Information Technology
Inside and Outside
- David Cyganski & John A. Orr

VII. Networks and the Internet

19. The Local Area Network

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19. The Local Area Network

- Objectives:
  - basic design characteristics, including short length and relatively short bursts of data transmitted between random pairs of terminals;
  - virtual circuits as a compromise between circuit-oriented and packet-oriented networks;
  - protocols for assigning addresses and performing routing based on addresses;
  - the Datagram;
  - Ethernet as an example of a shared-medium LAN which allows ``collisions'' between data packets; and
  - principles by which order is maintained in an Ethernet-type LAN with no central controller.

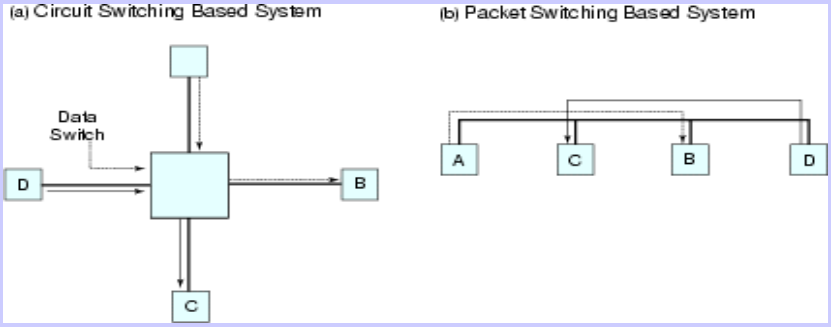
19.1 Introduction

- A **very dense, highly malleable collection** of computational devices,
- A **large business complex** or **university** setting
- A **LAN** is an **interconnection of computers and other devices for digital information exchange** that:
  - **is limited in size, typically spanning no more than a mile;**
  - **is very fast, moving data with speeds from 10 Mbps to 1 Gbps;**
  - **requires very little wiring, typically with a single cable connecting to each device; and**
  - **permits any device to send messages to any other device, without the overhead of creating and tearing down virtual connections.**

19.1 Introduction(2)

- Circuit Switching v.s. Packet Switching

Figure 19.1: (a) Node A communicates to node B via a circuit created by the data switch; the same for Nodes D and C. (b) All nodes talk on a shared medium where they take turns sending information via packets, which contain addresses of both the communicating nodes.



19.1 Introduction(3)

- **prevented** wide-spread acceptance of **ISDN** technology:
  - The **relatively low speeds of ISDN** technology, which are linked to its relationship with telephone wiring and the need to centrally (at the packet-switching node) handle the movement of each packet.
  - The fact that end points are identified in part by their wired connection (in effect, the telephone number of the connection). Hence, **moves from one wall to another**, for example, **mean a change of telephone number** about which every other user must be notified.
- **The most popular LAN** is called the **Ethernet**.

19.2 Datagram Packet Switching

- A ***telegram*** is an **addressed letter** that is transmitted electronically over several long distance hops into the local area of the destination.
- A ***datagram*** is a **packet of information** that is self-contained. That is, in addition to the message content itself, it contains the entire ***universal address*** **of the sender and recipient**.
  - the **basic message transfer unit** used **in both LANs and internetwork communications**, such as in the operation of the Internet

19.3 The Ethernet

- **In 1976**, a paper was published by members of the Xerox Palo Alto Research Center (**Xerox PARC**) **group**
  - link 256 computers and other office equipment for the purposes of sharing documents and other information
- **Ethernet** as industry standard **in September of 1980** by the team formed by **Digital Equipment Corporation, Intel, and Xerox**.
  - **Ethernet DIX**
- **Ethernet II**: the basis for most LAN implementations in use today. The Institute of Electrical and Electronic Engineers (IEEE) modified the specifications for Ethernet protocol and published it as **IEEE Standard 802.3 in 1984**.
  - **10 Mbps** data streams among large numbers of computers distributed **over a 2.5 km (1.5 mile)** diameter area. Later revisions of the Ethernet scheme have realized data speeds as high as **1 Gbps**.

19.3 The Ethernet (2)

- **two components of the Ethernet architecture that are of interest to us here.**
  - **Datagram**: what is packaged inside this electronic telegram.
  - the Ethernet uses to **move datagrams to and from many users efficiently and without the need for prearranged connections.**

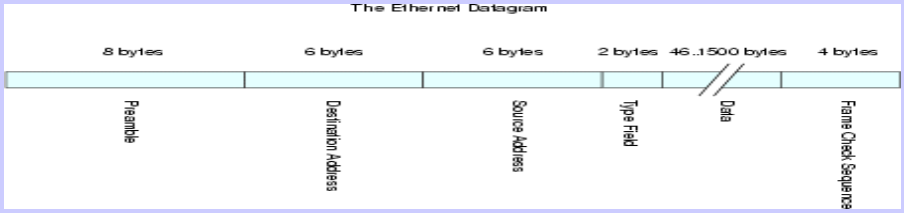
Figure 19.2: This computer is connected to a 10 Megabit per second Ethernet LAN, which uses a thin coaxial cable to communicate data grams between the members of the LAN. The computer in this case attaches by means of a *T* connector, which simply allows it to place its transmissions on the cable and listen to transmissions from all the other computers on its LAN. The use of coaxial cables is rapidly being phased out in favor of the use of more cost effective Unshielded Twisted Pair (UTP) cables. The Ethernet card in this picture has a socket for a UTP cable connector just above the coaxial connector.

19.3 The Ethernet (3)

19.3.1 The Ethernet Datagram

- **Preamble:** An **8-byte sequence** that is always the same. This acts as **a flag** that a receiving system can watch for and synchronize itself with, so that the body of the message can be properly identified.The preamble provides an important protocol service: it stands out in a way that cannot be mistaken for any other part of a message. Every recipient knows what information to expect and in what order immediately after seeing the preamble.

Figure 19.3:Diagram of an Ethernet data packet (datagram).



19.3 The Ethernet (4)

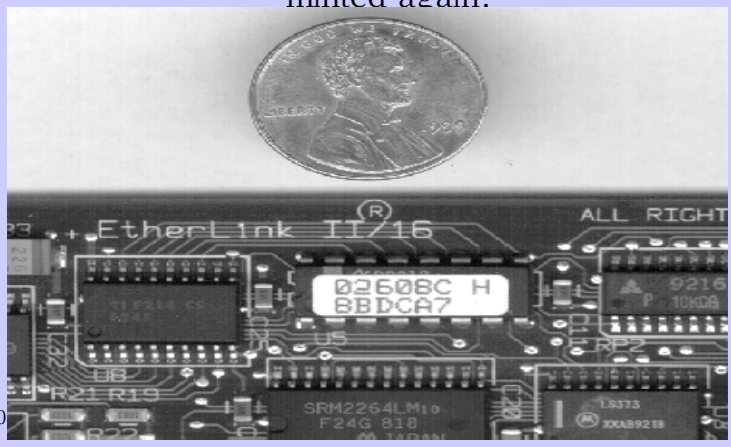
- **Destination Address:** A **6-byte address** that uniquely identifies the recipient of the datagram from all recipients throughout the world. That's right: A **48-bit number** is big enough that every computer can have its own address without overlap.
- **Source Address:** Another **6-byte address** that identifies the sender of the datagram.
- **Type Field:** A **2-byte identifier of the type of handling** that this datagram should receive by the recipient. There are groups that issue standards regarding how this number is used. For example, a type value of **0800 Hex identifies an Internet Protocol packet** as would be generated by Internet-related services.
- **Data: From 46 to 1500 bytes of data** intended for use by the destination system. This would contain perhaps a fragment of a picture being moved through the Web or a piece of text from an e-mail.

19.3 The Ethernet (5)

- **Frame Check Sequence:** A **4-byte number** constructed from processing of all the data that follows the preamble in a certain way. The chances that the same number would result from similarly processing an altered version of this data are very, very, small. Thus, the recipient can process the received data in the same way and check its FCS calculation with the one that was received. If they differ, the message can be discarded as being in error.
- With a **48 bit address size**, there are approximately **$3x10^{14}$ addresses** available--that is, about **20,000,000 addresses per person** on the face of the Earth
- The **IEEE** was given the duty in **January of 1986** to issue these addresses, which they renamed Organizationally Unique Identifiers (**OUIs**).

19.3 The Ethernet (6)

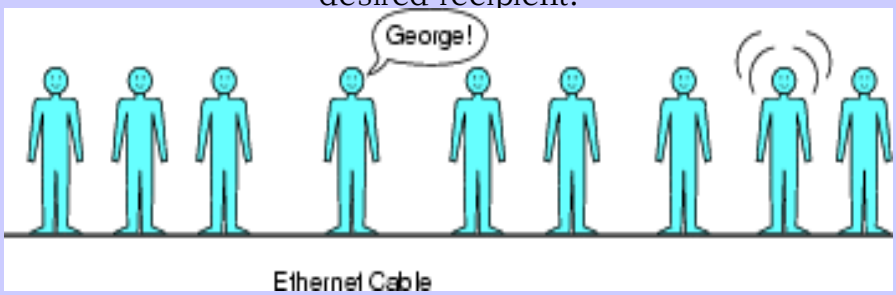
Figure 19.4: On this Ethernet network interface card (NIC) a chip holds the Organizationally Unique Identifier for this card. The 48 bit OUI, which is written in Hexadecimal format on the chip label, 02608C8BDCA7, will never be minted again!



19.3 The Ethernet (7)

19.3.2 Datagram Transmission and Delivery

Figure 19.5: Ethernet Local Area Network technology is based upon an efficient message delivery scheme (for small collections of computers) in which all messages are simply transmitted on a single shared cable and the unique addresses (names) on the datagram alert the desired recipient.



19.3 The Ethernet (8)

19.3.2 Datagram Transmission and Delivery(2)

- In the Ethernet : All the computers in an Ethernet LAN are connected to a single piece of cable (it may be broken into smaller pieces for convenience, but these are hooked up to act like a single piece of wire).
- When one computer wishes to send a message to another, it simply transmits the datagram by causing a variation of the voltage on the wire.This variation can be seen by all the computers attached to that wire. It is as if the computer shouted the telegram in a room (the cable) occupied by all the computers.
- The Ethernet hardware in each computer observes the destination addresses for each datagram and only passes on to its computer those data grams that are addressed in a way that matches its own address

19.3 The Ethernet (9)

19.3.3 Collision Detection Multiple Access(CSMA/CD)

- **Ethernet avoids the bottleneck of a circuit switch**; that is, of a device that has to **direct each packet** from its input connections appropriately to the correct output connection by distributing the **packet-switching** function to all connected devices.
- **When a datagram is transmitted**, all connected devices see it and **only the addressed recipient extracts the data** from it and processes that data.

19.3 The Ethernet (10)

19.3.3 Collision Detection Multiple Access(CSMA/CD)(2)

- **The solution in the case of Ethernet(Carrier Sense Multiple Access with Collision Detection)**
  - We **wait** till the cable seems unused and begin **transmitting**.
  - Every computer connected to the cable watches to see if two transmissions overlap. This is called a **collision**.
  - If anyone sees a collision they ``yell" an announcement of the fact. (This is called ***jamming*** in Ethernet lingo.)
  - If anyone who is transmitting **hears a collision or jamming** announcement while they were transmitting, they **stop**.
  - Each individual who aborted a transmission now rolls a pair of dice and **waits that many seconds** (in Ethernet it is actually a certain number of nanoseconds, or billionths of a second) before **trying again**.
  - Whoever got the low roll obviously goes first and the ***contention*** for the use of the cable is resolved.