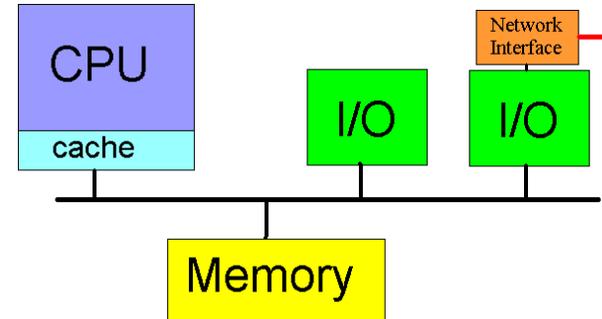


# Ethernet Wiring and Addressing

COMP476 Networked  
Computer Systems

## Network Interface

- The network interface connects to the network cable (or antennae) and the I/O controller.



## Network Interface

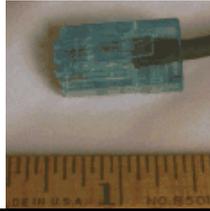
- The Network Interface, Network Interface Card or NIC manages the network protocol.
- The NIC receives packets, checks for errors, determines if the packet is for this computer and saves the data in memory.
- To send packets it creates the header and trailer and transmits the bits on the network.
- The interface interrupts the CPU when data is received or sent.

## CPU Involvement

- The CPU does not have to do a lot of processing to handle the network.
- The network interface operates in parallel with the CPU.
- Fast Ethernet runs at 1 Gbit/sec
- Fast CPUs run at 3.5 GHz. If it can execute on instruction per cycle, it would be difficult to process each bit.

## Ethernet Wires

- Originally Ethernet used thin or thick coax cables.
  - The wires were expensive
  - Routing the wires through a building to form a bus topology could be a challenge.
- Most Ethernets used twisted pair cables.
- The connections use an RJ-45 connector.



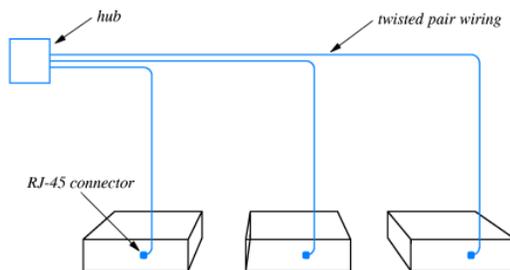
## Types of Twisted Pair

Category	Bandwidth	Typical Uses
3	16 MHz	older, low-speed networks; analog telephones
4	20 MHz	short distance 10Base-T
5	100 MHz	10Base-T Ethernet; some 100Base-T
5E	100 MHz	100Base-T (Fast Ethernet); some 1000Base-T
6	250 MHz	1000Base-T Gigabit Ethernet) or ATM
7	600 MHz	future (possibly 10 Gigabit Ethernet)

Most installations use “Cat 5” wiring, although “Cat 6” is becoming popular for future expansion.

## Ethernet Wiring

A twisted pair wire connects each computer to a central hub or switch.



## Ethernet Central Connection

- Twisted pair Ethernet connects to an Ethernet hub, switch or router.
- Switches usually connect from 4 to 48 nodes.
- If the switch breaks, the network stops working.



## Hub vs. Switch

- A hub looks like it just connects all the wires.
- Network packets sent to a hub are forwarded to all nodes.
- A switch checks the address and only sends packets to a node if it is to receive it.
- A switch can avoid a collision if X sends to Y while W sends to Z. A hub would have collision.
- Switches are more expensive.

## Auto-Speed Detection

- Original 10Base-T operated at 10 Mbps
- 100Base-T Ethernet operates at 100 Mbps
- 1000Base-T Ethernet operates at 1 Gbps
- All three twisted pair wiring schemes use the RJ-45 connectors
- New technology is designed to be backward compatible
- The systems negotiate a speed when a physical connection is first established

## LAN Addressing

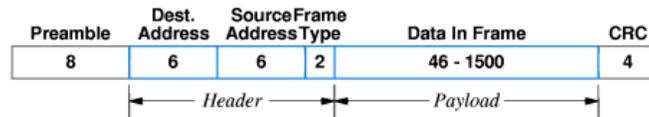
- Nodes on a LAN have an address that identifies that node to other nodes on that network.
- Packets are sent using the LAN address to identify the node on that network that should receive the packet.
- LAN addresses are meaningless outside of the LAN.

## Types of LAN Addresses

The various address forms can be grouped into three broad categories:

- Static
  - Manufacturer assigns a unique address to each NIC
- Configurable
  - Customer can set the address
- Dynamic
  - Automatically assigns an address to a station when the station first boots

## Ethernet Addresses



- Ethernet uses static 48 bit (6 byte) addresses
- Every Ethernet interface has a unique address set by the manufacturer.
- Both the sending and receiving computer's Ethernet address are in the header

## NIC Filters Packets

- The network interface card examines the destination address of all received packets.
- If the destination address matches the node's address, the packet is stored in RAM. The NIC interrupts the CPU to inform the software that a packet has arrived.
- If the destination address does not match, the NIC does not save the message or interrupt the CPU.

## Broadcasting

- Broadcasting is when a single packet is sent to all nodes on the network.
- A special network address specifies that a packet is to be accepted by all nodes.
- The Ethernet broadcast address is all 1 bits  
FF:FF:FF:FF:FF:FF

## Identifying Packet Contents

- The Ethernet header contains a frame type field that indicates the protocol that should handle the packet.
- There is a frame type code specifying that the "data" in the Ethernet packet is an Internet Protocol packet.

## Ethernet type values

Value	Meaning
0000-05DC	Reserved for use with IEEE LLC/SNAP
0800	Internet IP Version 4
0805	CCITT X.25
0900	Ungermann-Bass Corporation network debugger
0BAD	Banyan Systems Corporation VINES
1000-100F	Berkeley UNIX Trailer encapsulation
6004	Digital Equipment Corporation LAT
6559	Frame Relay
8005	Hewlett Packard Corporation network probe
8008	AT&T Corporation
8014	Silicon Graphics Corporation network games
8035	Internet Reverse ARP
8038	Digital Equipment Corporation LANBridge
805C	Stanford University V Kernel
809B	Apple Computer Corporation AppleTalk
80C4-80C5	Banyan Systems Corporation
80D5	IBM Corporation SNA
80FF-8103	Wellfleet Communications
8137-8138	Novell Corporation IPX
818D	Motorola Corporation
FFFF	Reserved

## Packet Identification in the Data

- Some packets do not have a data type field in the header.
- The first few bytes of the Ethernet “data” identify what should be done with the packet
- The IEEE LLC / SNAP header is often used to identify the protocol for the packet
  - Logical Link Control (LLC)
  - Sub Network Attachment Point SNAP header

## Network Analyzers

- Network analyzers can display all packets on the wire.
- To read packets, analyzer software places the computer's network interface hardware into promiscuous mode
- Promiscuous mode means the NIC is configured to accept all frames, not just the one's with the computer's address.

## Security Implications

- Anybody can read all the packets that arrive at their computer even if they are not addressed to their computer.
- Messages sent over a LAN are not guaranteed to be private.