Networking Protocols

A protocol is a set of rules that governs the communications between computers on a network. These rules include guidelines that regulate the following characteristics of a network: access method, allowed physical topologies, types of cabling, and speed of data transfer.

Layered Software and the OSI Model

Computers communicate using a layered set of protocols, the primay example of which is the **Open Systems Interconnection (OSI) reference model**. This is a model that was propsed as a set of standard layers and protocols for communication between different computers around the world and has been in use since 1983. Although not universally adopted, much of this model is considered the standard and in heavy use. This protocol is different from TCP/IP which will discussed later.

Layers provide a division of the work done by a network. Networks are set up with a protocol hierarchy that divides the communication task into several layers. A **protocol** is a set of rules for communication *within* a layer. A **service** is what the layer provides to the layer above it through an **interface**. Protocols at one layer are unaware of issues at another layer.

The OSI Layers

The OSI reference model organizes a network into seven layers (a **protocol stack**). These layers define how networking hardware and software are to hand data and transfer it across a network. Interoperability, the purpose for defining a standard protocol model, exists when there is compatibility between the protocol stack of one workstation or peripheral device and that of another. Each layer is able to communicate with the corresponding layer of a receiving station.

Application Layer	Application Layer
Presentation Layer	Presentation Layer
Session Layer	Session Layer
Transport Layer	Transport Layer
Network Layer	Network Layer
Data Link Layer	Data Link Layer
Physical Layer	Physical Layer

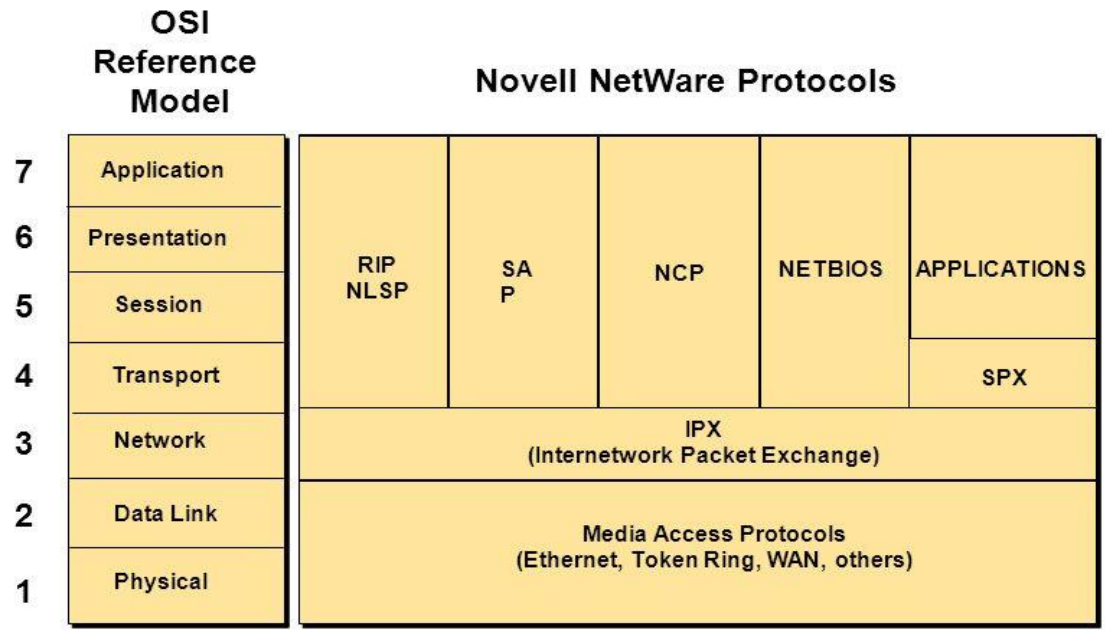
- **Physical Layer** - has rules for dealing with hardware, such as voltages, bit-rates, frequencies, etc. Note that this is not the actual physical medium (wire or the optic fiber or air space). The medium is below this and not given an actual layer assignment. Despite the fact that this layer is not the communicating hardware per se, the fules can be contained implicitly in the **network interface card (NIC)** inside the computer, which connects it to the wire. **Network Interface Cards (NICs), Repeaters and Hubs operate primarily in the Physical Layer.**
- **Data-Link Layer** - this layer communicates via chunks of data called **frames**. The data-link layer can perform error checking and control the rate of flow of information. The data link layer is for a wire with just two ends, one sender and one receiver. An exception is when the sublayer called the **Medium Access Sublayer** is used. This sublayer is necessary when frames collide as many entities attempt to use the medium at the same time. This sublayer arbitrates collisions to provide intact frames that the rest of the data-link layer can use. (Note: Ethernet is primarily concerned with the Medium Access Sublayer.) **Bridges and Switches manipulate data in the Data-Link Layer.**
- **Network Layer** - The network layer deals with addresses and provides message or **packet routing**. (Note: packets are like frames, but in the network layer.) Because not all devices are directly connected to each other, some packets may have to take several **hops** to get from source to destination. Finding a route for packets in a potentially large and changing network is the job of the network layer. **IP** is a network layer protocol, and **IP address** is what IP uses to determine where a packet should go. **Logical network addressing and routing occur in the Network Layer. Routers and Layer 3 switches are devices that operate at the Network layer.**

- **Transport Layer** - The transport layer provides reliable, transparent transfer of data between commputers on a network. The transport layer is the lowest layer to provide and end-to-end view of the communication. The transport layer may have to break the data into packets for the network layer. It is then the transport layer's job to make sure they are reassembled in the right order. The interaction between the end-to-end view of this layer and the machine-to-machine view of the network layer is probably the most critical one in the hierarchy. **TCP** is a transport protocol. Actually, both **TCP** and **IP** are part of the **TCP/IP model** instead of the OSI model. The TCP/IP model owes its success (and its name) to these two hardworking protocols, despite definitions in other layers in the TCP/IP model that are weaker than those in the OSI model. **TCP/IP and IPX/SPX Protocols are active at the Transport Layer.**
- **Session Layer** - The session layer provides remote logons and some other things. May software developers have considered this layer fairly useless and simply absorb any needed functions into their application programs. Different network operating systems (Novell,WindowsNT) utilize this layer for different purposes.
- **Presentation Layer** - The presentation layer is also frequently bypassed, but it can provide translation of data transferred between applications. If data from a spreadsheet needs to be converted to data for a database, this happens at the presentation layer.
- **Application Layer** - The application layer contains communication services that include file transfer and message handling like Telnet, FTP, and email. These services then interact with other applications such as word processing, databases, and World Wide Web browsers.

The OSI model related to both IPX/SPX (Novell Netware) and TCP/IP (WindowsNT & UNIX) Protocol Models

IPX/SPX (Novell Netware)

Novell NetWare Protocol Stack



Netware Lower-Layer Protocols

Netware normally runs over standard lower-layer protocols, such as Ethernet (IEEE 802.3). The lower-layer protocol briefly discussed here, MLID, is a proprietary standard for network interface card drivers.

MLID (Multiple Link Interface Driver) - operates at the Medium Access Sublayer of the Data-Link Layer of the OSI model. MLID is a standard for NIC cards and takes on the form of a driver for the NIC card.

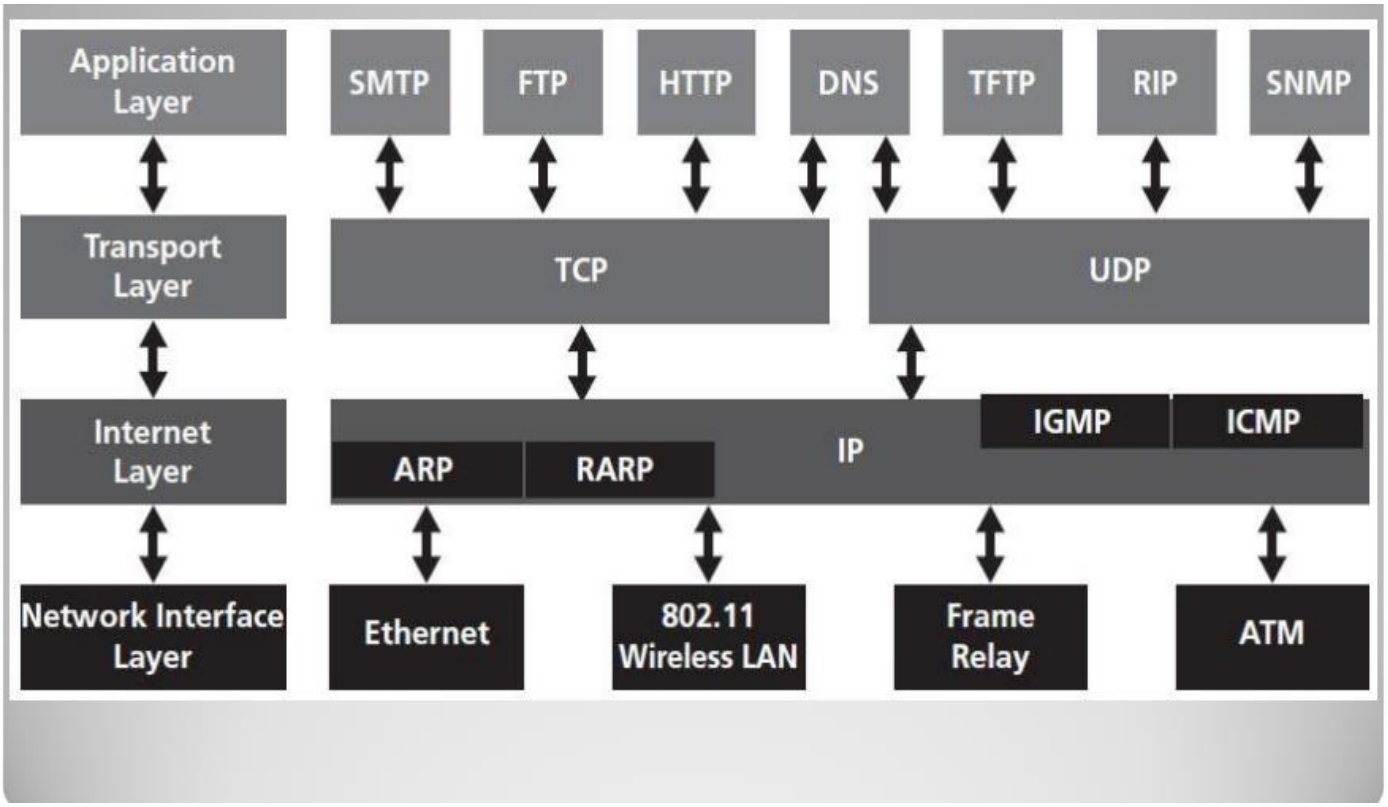
NetWare Middle-Layer Protocols:

- **IPX (Internetwork Packet Exchange)**: Used for transfering packets
- **RIP (Routing Information Protocol) and NLSP (Network Link Services Protocol)**: Routing protocols
- **SPX (Sequence Packet Exchange)**: Runs at the transport layer and addes connection oriented service

Netware Upper-Layer Protocols

- **NCP (NetWare Core Protocols):** At the transport level, it provides connection services; at the session layer, it handles session administration for data transfer; at the presentation layer, is is responsible for translation; and at the application layer, it deals with service use by providing operating system redirection.
- **SAP (Service Advertising Protocol):** provides session administration for file transfer.

TCP/IP (MicrosoftNT and UNIX)



Internet Protocols (TCP/IP)

The Internet Protocol suite is unique in that it is made up of non-proprietary protocols. This means that they do not belong to any one company and that the technology is available for anyone to use them. The above diagram only roughly maps the comparison of the two models. As you may notice, the Internet model

does not cover the two layers of the OSI model. This means that TCP/IP is hardware independent. Since TCP/IP does not include lower level protocols, we'll start with the middle level protocols.

Internet Middle-Layer Protocols

OSI model's network and transport layers are concerned with transporting packets across the internetwork. TCP/IP and other Internet protocols use three types of addresses for network addressing:

- Hardware or physical addresses used the data link and physical layers
- IP addresses the provide logical node IDs. IP addresses are unique addresses assigned by an administrator according to certain guidelines. They are expressed in four-part dotted-decimal notation--i.e. 123.144.131.12
- Logical node names, which an administrator can assign, such as SELU.EDU

IP (Internet Protocol) - works at the network layer. It handles addressing, packet-switching, route selection and error control for communication.

TCP (Transmission Control Protocol) - the Internet protocol's main transport layer protocol. It also provides addressing services at the network layer.

DNS (Domain Name System) - a distributed database system that works at the transport layer to provide name-to-address mapping for client applications. DNS servers maintain databases that consist of hierarchical name structures of the various domains in order to use logical names for device identification.

Internet Upper-Layer Protocols

FTP (File Transfer Protocol) - used for file transfer between internetwork nodes. It also allows users to initiate processes on a remote host. It funtions at the top three layers of the OSI model: at the session layer, FTP provides session adminisrtation; at the presentation layer, FTP is concerned with translation using machine independent file translation; and at the application layer, FTP supplies network services such as file services. **FTP is a peer-to-peer protocol.**

Telnet - used for remote terminal emulation. It enables users to access host-based applications by emulating one of the host's terminals. **Telnet provides**

connectivity between dissimilar operating systems. At the session layer, it provides dialog control; at the presentation layer, telnet provides translation using byte order and character codes; and at the application layer, telnet provides the services for remote operations.

SMPT (Simple Mail Transfer Protocol) - a protocol for routing email messages. It works at the application layer to provide message service.

Miscellaneous Protocols

Serial Line Internet Protocol - SLIP -Used with dial up connections to the Internet. Works exclusively at the Physical Layer of the OSI model. An older protocol that was improved upon with PPP.

Point-to-Point Protocol - PPP - Provides dial up connectivity to the Internet. Operates at the Physical and Data-Link Layer of the OSI model. It provides physical device addressing and error control.

Integrated Services Digital Network - ISDN - a set of standards to provide voice, video and data transmission over digital telephone lines. ISDN operates at the Physical, Data-Link, Network and Transport layers of the OSI model.