

# An Overview of Physical Layer Protocol in the OSI Reference Model

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**Abstract**— In Open System Interconnection (OSI) model there are seven layers. Each layer has its own protocol & perform its distinct function. The lowest layer in OSI model is physical layer. It defines the relationship between physical device & transmission media. It performs an important role in the sharing of available resources in communication. Protocol is the set of rules that governs the communication between devices in a network. One or more protocols are used in each layer. The most common protocol used in physical layer is Ethernet protocol. Ethernet protocol can be categorized in different forms. This paper explains different types of Ethernet protocol that are used in physical layer. Each type of Ethernet protocol has its own speed, cabling system, block coding & line coding scheme.

**Key words:** Physical Layer Protocol, OSI Reference Model

## I. INTRODUCTION

Data communication means exchange of information between source & receiver. In data communication one of the core concept is layered architecture which refers to the open system interconnection (OSI) model of the network.

In designing & understanding of a new network model the OSI model assist a lot. The International organization of standards (ISO) started their work about OSI model in late of 1970s. It ratified in 1984. It is a networking framework which have seven layers. OSI model also gives suggestion for troubleshooting the network. The seven layers are as follows:

- 1) Application layer
- 2) Presentation layer
- 3) Session layer
- 4) Transport layer
- 5) Network layer
- 6) Data link layer
- 7) Physical layer

Physical layer defines a connection between a device & physical transmission media (Cu/optical fiber). It is associated with the movement of bits from node to another. It involves with physical characteristics of bits, data rate, and synchronization of bits, line configuration, physical topology & transmission mode. In this layer the smallest unit work with is called data, which is created by a device. Then D/A & A/D conversion is happens. Some of the example of protocol that are used in physical layer: Ethernet protocol, Universal serial bus, Bluetooth, Digital subscriber line (DSL), Infrared data association.

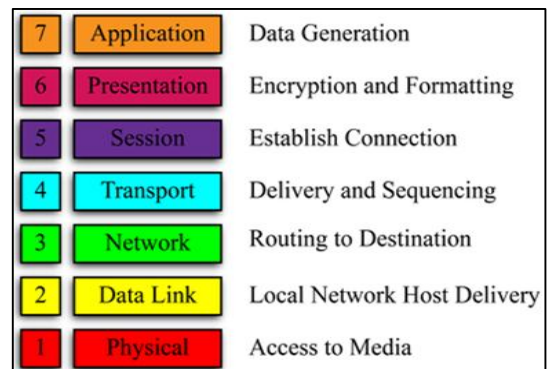


Fig. 1: Layers of OSI Model

## II. ETHERNET

Ethernet is a protocol which is used for limited geographical area (LAN) computers & smart devices. The inventor of Ethernet-LAN is Robert Metcalfe. Some technologies that are related to the LAN is Ethernet, Token ring, Token bus, FDDI & ATM-LAN. Ethernet is the dominant technology among all.

Ethernet protocol can be categorized in 4 types.

- 1) Standard Ethernet
- 2) Fast Ethernet
- 3) Gigabit Ethernet
- 4) Ten gigabit Ethernet

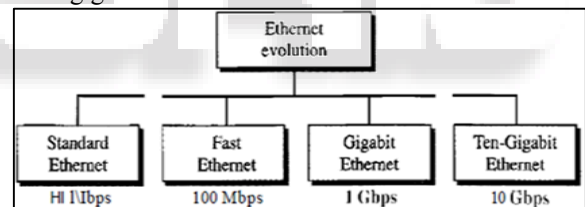


Fig. 2: Types of Ethernet

## III. STANDARD ETHERNET

This is the first evolution of Ethernet. It uses CSMA/CD access method. The slot time is the addition of round trip time & time required to send the jam sequence. Each station of the ethernet network has a NIC card & it has 6 byte (48 bits) physical address. This standards frame contains seven fields. Preamble, start frame delimiter, Destination address, source address, length or type, data, CRC

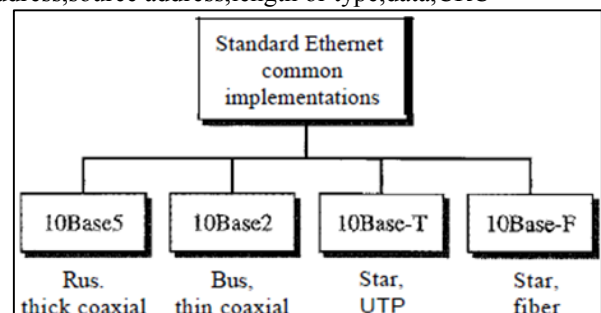


Fig. 3: Types of standard ethernet

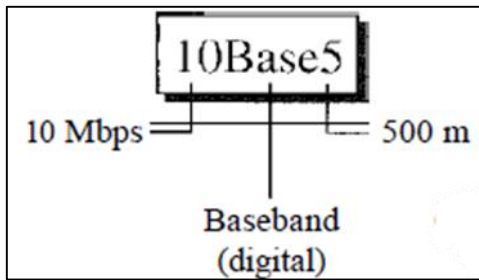


Fig. 4: 10 Base-5 Implementation

A. 10 base-5 Ethernet

It is the first Ethernet specification which is used in bus topology. It is also called thicknet. An attachment unit interface (AUI) cable is connected to the ethernet adapter port which is basically a DB-15 connector mounted on the computer. A coaxial cable almost may be 500 meter long & AUI cable may be 50 meter long. In 1985 the IEEE standardized this configuration as 10 mbps baseband signalling up to 500 meters in length.

B. 10 base-2 Ethernet

It is thinner & cheaper specification than 10base-5 ethernet. It has the similarity to the previous one that it uses bus topology but here the transceiver is internal. It is easier to install than 10 base-5. BNC style connector, terminators & taps are used to cable the system. The length of each segment does not exceed 185 meter

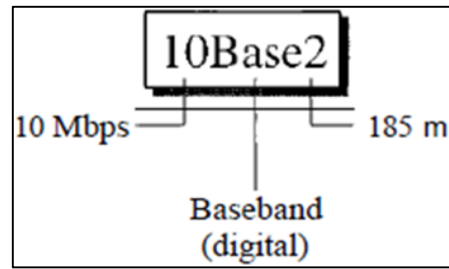


Fig. 5: 10 Base 2 Implementation

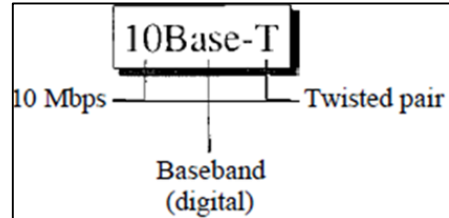


Fig. 6: 10 Base T Implementation

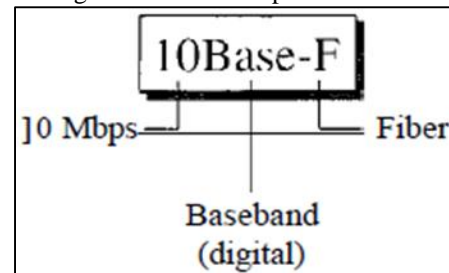


Fig. 7: 10 Base-f Implementation

Characteristics	10 base-5	10 base-2	10 base-T	10 base-F
Media	Thick coaxial cable	Thin coaxial cable	2-UTP	2 Fibre
Maximum length	500 m	185 m	100 m	2000 m
Line coding	Manchester	Manchester	Manchester	Manchester

Table 1: Summary of Standard Ethernet

IV. FAST ETHERNET

The first ethernet has speed 100 mbps in twisted pair cable & also fibre optic cable. The 10 mbps was not practical in video applications. It can be categorized either two wire or four wire. Two wire can be 100base-TX or 100base-FX. The four wire is 100base-T4

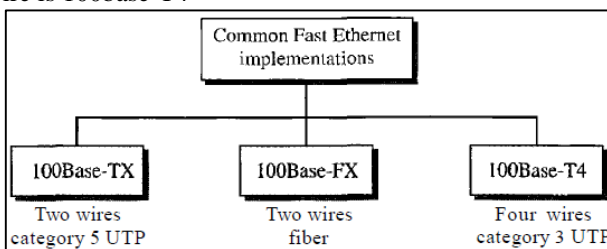


Fig. 8: Types of First Ethernet

A. 100 base-TX

In this type two pair of twisted pair cable are used. For bit synchronization 4B/5B block coding are used. Speed in this Ethernet is 100 mbps & baseband type of communication is used by this Ethernet. Baseband means when transmitting a computer use all the available bandwidth & broadband refers

Characteristics	100 base-TX	100 base-FX	100 base-T4
Media	CAT 5 UTP or STP	Fiber	CAT-4 UTP
Number of wires	2	2	4
Maximum length	100 m	100 m	100 m

to share the available bandwidth. The term TX means it's a CAT-5 UTP cable using 2 or 4 pair. Its speed up to 100 mbps & maximum length between two nodes are 2.5 meters.

B. 100 base-FX

In this ethernet there use two pair of fibre optic cables. NRZ-1 encoding scheme is used for encoding the signal using this standard. There is a problem in NRZ-1 scheme, it has a bit synchronization error in long sequence. To overcome this problem the designer use 4B/5B block encoding method. Block encoding increase the bit rate upto 125 mbps & fibre optic can easily handle this. Here the abbreviation FX means two strand fibre optic cable speeds upto 100 mbps. Maximum length is usually 2 kms.

C. 100 base-T4

100 base-TX are not cost effective in many application that's why the emergence of 100 base-T4 take the space. This ethernet is used four pair of UTP for transmitting 100 mbps. Encoding & Decoding are more complex in this standard. Maximum length of this standard is 100 meters & minimum length is between node is 2.5 meter.

Block Encoding	4B/5B	4B/5B	
Line Encoding	MLT-3	NRZ-1	8B/6T

Table 2: Summary of First Ethernet

### V. GIGABIT ETHERNET

It is a part of ethernet family & theoretical data rate is 1000 mbps or 1 Gbps. Gigabit ethernet works well in twisted pair copper cable (CAT5e/CAT6). It can be categorized either two wire or four wire implementations. we can use gigabit ethernet both copper & optical fibre but there are some problems in copper wire like electromagnatic interference & radio frequency interference. so fibre is more suitable solution than copper wire in the gigabit Ethernet. IN 2 wire

implecations 8B/10B block encoding method is used & in 4 wire implecations 4D-PAM-5 encoding method is used.

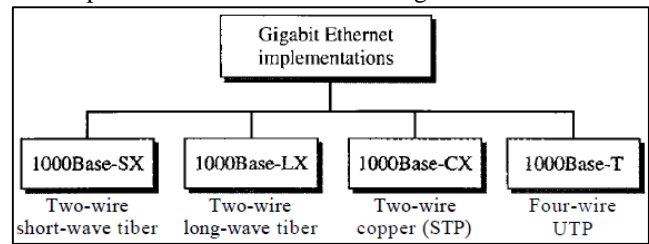


Fig. 9. Types of Gigabit Ethernet

Characteristics	1000 base-SX	1000 base-LX	1000 base-CX	1000 base-T
Media	Fibre short wave	Fibre long wave	STP	CAT-5-UTP
Number of Wires	2	2	2	4
Maximum length	550 m	5000 m	25 m	100 m
Block encoding	8B/10B	8B/10B	8B/10B	
Line encoding	NRZ	NRZ	NRZ	4D-PAM5

Table 3: Summary of Gigabit Ethernet

#### A. Block-coding

Block coding is a method which improve the performance of line coding .In block coding the m-bit block changes into n-bit block. Here n is larger than m. The slash differ block encoding from multilevel encoding. Block encoding has mainly 3 steps:

- 1) Division
- 2) Substitution
- 3) Combination

Consider the example mB/nB. In division stage a sequence of bits is divided into group of m bits. The heart of block coding is substitution step which substitute an m-bit group for an n-bit group. Finally the n-bit group are combined and form a stream.

##### 1) 8B/10B

The 8 bit binary/10 bit binary encoding is similar to 4B/5B encoding but here 8 bit is substituted by 10 bit binary combination. It's error detection capability is higher than 4B/5B. The 8B/10B block coding is actually a combination of 5B/6B & 3B/4B encoding method. If the current block is generated a disparity then each bit in the code needs to be complemented. The coding has  $2^n - 2^m = 2^{10} - 2^8 = 768$  redundant group for disparity checking & error detection.

#### B. Line Coding

Line coding is the process where digital data is converted into digital signals. line coding scheme may be 5 types:

- Unipolar
- Polar
- Bipolar
- Multilevel(4D-PAM-5)
- Multitransition

##### 1) 4D-PAM-5

It is a multilevel line coding scheme. The 4D means that data is sent over four wires at the same time. PAM refers to pulse amplitude modulation & 5 means it has five voltage level. Like -2,-1,0,1,2. Voltage level 0 & 1 are used for forward error detection. The code designer classify the code types as mBnL.

- m=length of the binary pattern
- n=length of the signal pattern
- L=Number of levels in signalling
- In place of L any letter can be found like B=Binary;L=2
- T for L=3[ternary]
- Q for L=4[Quaternary]
- If  $2^m = L^n$  then each data pattern is encoded into one signal patterns.
- If  $2^m < L^n$  data pattern occupy only a subset of signal patterns.
- Data Encoding is not possible if  $2^m > L^n$

### VI. CONCLUSION

In this paper i have tried to explain different protocols that are used in physical layer in the OSI reference model. Various types of Ethernet family have discussed here. Each & every family has its own feature & applications. Speed of each ethernet family varies with other. Cabling efficiency are also dintinct. Suppose coaxial cable is efficient in fast ethernet but this cable is not perfect in Gigabit ethernet. This paper may support the people who wants to work with protocols in the physical layer & also some further information about line coding & Block coding also gives in this paper

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