Open System Interconnection (OSI) Protocols

Background

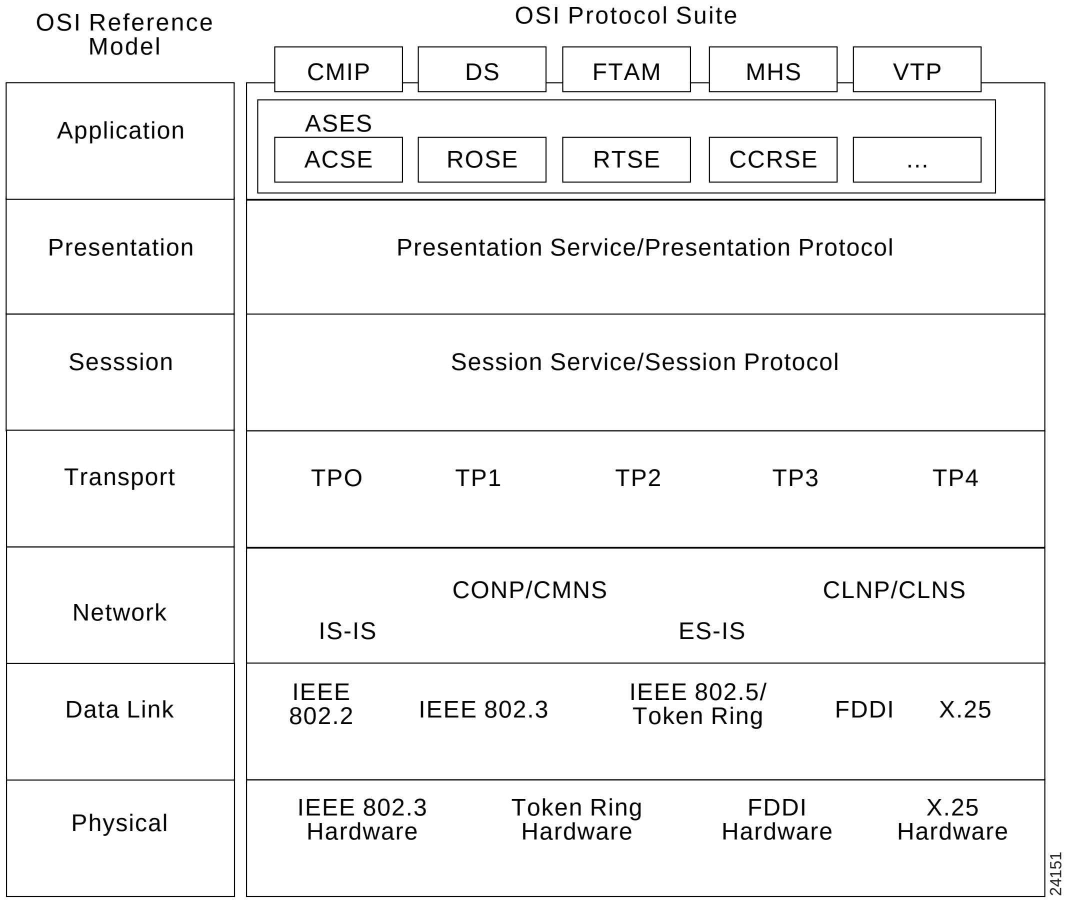
The Open System Interconnection (OSI) protocol suite is comprised of numerous standard protocols that are based on the OSI reference model. These protocols are part of an international program to develop data-networking protocols and other standards that facilitate multivendor equipment interoperability. The OSI program grew out of a need for international networking standards and is designed to facilitate communication between hardware and software systems despite differences in underlying architectures.

The OSI specifications were conceived and implemented by two international standards organizations: the International Organization for Standardization (ISO) and the International Telecommunication Union-Telecommunication Standardization Sector (ITU-T). This chapter provides a summary of the OSI protocol suite and illustrates its mapping to the general OSI reference model.

OSI Networking Protocols

Figure 32-1 illustrates the entire OSI protocol suite and its relation to the layers of the OSI reference model. Each component of this protocol suite is discussed briefly in this chapter. The OSI routing protocols are addressed in more detail in Chapter 42, “Open Shortest Path First (OSPF).”

Figure 32-1 The OSI protocol suite maps to all layers of the OSI reference model.



OSI Physical and Data Link layers

The OSI protocol suite supports numerous standard media-access protocols at the physical and data link layers. The wide variety of media-access protocols supported in the OSI protocol suite allows other protocol suites to exist easily alongside OSI on the same network media. Supported media-access protocols include IEEE 802.2 LLC, IEEE 802.3, Token Ring/IEEE 802.5, Fiber Distributed Data Interface (FDDI), and X.25.

OSI Network Layer

The OSI protocol suite specifies two routing protocols at the network layer: End System-to-Intermediate System (ES-IS) and Intermediate System-to-Intermediate System (IS-IS). In addition, the OSI suite implements two types of network services: connectionless service and connection-oriented service.

OSI-Layer Standards

In addition to the standards specifying the OSI network-layer protocols and services, the following documents describe other OSI network-layer specifications:

- ISO 8648—This standard defines the *internal organization of the network layer* (IONL), which divides the network layer into three distinct sublayers to support different subnetwork types.
- ISO 8348—This standard defines network-layer addressing and describes the connection-oriented and connectionless services provided by the OSI network layer.
- ISO TR 9575—This standard describes the framework, concepts, and terminology used in relation to OSI routing protocols.

OSI Connectionless Network Service

OSI connectionless network service is implemented by using the Connectionless Network Protocol (CLNP) and Connectionless Network Service (CLNS). CLNP and CLNS are described in the ISO 8473 standard.

CLNP is an OSI network-layer protocol that carries upper-layer data and error indications over connectionless links. CLNP provides the interface between the Connectionless Network Service (CLNS) and upper layers.

CLNS provides network-layer services to the transport layer via CLNP.

CLNS does not perform connection setup or termination because paths are determined independently for each packet that is transmitted through a network. This contrasts with Connection-Mode Network Service (CMNS).

In addition, CLNS provides best-effort delivery, which means that no guarantee exists that data will not be lost, corrupted, misordered, or duplicated. CLNS relies on transport-layer protocols to perform error detection and correction.

OSI Connection-Oriented Network Service

OSI connection-oriented network service is implemented by using the Connection-Oriented Network Protocol (CONP) and Connection-Mode Network Service (CMNS).

CONP is an OSI network-layer protocol that carries upper-layer data and error indications over connection-oriented links. CONP is based on the X.25 Packet-Layer Protocol (PLP) and is described in the ISO 8208 standard, “X.25 Packet-Layer Protocol for DTE.”

CONP provides the interface between CMNS and upper layers. It is a network-layer service that acts as the interface between the transport layer and CONP and is described in the ISO 8878 standard.

CMNS performs functions related to the explicit establishment of paths between communicating transport-layer entities. These functions include connection setup, maintenance, and termination, and CMNS also provides a mechanism for requesting a specific quality of service (QOS). This contrasts with CLNS.

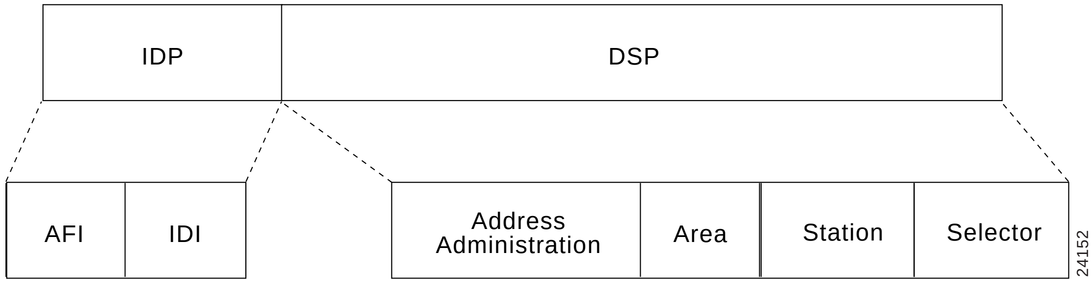
Network-Layer Addressing

OSI network-layer addressing is implemented by using two types of hierarchical addresses: network service access-point addresses and network-entity titles.

A network service-access point (NSAP) is a conceptual point on the boundary between the network and the transport layers. The NSAP is the location at which OSI network services are provided to the transport layer. Each transport-layer entity is assigned a single NSAP, which is individually addressed in an OSI internetwork using NSAP addresses.

Figure 32-2 illustrates the format of the OSI NSAP address, which identifies individual NSAPs.

Figure 32-2 The OSI NSAP address is assigned to each transport-layer entity.



NSAP Address Fields

Two NSAP Address fields exist: the Initial Domain Part (IDP) and the Domain-Specific Part (DSP).

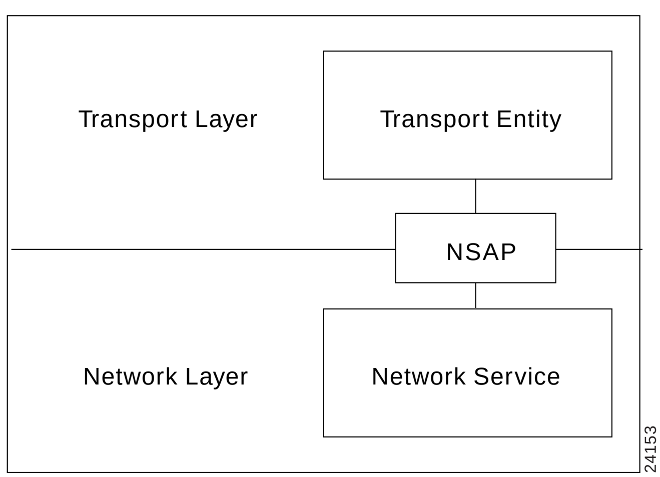
The IDP field is divided into two parts: the Authority Format Identifier (AFI) and the Initial Domain Identifier (IDI). The AFI provides information about the structure and content of the IDI and DSP fields, such as whether the IDI is of variable length and whether the DSP uses decimal or binary notation. The IDI specifies the entity that can assign values to the DSP portion of the NSAP address.

The DSP is subdivided into four parts by the authority responsible for its administration. The Address Administration fields allow for the further administration of addressing by adding a second authority identifier and by delegating address administration to subauthorities. The Area field identifies the specific area within a domain and is used for routing purposes. The Station field identifies a specific station within an area and also is used for routing purposes. The Selector field provides the specific n-selector within a station and, much like the other fields, is used for routing purposes. The reserved n-selector 00 identifies the address as a network entity title (NET).

End-System NSAPs

An OSI end system (ES) often has multiple NSAP addresses, one for each transport entity that it contains. If this is the case, the NSAP address for each transport entity usually differs only in the last byte (called the *n-selector*). Figure 32-3 illustrates the relationship between a transport entity, the NSAP, and the network service.

Figure 32-3 The NSAP provides a linkage between a transport entity and a network service.



A network-entity title (NET) is used to identify the network layer of a system without associating that system with a specific transport-layer entity (as an NSAP address does). NETs are useful for addressing intermediate systems (ISs), such as routers, that do not interface with the transport layer. An IS can have a single NET or multiple NETs, if it participates in multiple areas or domains.

OSI Protocols **Transport Layer**

The OSI protocol suite implements two types of services at the transport layer: connection-oriented transport service and connectionless transport service.

Five connection-oriented transport-layer protocols exist in the OSI suite, ranging from Transport Protocol Class 0 through Transport Protocol Class 4. Connectionless transport service is supported only by Transport Protocol Class 4.

Transport Protocol Class 0 (TP0), the simplest OSI transport protocol, performs segmentation and reassembly functions. TP0 requires connection-oriented network service.

Transport Protocol Class 1 (TP1) performs segmentation and reassembly and offers basic error recovery. TP1 sequences protocol data units (PDUs) and will retransmit PDUs or reinitiate the connection if an excessive number of PDUs are unacknowledged. TP1 requires connection-oriented network service.

Transport Protocol Class 2 (TP2) performs segmentation and reassembly, as well as multiplexing and demultiplexing data streams over a single virtual circuit. TP2 requires connection-oriented network service.

Transport Protocol Class 3 (TP3) offers basic error recovery and performs segmentation and reassembly, in addition to multiplexing and demultiplexing data streams over a single virtual circuit. TP3 also sequences PDUs and retransmits them or reinitiates the connection if an excessive number are unacknowledged. TP3 requires connection-oriented network service.

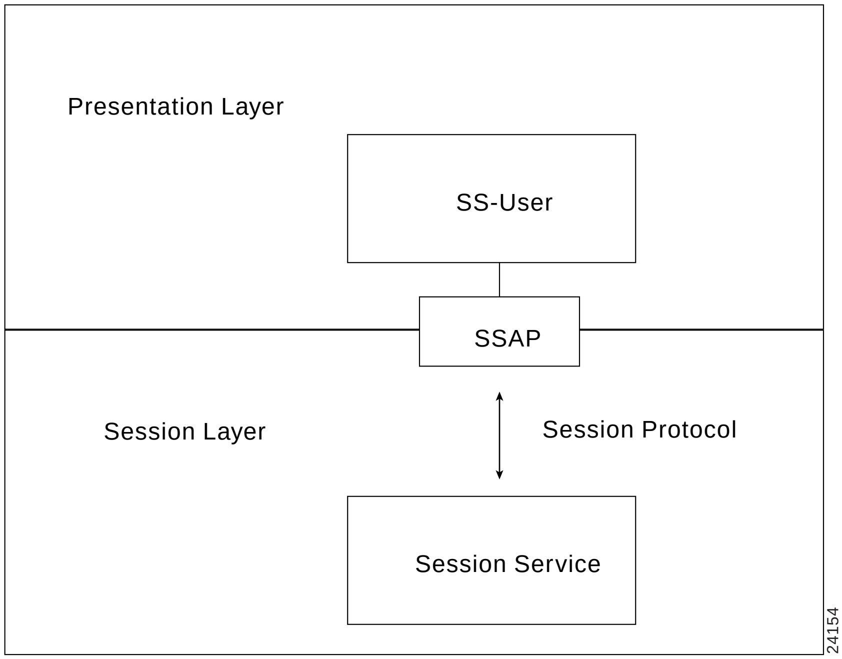
Transport Protocol Class 4 (TP4) TP4 offers basic error recovery, performs segmentation and reassembly, and supplies multiplexing and demultiplexing of data streams over a single virtual circuit. TP4 sequences PDUs and retransmits them or reinitiates the connection if an excessive number are unacknowledged. TP4 provides reliable transport service and functions with either connection-oriented or connectionless network service. It is based on the Transmission Control Protocol (TCP) in the Internet Protocols suite and is the only OSI protocol class that supports connectionless network service.

OSI Protocols Session Layer

The session-layer implementation of the OSI protocol suite consists of a session protocol and a session service. The session protocol allows session-service users (SS-users) to communicate with the session service. An *SS-user* is an entity that requests the services of the session layer. Such requests are made at Session-Service Access Points (SSAPs), and SS-users are uniquely identified by using an SSAP address. Figure 32-4 shows the relationship between the SS-user, the SSAP, the session protocol, and the session service.

Session service provides four basic services to SS-users. First, it establishes and terminates connections between SS-users and synchronizes the data exchange between them. Second, it performs various negotiations for the use of session-layer tokens, which must be possessed by the SS-user to begin communicating. Third, it inserts synchronization points in transmitted data that allow the session to be recovered in the event of errors or interruptions. Finally, it allows SS-users to interrupt a session and resume it later at a specific point.

Figure 32-4 Session layer functions provide service to presentation layer functions via a SSAP.



Session service is defined in the ISO 8326 standard and in the ITU-T X.215 recommendation. The session protocol is defined in the ISO 8327 standard and in the ITU-T X.225 recommendation. A connectionless version of the session protocol is specified in the ISO 9548 standard.

OSI Protocols Presentation Layer

The presentation-layer implementation of the OSI protocol suite consists of a presentation protocol and a presentation service. The presentation protocol allows presentation-service users (PS-users) to communicate with the presentation service.

A PS-user is an entity that requests the services of the presentation layer. Such requests are made at Presentation-Service Access Points (PSAPs). PS-users are uniquely identified by using PSAP addresses.

Presentation service negotiates transfer syntax and translates data to and from the transfer syntax for PS-users, which represent data using different syntaxes. The presentation service is used by two PS-users to agree upon the transfer syntax that will be used. When a transfer syntax is agreed upon, presentation-service entities must translate the data from the PS-user to the correct transfer syntax.

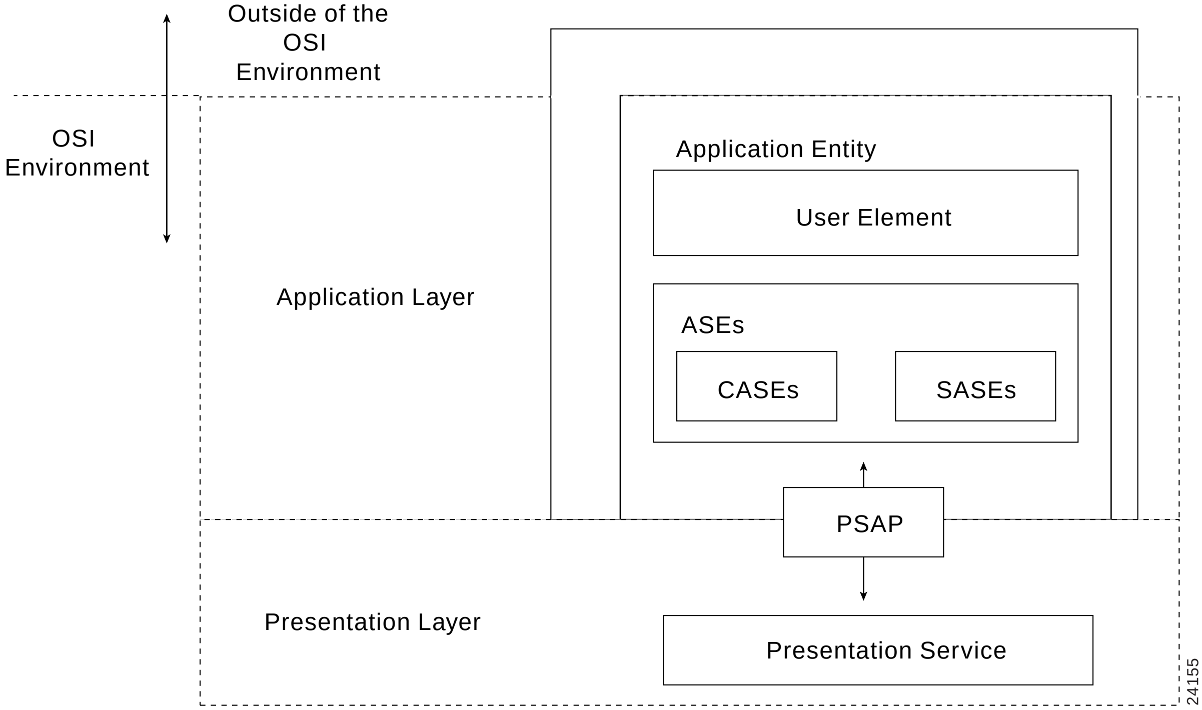
The OSI presentation-layer service is defined in the ISO 8822 standard and in the ITU-T X.216 recommendation. The OSI presentation protocol is defined in the ISO 8823 standard and in the ITU-T X.226 recommendation. A connectionless version of the presentation protocol is specified in the ISO 9576 standard.

OSI Protocols Application Layer

The application-layer implementation of the OSI protocol suite consists of various application entities. An application entity is the part of an application process that is relevant to the operation of the OSI protocol suite. An application entity is composed of the user element and the application service element (ASE).

The user element is the part of an application entity that uses ASEs to satisfy the communication needs of the application process. The ASE is the part of an application entity that provides services to user elements and, therefore, to application processes. ASEs also provide interfaces to the lower OSI layers. Figure 32-5 portrays the composition of a single application process (composed of the application entity, the user element, and the ASEs) and its relation to the PSAP and presentation service.

Figure 32-5 An application process relies on the PSAP and presentation service.



ASEs fall into one of the two following classifications: Common-Application Service Elements (CASEs) and Specific-Application Service Elements (SASEs). Both of these might be present in a single application entity.

Common-Application Service Elements (CASEs)

Common-Application Service Elements (CASEs) are ASEs that provide services used by a wide variety of application processes. In many cases, multiple CASEs are used by a single application entity. The following four CASEs are defined in the OSI specification:

- *Association Control Service Element (ACSE)*—Creates associations between two application entities in preparation for application-to-application communication
- *Remote Operations Service Element (ROSE)*—Implements a request-reply mechanism that permits various remote operations across an application association established by the ACSE
- *Reliable Transfer Service Element (RTSE)*—Allows ASEs to reliably transfer messages while preserving the transparency of complex lower-layer facilities
- *Commitment, Concurrence, and Recovery Service Elements (CCRSE)*—Coordinates dialogues between multiple application entities.

Specific-Application Service Elements (SASEs)

Specific-Application Service Elements are ASEs that provide services used only by a specific application process, such as file transfer, database access, and order-entry, among others.

OSI Protocols Application Processes

An application process is the element of an application that provides the interface between the application itself and the OSI application layer. Some of the standard OSI application processes include the following:

- *Common Management-Information Protocol (CMIP)*—Performs network management functions, allowing the exchange of management information between ESs and management stations. CMIP is specified in the ITU-T X.700 recommendation and is functionally similar to the Simple Network-Management Protocol (SNMP) and NetView.
- *Directory Services (DS)*—Serves as a distributed directory that is used for node identification and addressing in OSI internetworks. DS is specified in the ITU-T X.500 recommendation.
- *File Transfer, Access, and Management (FTAM)*—Provides file-transfer service and distributed file-access facilities.
- *Message Handling System* (MHS)—Provides a transport mechanism for electronic messaging applications and other applications by using store-and-forward services.
- *Virtual Terminal Protocol* (VTP)—Provides terminal emulation that allows a computer system to appear to a remote ES as if it were a directly attached terminal.