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Types of data link layer protocols

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 propsoed 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 files 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 computers 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) 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 transferring packets RIP (Routing Information Protocol) and NLSP (Network Link Services Protocol). Routing protocols SPX (Sequence Packet Exchange): Runs at the transport layer and addces 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 (MicrosofNT 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 functions at the top three layers of the OSI model. at the session layer, FTP provides session administration; 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. SMTP (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. System Administration Guide: IP Services The OSI model describes idealized network communications with a family of protocols. TCP/IP does not directly correspond to this model. TCP/IP either combines several OSI layers into a single layer, or does not use certain layers at all. The following table shows the layers of the Oracle Solaris implementation of TCP/IP. The table lists the layers from the topmost layer (application) to the bottommost layer (physical network), Table 1-2 TCP/IP Protocol Stack OSI Ref. Layer No. OSI Layer Equivalent TCP/IP Layer TCP/IP/IP Protocol Examples 5,6,7 Application, session, presentation Application NFS, NIS, DNS, LDAP, telnet, ftp, rlogin, rsh, rcp, RIP, RDISC, SNMP, and others 4 Transport Transport TCP, UDP, SCTP 3 Network Internet IPv4, IPv6, ARP, ICMP 2 Data link Data link PPP, IEEE 802.2 1 Physical Physical network Ethernet (IEEE 802.3), Token Ring, RS-232, FDDI, and others The table shows the TCP/IP protocol layers and the OSI model equivalents. Also shown are examples of the protocols that are available at each level of the TCP/IP protocol stack. Each system that is involved in a communication transaction runs a unique implementation of the protocol stack. Physical Network Layer The physical network layer specifies the characteristics of the hardware to be used for the network. For example, physical network layer specifies the physical characteristics of the communications media. The physical layer of TCP/IP describes hardware standards such as IEEE 802.3, the specification for Ethernet network media, and RS-232, the specification for standard pin connectors. Data-Link Layer The data-link layer identifies the network protocol type of the packet, in this instance TCP/IP. The data-link layer also provides error control and "framing." Examples of data-link layer protocols are Ethernet IEEE 802.2 framing and Point-to-Point Protocol (PPP) framing. Internet Layer The Internet layer, also known as the network layer or IP layer, accepts and delivers packets for the network. This layer includes the powerful Internet Protocol (IP), the Address Resolution Protocol (ARP), and the Internet Control Message Protocol (ICMP). IP Protocol The IP protocol and its associated routing protocols are possibly the most significant of the entire TCP/IP suite. IP is responsible for the following: IP addressing - The IP addressing conventions are part of the IP protocol. Designing an IPv4 Addressing Scheme introduces IPv4 addressing and IPv6 Addressing Overview introduces IPv6 addressing. Host-to-host communications - IP determines the path a packet must take, based on the receiving system's IP address. Packet formatting - IP assembles packets into units that are known as datagrams. Datagrams are fully described in Internet Layer: Where Packets Are Prepared for Delivery. Fragmentation - If a packet is too large for transmission over the network media, IP on the sending system breaks the packet into smaller fragments, IP on the receiving system then reconstructs the fragments into the original packet. Oracle Solaris supports both IPv4 and IPv6 addressing formats, which are described in this book. To avoid confusion when addressing the Internet Protocol, one of the following conventions is used: When the term "IP" is used in a description, the description applies to both IPv4 and IPv6. When the term "IPv4" is used in a description, the description applies only to IPv4. When the term "IPv6" is used in a description, the description applies only to IPv6. ARP Protocol The Address Resolution Protocol (ARP) conceptually exists between the data-link and Internet layers. ARP assists IP in directing datagrams to the appropriate receiving system by mapping Ethernet addresses (48 bits long) to known IP addresses (32 bits long). ICMP Protocol The Internet Control Message Protocol (ICMP) detects and reports network error conditions. ICMP reports on the following: Dropped packets - Packets that arrive too fast to be processed Connectivity failure - A destination system cannot be reached Redirection - Redirecting a sending system to use another router Chapter 8, Administering a TCP/IP Network (Tasks) contains more information on Oracle Solaris commands that use ICMP for error detection. Transport Layer The TCP/IP transport layer ensures that packets arrive in sequence and without error, by swapping acknowledgments of data reception, and retransmitting lost packets. This type of communication is known as end-to-end. Transport layer protocols at this level are Transmission Control Protocol (TCP), User Datagram Protocol (UDP), and Stream Control Transmission Protocol (SCTP). TCP and SCTP provide reliable, end-to-end service. UDP provides unreliable datagram service. TCP Protocol TCP enables applications to communicate with each other as though they were connected by a physical circuit. TCP sends data in a form that appears to be transmitted in a character-by-character fashion, rather than as discrete packets. This transmission consists of the following: Starting point, which opens the connection Entire transmission in byte order Ending point, which closes the connection. TCP attaches a header onto the transmitted data. This header contains many parameters that help processes on the sending system connect to peer processes on the receiving system. TCP confirms that a packet has reached its destination by establishing an end-to-end connection between sending and receiving hosts. TCP is therefore considered a "reliable, connection-oriented" protocol. SCTP Protocol SCTP is a reliable, connection-oriented transport layer protocol that provides the same services to applications that are available from TCP. Moreover, SCTP can support connections between systems that have more than one address, or multihomed. The SCTP connection between sending and receiving system is called an association. Data in the association is organized in chunks. Because TCP supports multithoming, certain applications, particularly applications used by the telecommunications industry, need to run over SCTP, rather than TCP. UDP Protocol UDP provides datagram delivery service. UDP does not verify connections between receiving and sending hosts. Because UDP eliminates the processes of establishing and verifying connections, applications that send small amounts of data use UDP. Application Layer The application layer defines standard Internet services and network applications that anyone can use. These services work with the transport layer to send and receive data. Many application layer protocols exist. The following list shows examples of application layer protocols: Standard TCP/IP services such as the ftp, tftp, and telnet commands UNIX "r" commands, such as rlogin and rsh Name services, such as NIS and the domain name system (DNS) Directory services (LDAP) File services, such as the NFS service Simple Network Management Protocol (SNMP), which enables network management Router Discovery Server protocol (RDISC) and Routing Information Protocol (RIP) routing protocols Standard TCP/IP Services FTP and Anonymous FTP - The File Transfer Protocol (FTP) transfers files to and from a remote network. The protocol includes the ftp command and the in.ftpd daemon. FTP enables a user to specify the name of the remote host and file transfer command options on the local host's command line. The in.ftpd daemon on the remote host then handles the requests from the local host. Unlike rcp, ftp works even when the remote computer does not run a UNIX based operating system. A user must log in to the remote system to make an ftp connection, unless the remote system has been configured to allow anonymous FTP. You can obtain an enormous amount of material from anonymous FTP servers that are connected to the Internet. Universities and other institutions set up these servers to offer software, research papers, and other information to the public domain. When you log in to this type of server, you use the login name anonymous, hence the term "anonymous FTP server." Using anonymous FTP and setting up anonymous FTP servers is outside the scope of this manual. However, many books, such as The Whole Internet User's Guide & Catalog, discuss anonymous FTP in detail. Instructions for using FTP are in System Administration Guide: Network Services. The ftp(1) man page describes all ftp command options that are invoked through the command interpreter. The ftpd(1M) man page describes the services that are provided by the in.ftpd daemon. Telnet - The Telnet protocol enables terminals and terminal-oriented processes to communicate on a network that runs TCP/IP. This protocol is implemented as the telnet program on local systems and the in.telnetd daemon on remote machines. Telnet provides a user interface through which two hosts can communicate on a character-by-character or line-by-line basis. Telnet includes a set of commands that are fully documented in the telnet(1) man page. TFTP - The Trivial File Transfer Protocol (tftp) provides functions that are similar to ftp, but the protocol does not establish ftp's interactive connection. As a result, users cannot list the contents of a directory or change directories. A user must know the full name of the file to be copied. The tftp(1)man page describes the tftp command set. UNIX "r" Commands The UNIX "r" commands enable users to issue commands on their local machines that run on the remote host. These commands include the following: Instructions for using these commands are in the rcp(1), rlogin(1), and rsh(1) man pages. Name Services Oracle Solaris provides the following name services: DNS - The domain name system (DNS) is the name service provided by the Internet for TCP/IP networks. DNS provides host names to the IP address service. DNS also serves as a database for mail administration. For a complete description of this service, see System Administration Guide: Naming and Directory Services (DNS, NIS, and LDAP). See also the resolver(3RESOLV) man page, /etc files - The original host-based UNIX name system was developed for standalone UNIX machines and then adapted for network use. Many old UNIX operating systems and computers still use this system, but it is not well suited for large complex networks. NIS - Network Information Service (NIS) was developed independently of DNS and has a slightly different focus. Whereas DNS focuses on making communication simpler by using machine names instead of numerical IP addresses, NIS focuses on making network administration more manageable by providing centralized control over a variety of network information. NIS stores information about machine names and addresses, users, the network itself, and network services. NIS name space information is stored in NIS maps. For more information on NIS Architecture and NIS Administration, see System Administration Guide: Naming and Directory Services (DNS, NIS, and LDAP). Directory ServiceOracle Solaris supports LDAP (Lightweight Directory Access Protocol) in conjunction with the Sun Open Net Environment (Sun ONE) Directory Server, as well as other LDAP directory servers. The distinction between a name service and a directory service is in the differing extent of functionality. A directory service provides the same functionality of a naming service, but provides additional functionalities as well. See System Administration Guide: Naming and Directory Services (DNS, NIS, and LDAP). File Services The NFS application layer protocol provides file services for Oracle Solaris. You can find complete information about the NFS service in System Administration Guide: Network Services. Network Administration The Simple Network Management Protocol (SNMP) enables you to view the layout of your network and the status of key machines. SNMP also enables you to obtain complex network statistics from software that is based on a graphical user interface (GUI). Many companies offer network management packages that implement SNMP. Routing Protocols The Routing Information Protocol (RIP) and the Router Discovery Server Protocol (RDISC) are two available routing protocols for TCP/IP networks. For complete lists of available routing protocols for Oracle Solaris 10, refer to Table 5-1 and Table 5-2. © 2010, Oracle Corporation and/or its affiliates

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