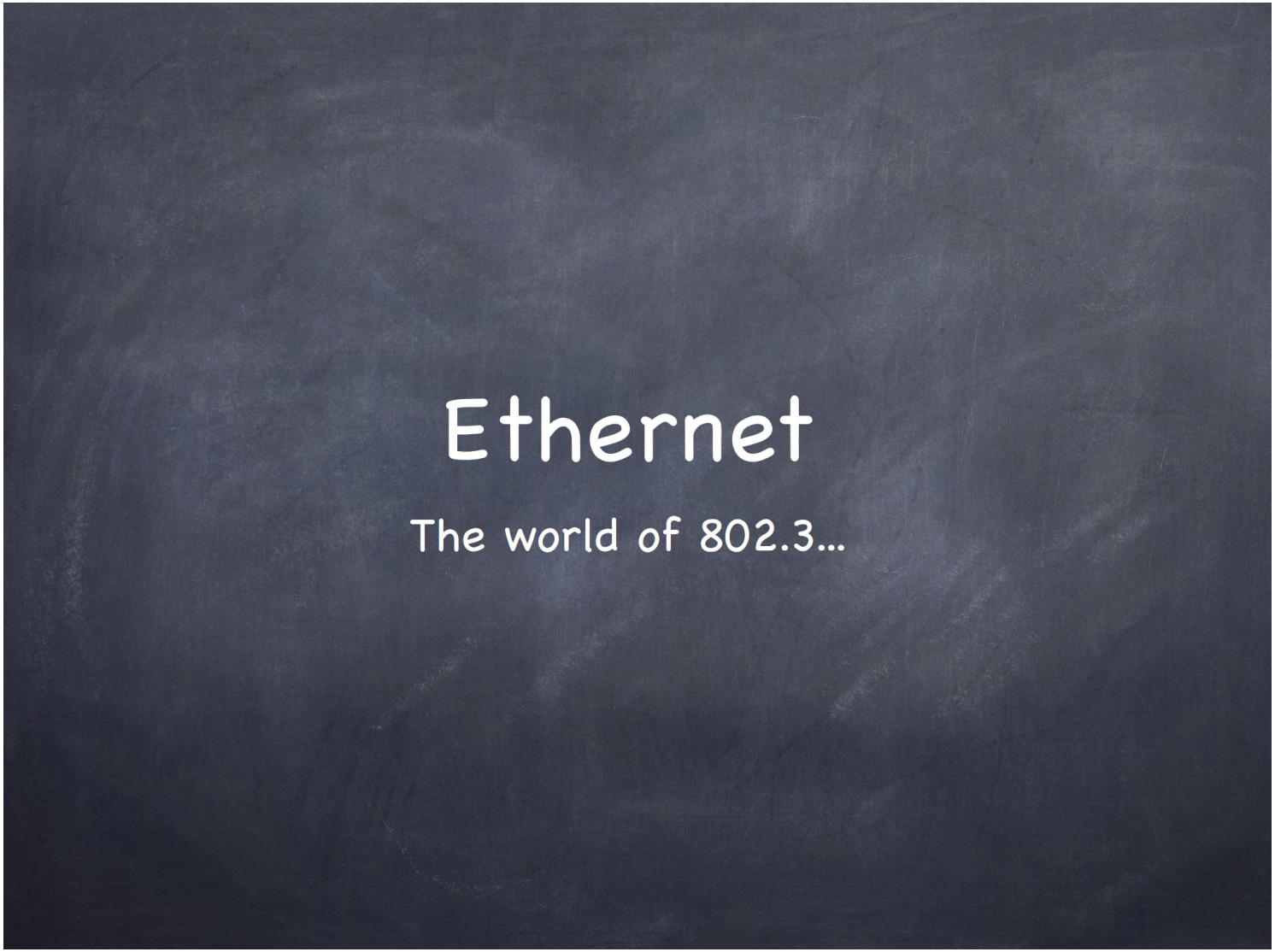
IT 609
Network and System Administration

Ethernet Basics

Thursday October 21, 2021

Ethernet Basics

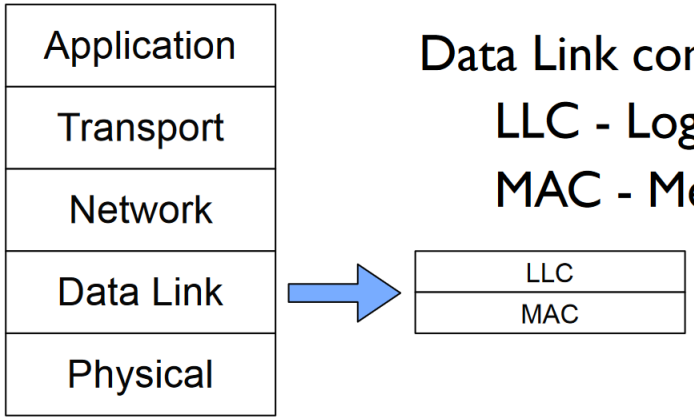


What is Ethernet?

A collection of networking protocols for Local Area Networking (LAN)

Ethernet, Fast Ethernet, Gigabit, and more

Specifications for both Layer 1 and Layer 2



Data Link components split

LLC - Logical Link Control

MAC - Media Access Control

CSMA-CD

CS = Carrier Sense

Listen for communications

Transmit when idle

MA = Multiple Access

Shared, baseband medium

All stations receive all transmissions

CD = Collision Detection

Sense simultaneous, garbled communications

Wait random time and retransmit

Ethernet PHY

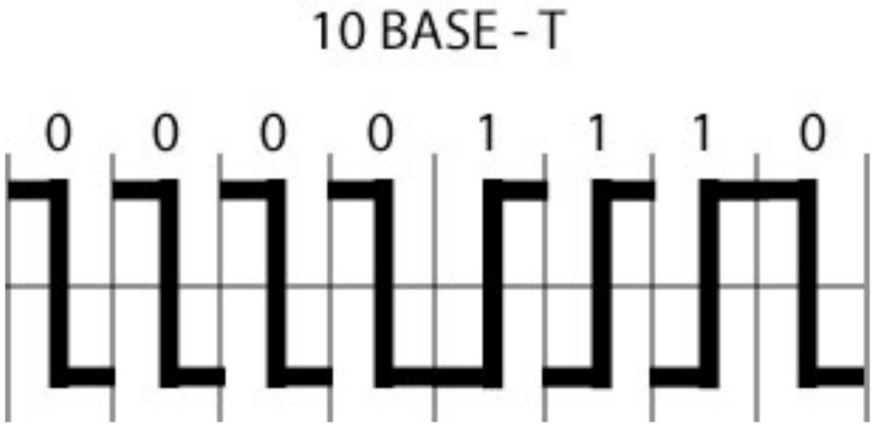
Physical or Layer 1 components

Specifications for cabling

Turning the bits into signals

Multiple speeds ranging from 3 Mbps to 100 Gbps

Ethernet Signals



An example of how information can be encoded at electrical signals for Ethernet transmission

Represents the number 14 (x0E)

Manchester encoding

zero - high to low voltage

one - low to high voltage

Ethernet Cabling

Coaxial cable

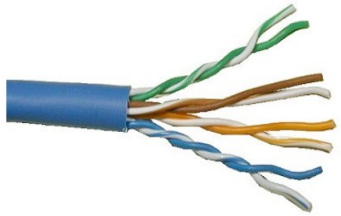
- Not used today

UTP

- Unshielded Twisted Pair
- Twisted pairs of copper wires cut down on crosstalk
- Cheap!

Fiber

- Used to be necessary for higher speeds



Prices as of Oct. 2017	
1000 feet Cat 5e	$50
1000 feet Cat 6	$65
1000 feet fiber	$150

UTP Cable Standards
TIA-568B

100 meter maximum distance

Based on timing for signals to travel this distance

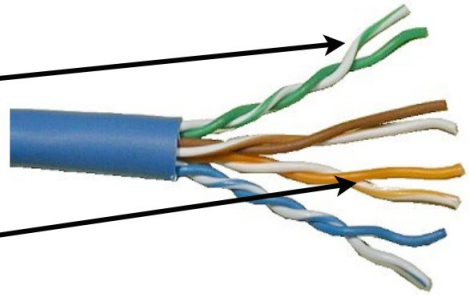
Only 2 pairs used for original 10BASE-T Ethernet

1 - Transmit + (green stripe)

2 - Transmit - (green solid)

3 - Receive + (orange stripe)

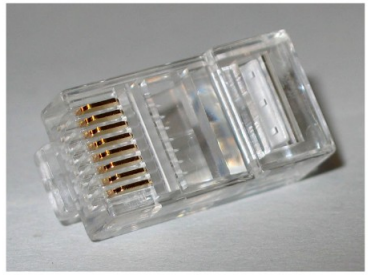
6 - Receive - (orange solid)



4, 5, 7, 8 unused (blues & browns)

8P8C connectors

Often called RJ-45 incorrectly



Fiber Optic Cabling

Lots of variety in terms of sizes and capabilities

- Single-mode vs. multi-mode
- 50/125 µm, 65/125 µm cables
- 850 nm, 1300 nm, 1550 nm light

Need to make choices specific to the application and equipment used

Highest costs are for termination, not installation or the cable itself

Speeds & Standards

	Speed	Category 3	Category 5	Category 5e	Category 6	Category 6a
10BASE-T	10 Mbps	2-pairs	2-pairs	2-pairs	2-pairs	2-pairs
100BASE-TX	100 Mbps		2-pairs	2-pairs	2-pairs	2-pairs
1000BASE-T	1 Gbps			4-pairs	4-pairs	4-pairs
10GBASE-T	10 Gbps					4-pairs

Ethernet DLL

MAC - Media Access Control

Addressing

Channel Access Control - multiple devices sharing the same channel (CSMA-CD)

LLC - Logical Link Control

Interface to Layer 3

MAC Addresses

6-byte address

Written in hexadecimal notation

00:30:65:1a:b6:74

Address ranges assigned to companies

Broadcast address

FF:FF:FF:FF:FF:FF

Broadcasts

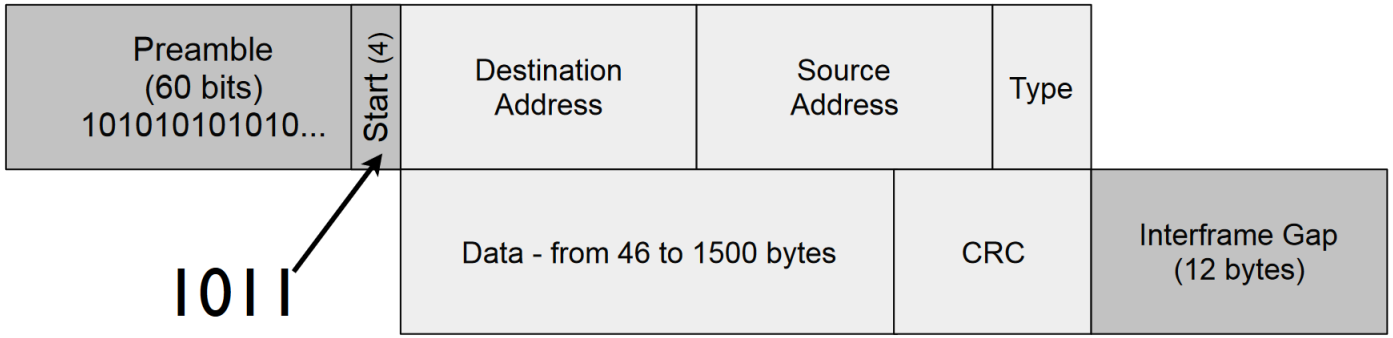
- Communication to all devices on a network
- Why?
  - Discovery and auto-configuration
  - Efficiency
- Limitations
  - Local network segment (aka a broadcast domain)
    - Both good and bad!
  - Excessive broadcasts can overwhelm the network

Ethernet LLC

Logical Link Control

- Interfaces with the rest of the networking stack
- Flow and error control
- Allows multiple Network protocols to work over Ethernet together
- Higher level protocols do not need to be concerned with how to put bits on the wire, address other devices, etc

Ethernet Frame



Minimum size = 6+6+2+46+4 = 64 bytes

Maximum = 6+6+2+1500+4 = 1518 bytes

with Preamble & Gap Min 84 Max 1538 bytes

Jumbo Frames

Send more than 1500 bytes

9216 byte maximum

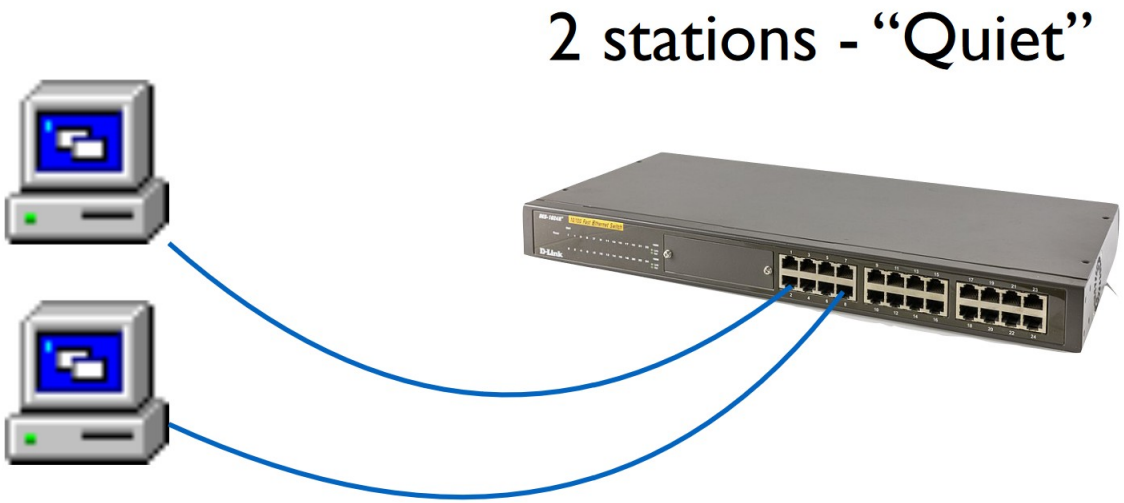
9000 bytes conventional "jumbo" size

Requires NIC and switch that both support the feature

99.14% efficiency vs. 94.93%

All devices on a network must have the same MTU setting so generally only done on small, private networks (e.g. Ethernet-based SAN)

An Experiment



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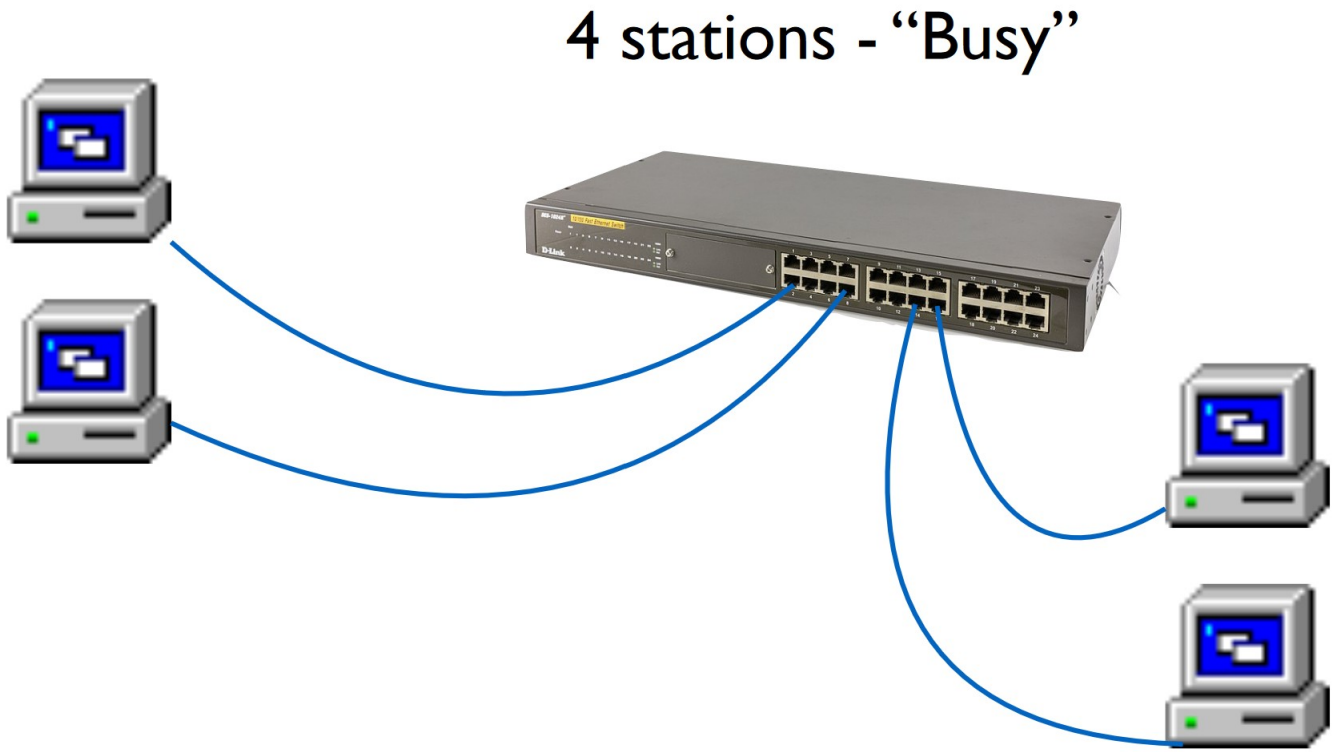
Results

Device Name	Ethernet Type	Quiet Network (kbps)
Dlink	1000BASE-T	940000
Asante FriendlyNet	10BASE-T	9351
Asante 100	100BASE-TX	91000
Dell	100BASE-TX	94845
Crossover		941004

An Experiment



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Results

Device Name	Ethernet Type	Quiet Network (kbps)	Busy Network (kbps)
Dlink	1000BASE-T	940000	940000
Asante FriendlyNet	10BASE-T	9351	4805
Asante 100	100BASE-TX	91000	41885
Dell	100BASE-TX	94845	94850
UNH		N/A	940992
Crossover		941004	

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Hub		Switch	
UNH		N/A	940992
Crossover		941004	

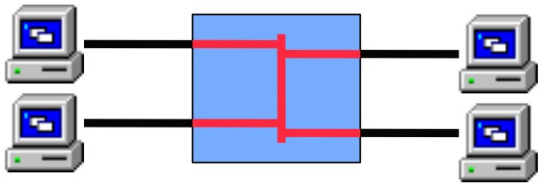
Ethernet Hubs

Hub creates a "star" topology network

Hubs are dumb devices

- Passive transmission
- No buffering
- No examination of information being transmitted

Links all computers to all other computers



Topology is like old bus-based Ethernet

Hubs +/-

Pluses

Simple

Cheap

Easy cabling

Minuses

Collisions, that increase with network size

Unlimited broadcasts

Limited to 4 hubs due to collision detection timing

Limited speeds

Switching

Unlike hubs, switches are "smart"

Only send data where it needs to go

- Buffer communications
- Examine destination address
- Forward frame only to the destination port

Multiple small collision domains

Switches buffer and retransmit so no 4 repeater rule

Broadcasts still unlimited

The bottom line = Faster! :-)

Half vs. Full Duplex

Twice as fast!

Full Duplex 10-BaseT = 20 Mb/sec
(10 Mb/sec each way)

Full Duplex 100-BaseTX = 200 Mb/sec total
(100 Mb/sec each way)

Switches only

No collisions (or at least very few)

Gigabit Ethernet is always switched and full-duplex