



Understanding Ethernet Communication - Protocols

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Protocols

All of us are familiar with protocols for human communication, society's rules about appearance, speaking, listening and understanding. These rules govern different layers of communication. They work to help us successfully communicate. Similarly, in the computer world, a protocol is a set of rules that governs communications between the computers on a network. So, no matter which operating system, network card, or application you use, you can communicate with computers located in the same office or on the other side of the world. Network engineers follow strict rules to enable successful communication between devices.

Like the layers of rules for human communications, there are layers of rules for computer communications. The rules include what cables to use, how the hosts listens, how to interrupt, how to say good-bye, what language to use, and many others. These rules are grouped together into a protocol suite.

The **Open Systems Interconnection (OSI)** Reference Model defines seven layers of networking protocols. See **Table 1**. Because of the relationship between the layers they are typically treated as 4 layers:

- Physical/Data Link Layers
- Network Layer
- Transport Layer
- Application/Presentation/Session Layers

Table 1 - OSI Reference Model

OSI Layer	Name	Common Protocols	
7	Application	HTTP FTP SMTP DNS	
6	Presentation		
5	Session		
4	Transport	TCP	SPX
3	Network	IP	IPX
2	Data Link	Ethernet	
1	Physical		

Physical/Data Link Layers – Ethernet, Local Talk, Token Ring

Ethernet

Starting with Ethernet protocol – this is the physical layer and focuses on hardware – cables, interface cards, repeaters. An Ethernet network specifies the type of cable, the topology, the maximum length of cables and so on. For example, a 10BaseT Ethernet protocol designates “10” for the speed of transmission at 10 megabits per second, the “base” stands for “baseband” meaning it has full control of the wire on a single frequency, and the “T” designates “twisted pair” cable.

The **data link layer** controls how data packets are sent from one node to another. The method used in Ethernet communications is **CSMA/CD or Carrier Sense Multiple Access/Collision Detection**. In this method the computer listens to the cable to see if the network is clear, and then transmits the data. If another node is already transmitting, the computer waits and tries again. When two computers try to transmit at the same time, a collision may occur. If this happens, both computers wait a random amount of time and resend the data. This delay is so small, it does not normally effect transmission speed on the network.

In addition to 10BaseT there are Fast Ethernet protocols and Gigabyte Ethernet protocols.

Fast Ethernet standards:

- 100BaseT – 100 Mbps over 2-pair category 5 or better UTP cable
- 100BaseFX – 100 Mbps over fiber optic cable
- 100BaseSX – 100 Mbps over multimode fiber optic cable
- 100BaseBX – 100 Mbps over single mode fiber cable

Gigabit Ethernet standards:

- 1000BaseT – 1000 Mbps over 2-pair category 5 or better UTP cable
- 1000BaseTX – 1000 Mbps over 2-pair category 6 or better UTP cable
- 1000BaseFX – 1000 Mbps over fiber optic cable
- 1000BaseSX – 1000 Mbps over multimode fiber cable
- 1000BaseBX – 1000 Mbps over single mode fiber cable

LocalTalk

LocalTalk is a network protocol originated by Apple Computers for Macintosh computers. Older computers can be connected through a serial port with special twisted pair cable and adapters. The biggest drawback of LocalTalk is the sluggish speed of 230 Kbps. Newer Macintosh computers come with Ethernet cards and adapters already installed.

Token Ring

This method involves computers connected so that the signal travels around the network in a ring. An electronic token moves around the ring, travelling from one computer to the next. As it arrives at a computer, if there is data waiting to be transmitted it collects the data, and travels with it around the ring until it arrives at the target computer. If there is no data to transmit the token moves on to the next computer, and so on. The Token Ring protocol requires a star-wired ring using twisted pair or fiber optic cable. Speeds of transmission range from 4 Mbps to 16 Mbps. The use of Token Rings is rapidly declining with the increasing popularity of Ethernet.

Network Layer – IP and IPX

The network layer routes data from one computer to another. IP and IPX are the most common protocols. For every network device (computer, printer, interface card) there is a unique physical address called a **MAC (Media Access Control)** address. The MAC address for a device cannot be changed. The IP and IPX protocols job is to assign the correct address, and then using routers



send data packets to other networks. One way to think of this is similar to mailing a present to a friend in another country. First you put the present in a box, and mark your friends complete address on the box. Putting your friends correct address on the box is the key to assuring the package is received. The package can even make its way to a foreign country because there are internationally agreed to addressing "protocols" that guide package delivery. Without the proper address the package will be lost, or returned to the sender.

Transport Layer – TCP and SPX

As the name implies, the transport layer is tasked with efficient transportation of the data packets between networks. Going back to our example of mailing a package to a friend, once the package is addressed, it is handed off to the postal employee who sends it on to a central processing hub, the hub then routes the package to a processing center in the country where your friend lives. That hub then routes the package to a regional hub or local postal office, which then assigns the package to a specific mail carrier, who then delivers the package to your friends proper city, street, and house number. Like the postal service, determining the route the data packet is sent and ensuring that it arrives is the purpose of the transport layer.

Most documents that are transmitted are not sent as a single piece. They are broken into smaller data packets, and tagged with a header that identifies the correct sequence and document. The packets do not need to take the same path over a network. Once the packets reach the recipient, they are re-assembled in the proper order. If a packet doesn't arrive, a message is sent to the originating network to re-send the message.

TCP, paired with IP, is the most popular protocol combination for network and transport. When IPX is used for the network protocol, it is paired with SPX for transport.

Session/Presentation/Application Layers – HTTP, FTP, SMTP and DNS

Among these protocols there are overlaps in function. Below are some of the most common protocols and a brief explanation of the role they play.

DNS (Domain Name System) – translates network address (IP address) to names meaningful to people

DHCP (Dynamic Host Configuration Protocol) – can automatically assign Internet addresses to computers and users

FTP (File Transfer Protocol) – used to transfer files on the Internet

HTTP (HyperText Transfer Protocol) – Internet-based protocol for sending and receiving web pages

IMAP (Internet Message Access Protocol) – protocol for e-mail messages on the Internet

IRC (Internet Relay Chat) – used for Internet chat and other communications

POP3 (Post Office Protocol version 3) – used by retrieve e-mail messages from remote servers

SMTP (Simple Mail Transfer Protocol) – protocol for email messages on the Internet

The protocols that are used in network communications ensure that we can transmit data and information with few barriers. And, while the protocols themselves are quite complex, simply understanding the basic OSI Reference Model layers of networking protocols provides a foundation for understanding electronic communications.

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