

Local Area Networks Ethernet (10Mbit/s)

Tutorial 4

This tutorial on Ethernet is broken down into the following sections:

- ◆ Introduction to Ethernet
- ◆ The various types of Ethernet systems
- ◆ The Ethernet Frame structure
- ◆ Introduction to Ethernet

The Ethernet network concept was developed by Xerox Corporation in the mid-seventies. Ethernet uses the CSMA/CD access method discussed in an earlier tutorial. This gives a system that can operate with little delay, if lightly loaded, but the access mechanism can fail completely if too heavily loaded with too much traffic. Ethernet is widely used commercially, and the network interface cards (or NIC's) are relatively cheap and produced in vast quantities. Because of its probabilistic access mechanism, there is no guarantee of message transfer and messages such as alarms cannot be prioritised. It is becoming more widely used industrially despite these disadvantages as it is low cost and a widely available Open standard.

The Ethernet 802.3 standard defines a range of cable types that can be used for a network based on this standard. They include coaxial cable, twisted pair cable and fibre optic cable. In addition, there are different signalling standards and transmission speeds that can be utilised. These include both baseband and broadband signalling, and traditional speeds of 1 Mbps and 10 Mbps. The standard is continuing to evolve, and 100 Mbps (and indeed Gigabit) Ethernet systems are now also available.

The various types of Ethernet Systems

The IEEE 802.3 standard documents support various cable media and transmission rates up to 10 Mb/s as follows:

- ◆ 10BASE-2 - Thin wire coaxial cable (0.25 inch diameter), 10 Mbps, single cable bus with a maximum segment length of 185 m.
- ◆ 10BASE-5 - Thick wire coaxial cable (0.5 inch diameter), 10 Mbps, single cable bus with a maximum segment length of 500m.
- ◆ 10BASE-T - Unscreened twisted pair cable (0.4 to 0.6 mm conductor diameter), 10 Mbps, twin cable bus with maximum length of 100m to the central hub for each leg.
- ◆ 10BASE-F - Optical fibre cables, 10 Mbps, twin fibre bus.

The most popular is the 10BaseT standard for Ethernet networks which uses AWG24 Unshielded Twisted Pair (UTP) cable for connection to the node. The physical topology of the standard is a star, with nodes connected to a wiring hub, or concentrator. Concentrators can then be connected to a backbone cable that may be coax or fibre optic. The node cable has a maximum length of 100 meters; consists of two pairs for receive and transmit and is connected via RJ45 plugs. Figure 1 shows schematically how the 10BaseT nodes are interconnected by the hub.

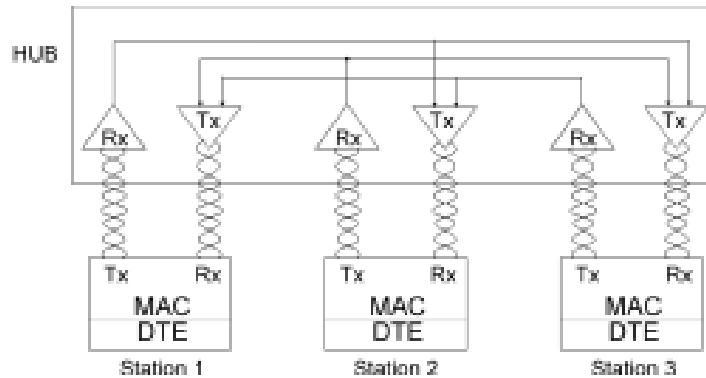


Figure 1 Schematic of a 10BaseT System

The standard has become increasingly popular for new networks. The 10BaseF standard, like the 10BaseT standard, is based on a star topology using wiring hubs. These are:

- 10BaseFL The Fibre Link segment standard that is basically a 2 km upgrade to the existing Fibre Optic Inter Repeater Link (FOIRL) standard. The original FOIRL as specified in the 802.3 standard was limited to a 1 km fibre link between two repeaters, with a maximum length of 2.5 km if there are 5 segments in the link. Note that this is a link between two repeaters in a network, and cannot have any nodes connected to it.

- 10BaseFP A star topology network based on the use of a passive fibre optic star coupler. Up to 33 ports are available per star, and each segment has a maximum length of 500m. The passive hub is completely immune to external noise and is an excellent choice for noisy industrial environments.

- 10BaseFB A Fibre Backbone link segment in which data is transmitted synchronously. It is designed only for connecting repeaters, and for repeaters to use this standard, they must include a built in transceiver. This reduces the time taken to transfer a frame across the repeater hub. The maximum link length is 2 km, although up to 15 repeaters can be cascaded, giving great flexibility in network design.

The Ethernet Frame structure

The basic frame format (or “protocol”) for an Ethernet network is shown below. There are eight fields in each frame, and they are described below.

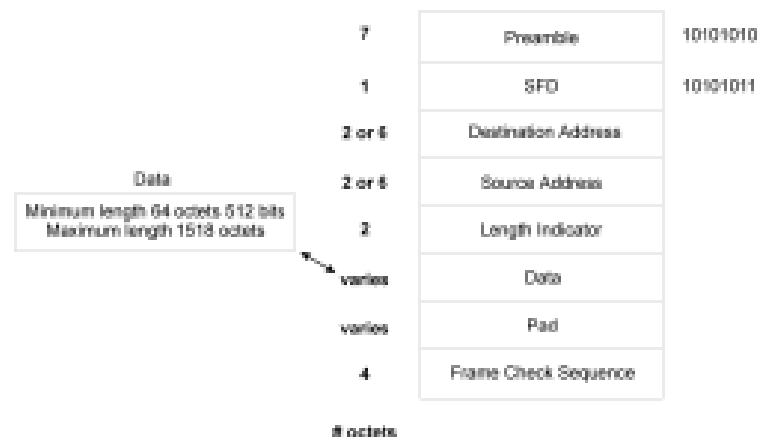


Figure 2 MAC Frame Format

The various fields comprise:

- ◆ Preamble. This field consists of 7 octets of the data pattern 10101010. The preamble is used by the receiver to synchronise its clock to the transmitter.
- ◆ Start Frame Delimiter. This single octet field consists of the data 10101011. It enables the receiver to recognise the commencement of the address fields.
- ◆ Source and Destination Address. These are the unique physical addresses of both the source and destination nodes. These are NOT to be confused with the software addresses (eg IP addresses) allocated by the network administrator.
- ◆ Length. A two octet field that contains the length of the data field. This is necessary since there is no end delimiter in the frame.
- ◆ Data. The information that is being transmitted.
- ◆ Pad. Since there is a minimum length of the frame of 64 octets (512 bits or 576 bits if the preamble is included) that must be transmitted to ensure that the collision mechanism works, the pad field will pad out any frame that does not meet this minimum specification.
- ◆ FCS A 32 bit CRC (or Error Check) value that is computed in hardware at the transmitter and appended to the frame to allow the receiver to detect errors.