BCS FINAL PROJECT

MPLS TAG SWITCHING WITH ADVANCED SECURITY

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MPLS TAG SWITCHING WITH ADVANCED SECURITY

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Approved By

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Head Project

ACKNOWLEDGEMENTS

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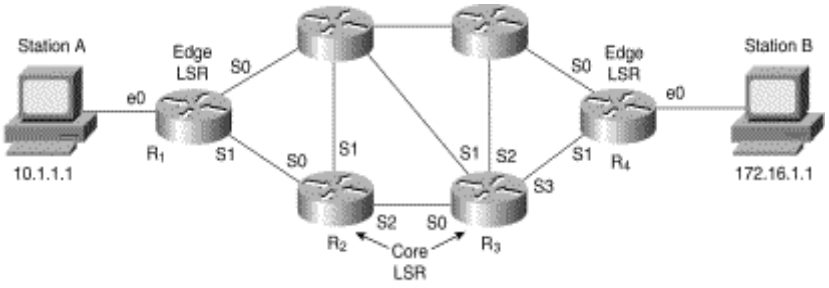
Finally, words alone cannot express the thanks we owe to Allah Almighty, who gave us the opportunity to work with such precious resource persons.

PROJECT OVERVIEW

In a normally routed environment, frames pass from a source to a destination in a hop-by-hop basis. Transit routers evaluate each frame's Layer 3 header and perform a route table lookup to determine the next hop toward the destination. This tends to reduce throughput in a network because of the intensive CPU requirements to process each frame. Although some routers implement hardware and software switching techniques to accelerate the evaluation process by creating high-speed cache entries, these methods rely upon the Layer 3 routing protocol to determine the path to the destination.

Unfortunately, routing protocols have little, if any, visibility into the Layer 2 characteristics of the network, particularly in regard to quality of service (QoS) and loading. Rapid changes in the type (and quantity) of traffic handled by the Internet and the explosion in the number of Internet users is putting an unprecedented strain on the Internet's infrastructure. This pressure mandates new traffic-management solutions. MPLS and its predecessor, tag switching, are aimed at resolving many of the challenges facing an evolving Internet and high-speed data communications in general.

To meet these new demands, *multiprotocol label switching (MPLS)* changes the hop-by-hop paradigm by enabling devices to specify paths in the network based upon QoS and bandwidth needs of the applications. In other words, path selection can now take into account Layer 2 attributes. Before MPLS, vendors implemented proprietary methods for switching frames with values other than the Layer 3 header.



Router	Incoming label	Incoming interface	Destination network	Outgoing interface	Outgoing label
R_1	—	e0	172.16.1	S1	6
R_2	6	S0	172.16.1	S2	11
R_3	11	S0	172.16.1	S3	7
R_4	7	S1	172.16.1	e0	—

AN EXAMPLE DIAGRAM OF MPLS

OBJECTIVES

The main objective is to implement a Cisco Routers based network infrastructure with advanced security technologies. This project is mainly a research based project, covering MPLS Tag-switching, cabling, different operating systems, network technologies, topologies, advanced security technologies, advance routing concepts, clients, internet sharing, NAT support, Enterprise Network Administration, LAN/WAN concepts and above of all how to implement them as well. We will demonstrate and show our work on WAN at the end of our research work. This project will open doors for us in the field of networking and our research based material and demonstration would also benefit students in their research projects as well. Some concepts of visual programming would also be learnt. In short words, this dynamic project will reflect our enthusiasm and devotion in the field of networking and we'll be able to compete with the foreign experts who charge heavily for their expertise from our enterprises. We will deliver same quality at least possible cost to the enterprises.

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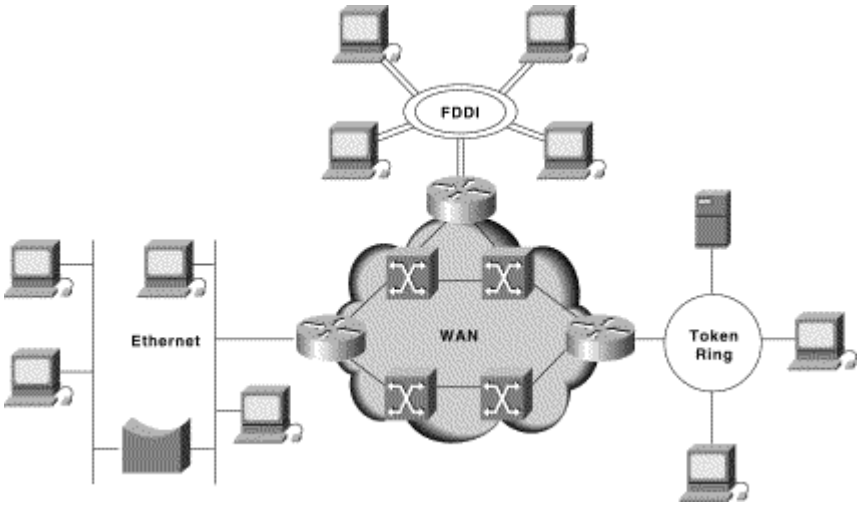
4. Introduction To Cisco MPLS VPN Technology

In this chapter, some fundamental concepts and terms used in the evolving language of internetworking are addressed. This chapter focuses mainly on mapping the Open System Interconnection (OSI) model to networking/internetworking functions, and also summarizes the general nature of addressing schemes within the context of the OSI model. The OSI model represents the building blocks for internetworks. Understanding the conceptual model helps understand the complex pieces that make up an internetwork.

1.1 What is an Internetwork?

An *internetwork* is a collection of individual networks, connected by intermediate networking devices, that functions as a single large network. Internetworking refers to the industry, products, and procedures that meet the challenge of creating and administering internetworks. Figure 1-1 illustrates some different kinds of network technologies that can be interconnected by routers and other networking devices to create an internetwork.

Figure 1-1: Different Network Technologies Can Be Connected to Create an Internetwork



1.1.1 History of Internetworking

The first networks were time-sharing networks that used mainframes and attached terminals. Such environments were implemented by both IBM's Systems Network Architecture (SNA) and Digital's network architecture.

Local-area networks (LANs) evolved around the PC revolution. LANs enabled multiple users in a relatively small geographical area to exchange files and messages, as well as access shared resources such as file servers and printers.

Wide-area networks (WANs) interconnect LANs with geographically dispersed users to create connectivity. Some of the technologies used for connecting LANs include T1, T3,

ATM, ISDN, ADSL, Frame Relay, radio links, and others. New methods of connecting dispersed LANs are appearing everyday.

Today, high-speed LANs and switched internetworks are becoming widely used, largely because they operate at very high speeds and support such high-bandwidth applications as multimedia and videoconferencing.

Internetworking evolved as a solution to three key problems: isolated LANs, duplication of resources, and a lack of network management. Isolated LANs made electronic communication between different offices or departments impossible. Duplication of resources meant that the same hardware and software had to be supplied to each office or department, as did separate support staff. This lack of network management meant that no centralized method of managing and troubleshooting networks existed.

1.1.2 Internetworking Challenges

Implementing a functional internetwork is no simple task. Many challenges must be faced, especially in the areas of connectivity, reliability, network management, and flexibility. Each area is key in establishing an efficient and effective internetwork.

The challenge when connecting various systems is to support communication among disparate technologies. Different sites, for example, may use different types of media operating at varying speeds, or may even include different types of systems that need to communicate.

Because companies rely heavily on data communication, internetworks must provide a certain level of reliability. This is an unpredictable world, so many large internetworks include redundancy to allow for communication even when problems occur.

Furthermore, network management must provide centralized support and troubleshooting capabilities in an internetwork. Configuration, security, performance, and other issues must be adequately addressed for the internetwork to function smoothly. Security within an internetwork is essential. Many people think of network security from the perspective of protecting the private network from outside attacks. However, it is just as important to protect the network from internal attacks, especially because most security breaches come from inside. Networks must also be secured so that the internal network cannot be used as a tool to attack other external sites.

Early in the year 2000, many major web sites were the victims of distributed denial of service (DDOS) attacks. These attacks were possible because a great number of private networks currently connected with the Internet were not properly secured. These private networks were used as tools for the attackers.

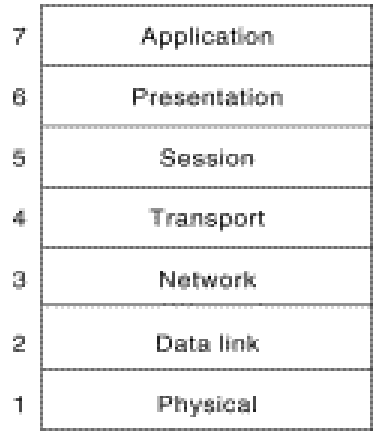
Because nothing in this world is stagnant, internetworks must be flexible enough to change with new demands.

1.2 Open System Interconnection Reference Model

The *Open System Interconnection (OSI) reference model* describes how information from a software application in one computer moves through a network medium to a software application in another computer. The OSI reference model is a conceptual model composed of seven layers, each specifying particular network functions. The model was developed by the International Organization for Standardization (ISO) in 1984, and it is now considered the primary architectural model for intercomputer communications. The OSI model divides the tasks involved with moving information between networked computers into seven smaller, more manageable task groups. A task or group of tasks is then assigned to each of the seven OSI layers. Each layer is reasonably self-contained so that the tasks assigned to each layer can be implemented independently. This enables the solutions offered by one layer to be updated without adversely affecting the other layers. The following list details the seven layers of the Open System Interconnection (OSI) reference model:

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

Figure 1-2: The OSI Reference Model Contains Seven Independent Layers



1.2.1 Characteristics of the OSI Layers

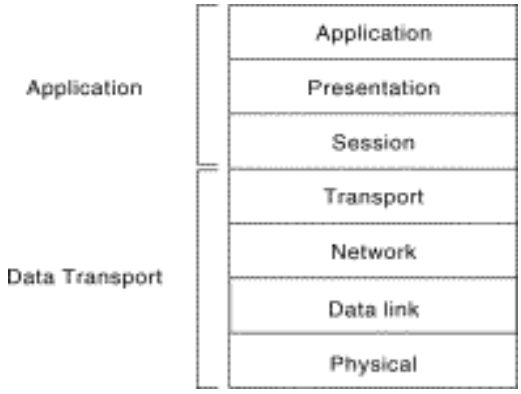
The seven layers of the OSI reference model can be divided into two categories: upper layers and lower layers.

The *upper layers* of the OSI model deal with application issues and generally are implemented only in software. The highest layer, the application layer, is closest to the end user. Both users and application layer processes interact with software applications that contain a communications component. The term upper layer is sometimes used to refer to any layer above another layer in the OSI model.

The *lower layer*s of the OSI model handle data transport issues. The physical layer and the data link layer are implemented in hardware and software. The lowest layer, the physical layer, is closest to the physical network medium (the network cabling, for example) and is responsible for actually placing information on the medium.

Figure 1-3 illustrates the division between the upper and lower OSI layers.

Figure 1-3: Two Sets of Layers Make Up the OSI Layers



1.2.2 Protocols

The OSI model provides a conceptual framework for communication between computers, but the model itself is not a method of communication. Actual communication is made possible by using communication protocols. In the context of data networking, a *protocol* is a formal set of rules and conventions that governs how computers exchange information over a network medium. A protocol implements the functions of one or more of the OSI layers.

A wide variety of communication protocols exist. Some of these protocols include LAN protocols, WAN protocols, network protocols, and routing protocols. *LAN protocols* operate at the physical and data link layers of the OSI model and define communication

over the various LAN media. *WAN protocols* operate at the lowest three layers of the OSI model and define communication over the various wide-area media. *Routing protocols* are network layer protocols that are responsible for exchanging information between routers so that the routers can select the proper path for network traffic. Finally, *network protocols* are the various upper-layer protocols that exist in a given protocol suite. Many protocols rely on others for operation. For example, many routing protocols use network protocols to exchange information between routers. This concept of building upon the layers already in existence is the foundation of the OSI model.

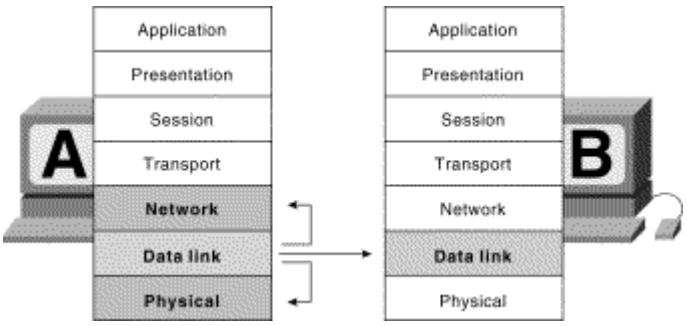
1.2.3 OSI Model and Communication between Systems

Information being transferred from a software application in one computer system to a software application in another must pass through the OSI layers. For example, if a software application in System A has information to transmit to a software application in System B, the application program in System A will pass its information to the application layer (Layer 7) of System A. The application layer then passes the information to the presentation layer (Layer 6), which relays the data to the session layer (Layer 5), and so on down to the physical layer (Layer 1). At the physical layer, the information is placed on the physical network medium and is sent across the medium to System B. The physical layer of System B removes the information from the physical medium, and then its physical layer passes the information up to the data link layer (Layer 2), which passes it to the network layer (Layer 3), and so on, until it reaches the application layer (Layer 7) of System B. Finally, the application layer of System B passes the information to the recipient application program to complete the communication process.

1.2.3.1 Interaction between OSI Model Layers

A given layer in the OSI model generally communicates with three other OSI layers: the layer directly above it, the layer directly below it, and its peer layer in other networked computer systems. The data link layer in System A, for example, communicates with the network layer of System A, the physical layer of System A, and the data link layer in System B. Figure 1-4 illustrates this example.

Figure 1-4: OSI Model Layers Communicate with Other Layers



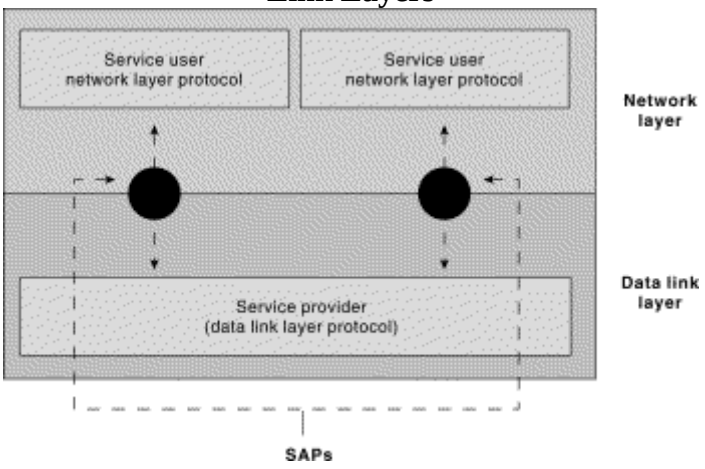
1.2.3.2 OSI Layer Services

One OSI layer communicates with another layer to make use of the services provided by the second layer. The services provided by adjacent layers help a given OSI layer communicate with its peer layer in other computer systems. Three basic elements are involved in layer services: the service user, the service provider, and the service access point (SAP).

In this context, the *service user* is the OSI layer that requests services from an adjacent OSI layer. The *service provider* is the OSI layer that provides services to service users. OSI layers can provide services to multiple service users. The SAP is a conceptual location at which one OSI layer can request the services of another OSI layer.

Figure 1-5 illustrates how these three elements interact at the network and data link layers.

Figure 1-5: Service Users, Providers, and SAPs Interact at the Network and Data Link Layers



1.2.3.3 OSI Model Layers and Information Exchange

The seven OSI layers use various forms of control information to communicate with their peer layers in other computer systems. This *control information* consists of specific requests and instructions that are exchanged between peer OSI layers.

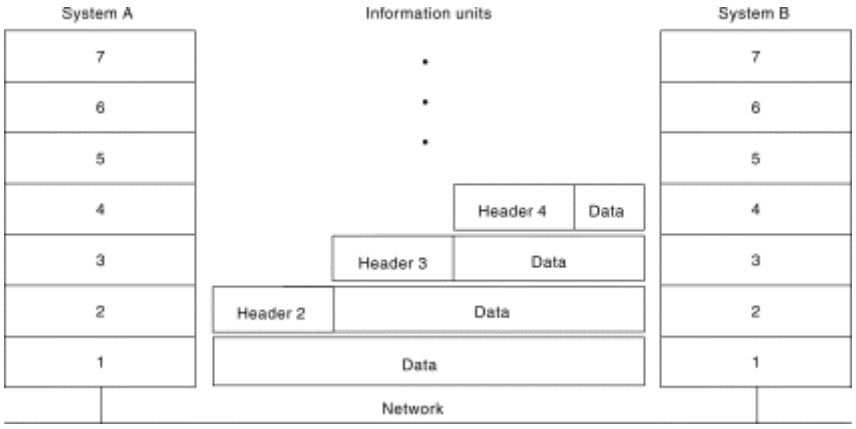
Control information typically takes one of two forms: headers and trailers. *Headers* are prepended to data that has been passed down from upper layers. *Trailers* are appended to data that has been passed down from upper layers. An OSI layer is not required to attach a header or a trailer to data from upper layers.

Headers, trailers, and data are relative concepts, depending on the layer that analyzes the information unit. At the network layer, for example, an information unit consists of a

Layer 3 header and data. At the data link layer, however, all the information passed down by the network layer (the Layer 3 header and the data) is treated as data.

In other words, the data portion of an information unit at a given OSI layer potentially can contain headers, trailers, and data from all the higher layers. This is known as *encapsulation*. Figure 1-6 shows how the header and data from one layer are encapsulated into the header of the next lowest layer.

Figure 1-6: Headers and Data Can Be Encapsulated During Information Exchange



1.2.3.4 Information Exchange Process

The information exchange process occurs between peer OSI layers. Each layer in the source system adds control information to data, and each layer in the destination system analyzes and removes the control information from that data.

If System A has data from a software application to send to System B, the data is passed to the application layer. The application layer in System A then communicates any control information required by the application layer in System B by prepending a header to the data. The resulting information unit (a header and the data) is passed to the presentation layer, which prepends its own header containing control information intended for the presentation layer in System B. The information unit grows in size as each layer prepends its own header (and, in some cases, a trailer) that contains control information to be used by its peer layer in System B. At the physical layer, the entire information unit is placed onto the network medium.

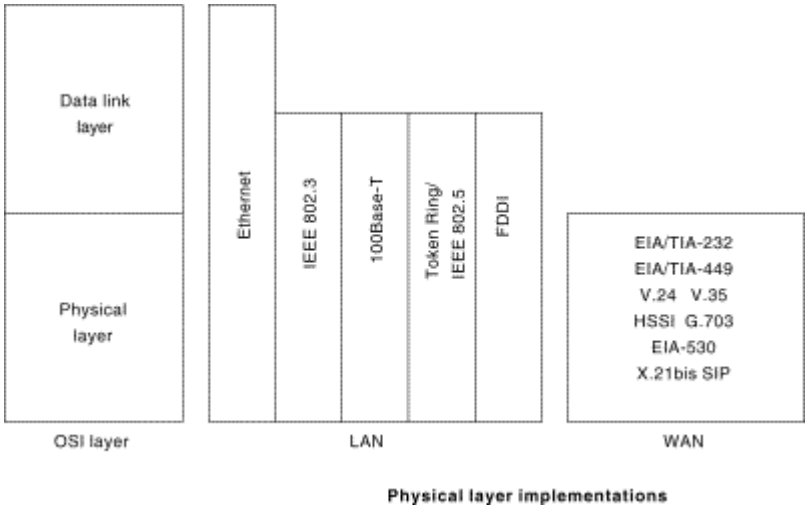
The physical layer in System B receives the information unit and passes it to the data link layer. The data link layer in System B then reads the control information contained in the header prepended by the data link layer in System A. The header is then removed, and the remainder of the information unit is passed to the network layer. Each layer performs the same actions: The layer reads the header from its peer layer, strips it off, and passes the

remaining information unit to the next highest layer. After the application layer performs these actions, the data is passed to the recipient software application in System B, in exactly the form in which it was transmitted by the application in System A.

1.2.4 OSI Model Physical Layer

The physical layer defines the electrical, mechanical, procedural, and functional specifications for activating, maintaining, and deactivating the physical link between communicating network systems. Physical layer specifications define characteristics such as voltage levels, timing of voltage changes, physical data rates, maximum transmission distances, and physical connectors. Physical layer implementations can be categorized as either LAN or WAN specifications. Figure 1-7 illustrates some common LAN and WAN physical layer implementations.

Figure 1-7: Physical Layer Implementations Can Be LAN or WAN Specifications



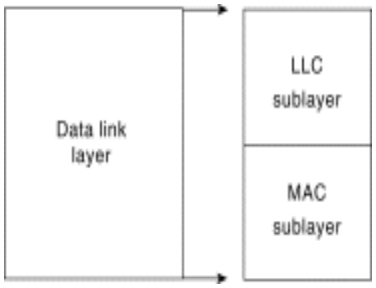
1.2.5 OSI Model Data Link Layer

The data link layer provides reliable transit of data across a physical network link. Different data link layer specifications define different network and protocol characteristics, including physical addressing, network topology, error notification, sequencing of frames, and flow control. Physical addressing (as opposed to network addressing) defines how devices are addressed at the data link layer. Network topology consists of the data link layer specifications that often define how devices are to be physically connected, such as in a bus or a ring topology. Error notification alerts upper-layer protocols that a transmission error has occurred, and the sequencing of data frames reorders frames that are transmitted out of sequence. Finally, flow control moderates the

transmission of data so that the receiving device is not overwhelmed with more traffic than it can handle at one time.

The Institute of Electrical and Electronics Engineers (IEEE) has subdivided the data link layer into two sublayers: Logical Link Control (LLC) and Media Access Control (MAC). Figure 1-8 illustrates the IEEE sublayers of the data link layer.

Figure 1-8: The Data Link Layer Contains Two Sublayers



The *Logical Link Control (LLC)* sublayer of the data link layer manages communications between devices over a single link of a network. LLC is defined in the IEEE 802.2 specification and supports both connectionless and connection-oriented services used by higher-layer protocols. IEEE 802.2 defines a number of fields in data link layer frames that enable multiple higher-layer protocols to share a single physical data link. The *Media Access Control (MAC)* sublayer of the data link layer manages protocol access to the physical network medium. The IEEE MAC specification defines MAC addresses, which enable multiple devices to uniquely identify one another at the data link layer.

1.2.6 OSI Model Network Layer

The network layer defines the network address, which differs from the MAC address. Some network layer implementations, such as the Internet Protocol (IP), define network addresses in a way that route selection can be determined systematically by comparing the source network address with the destination network address and applying the subnet mask. Because this layer defines the logical network layout, routers can use this layer to determine how to forward packets. Because of this, much of the design and configuration work for internetworks happens at Layer 3, the network layer.

1.2.7 OSI Model Transport Layer

The transport layer accepts data from the session layer and segments the data for transport across the network. Generally, the transport layer is responsible for making sure that the data is delivered error-free and in the proper sequence. Flow control generally occurs at the transport layer.

Flow control manages data transmission between devices so that the transmitting device does not send more data than the receiving device can process. Multiplexing enables data

from several applications to be transmitted onto a single physical link. Virtual circuits are established, maintained, and terminated by the transport layer. Error checking involves creating various mechanisms for detecting transmission errors, while error recovery involves acting, such as requesting that data be retransmitted, to resolve any errors that occur.

The transport protocols used on the Internet are TCP and UDP.

1.2.8 OSI Model Session Layer

The session layer establishes, manages, and terminates communication sessions. Communication sessions consist of service requests and service responses that occur between applications located in different network devices. These requests and responses are coordinated by protocols implemented at the session layer. Some examples of session-layer implementations include Zone Information Protocol (ZIP), the AppleTalk protocol that coordinates the name binding process; and Session Control Protocol (SCP), the DECnet Phase IV session layer protocol.

1.2.9 OSI Model Presentation Layer

The presentation layer provides a variety of coding and conversion functions that are applied to application layer data. These functions ensure that information sent from the application layer of one system would be readable by the application layer of another system. Some examples of presentation layer coding and conversion schemes include common data representation formats, conversion of character representation formats, common data compression schemes, and common data encryption schemes.

Common data representation formats, or the use of standard image, sound, and video formats, enable the interchange of application data between different types of computer systems. Conversion schemes are used to exchange information with systems by using different text and data representations, such as EBCDIC and ASCII. Standard data compression schemes enable data that is compressed at the source device to be properly decompressed at the destination. Standard data encryption schemes enable data encrypted at the source device to be properly deciphered at the destination.

Presentation layer implementations are not typically associated with a particular protocol stack. Some well-known standards for video include QuickTime and Motion Picture Experts Group (MPEG). QuickTime is an Apple Computer specification for video and audio, and MPEG is a standard for video compression and coding.

Among the well-known graphic image formats are Graphics Interchange Format (GIF), Joint Photographic Experts Group (JPEG), and Tagged Image File Format (TIFF). GIF is a standard for compressing and coding graphic images. JPEG is another compression and coding standard for graphic images, and TIFF is a standard coding format for graphic images.