CHAPTER 14

Chapter Goals

- Tell how SMDS works, and describe its components.
- Describe the operational elements of the SMDS environment, and outline its underlying protocol.
- Discuss related technologies.
- Discuss SMDS access classes and cell formats.

Switched Multimegabit Data Service

Introduction

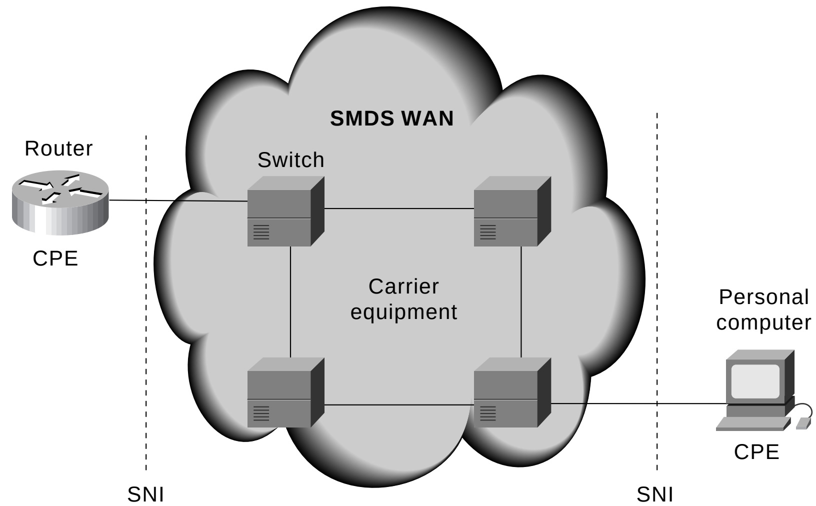
Switched Multimegabit Data Service (SMDS) is a high-speed, packet-switched, datagram-based WAN networking technology used for communication over public data networks (PDNs). SMDS can use fiber- or copper-based media; it supports speeds of 1.544 Mbps over Digital Signal level 1 (DS-1) transmission facilities, or 44.736 Mbps over Digital Signal level 3 (DS-3) transmission facilities. In addition, SMDS data units are large enough to encapsulate entire IEEE 802.3, IEEE 802.5, and Fiber Distributed Data Interface (FDDI) frames. This chapter summarizes the operational elements of the SMDS environment and outlines the underlying protocol. A discussion of related technologies, such as Distributed Queue Dual Bus (DQDB) is also provided. The chapter closes with discussions of SMDS access classes and cell formats.

SMDS Network Components

SMDS networks consist of several underlying devices to provide high-speed data service. These include customer premises equipment (CPE), carrier equipment, and the subscriber network interface (SNI). CPE is terminal equipment typically owned and maintained by the customer. CPE includes end devices, such as terminals and personal computers, and intermediate nodes, such as routers, modems, and multiplexers. Intermediate nodes, however, sometimes are provided by the SMDS carrier. Carrier equipment generally consists of high-speed WAN switches that must conform to certain network equipment specifications, such as those outlined by Bell Communications Research (Bellcore). These specifications define network operations, the interface between a local carrier network and a long-distance carrier network, and the interface between two switches inside a single carrier network.

The SNI is the interface between CPE and carrier equipment. This interface is the point at which the customer network ends and the carrier network begins. The function of the SNI is to render the technology and operation of the carrier SMDS network transparent to the customer. Figure 14-1 illustrates the relationships among these three components of an SMDS network.

Figure 14-1 The SNI Provides an Interface Between the CPE and the Carrier Equipment in SMDS



SMDS Interface Protocol

The *SMDS Interface Protocol (SIP)* is used for communications between CPE and SMDS carrier equipment. SIP provides connectionless service across the subscriber network interface (SNI), allowing the CPE to access the SMDS network. SIP is based on the IEEE 802.6 Distributed Queue Dual Bus (DQDB) standard for cell relay across metropolitan-area networks (MANs). The DQDB was chosen as the basis for SIP because it is an open standard that supports all the SMDS service features. In addition, DQDB was designed for compatibility with current carrier transmission standards, and it is aligned with emerging standards for Broadband ISDN (BISDN), which will allow it to interoperate with broadband video and voice services. Figure 14-2 illustrates where SIP is used in an SMDS network.

SIP Levels

SIP consists of three levels. SIP Level 3 operates at the Media Access Control (MAC) sublayer of the data link layer of the OSI reference model. SIP Level 2 operates at the MAC sublayer of the data link layer. SIP Level 1 operates at the physical layer of the OSI reference model. Figure 14-3 illustrates how SIP maps to the OSI reference model, including the IEEE data link sublayers.

Figure 14-2 SIP Provides Connectionless Service Between the CPE and Carrier Equipment

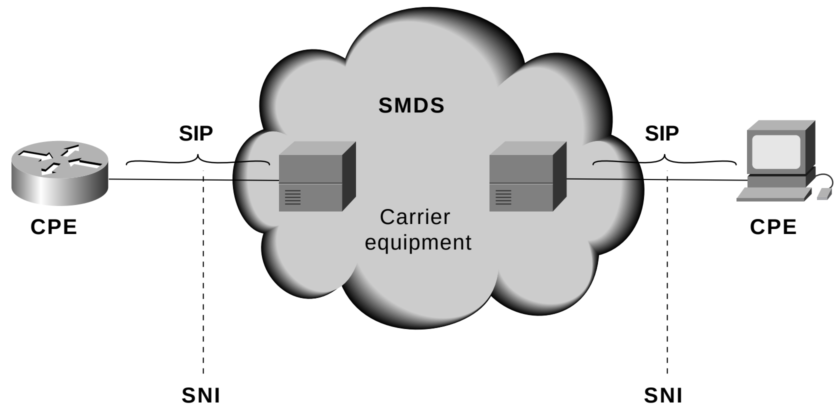
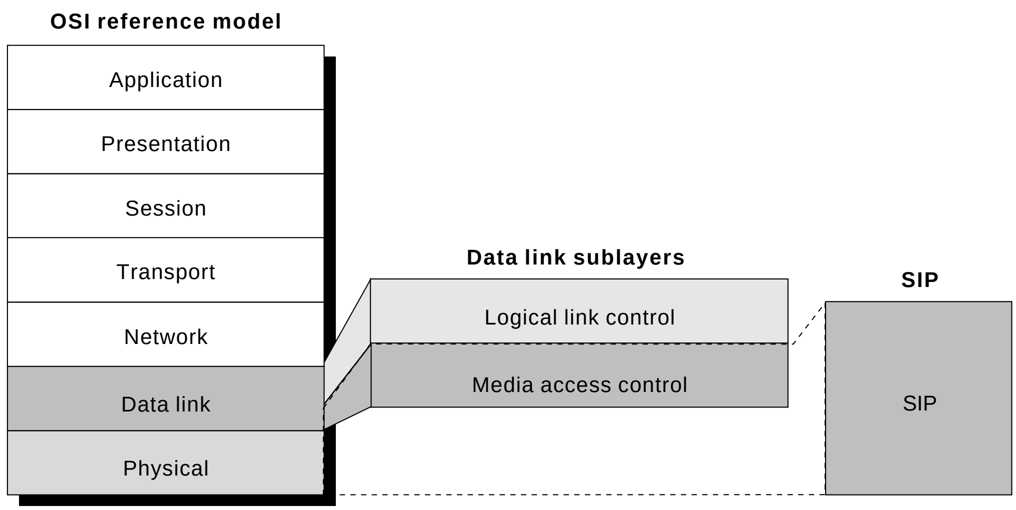


Figure 14-3 SIP Provides Services Associated with the Physical and Data Link Layers of the OSI Model



SIP Level 3 begins operation when user information is passed to it in the form of SMDS service data units (SDUs). SMDS SDUs then are encapsulated in a SIP Level 3 header and trailer. The resulting frame is called a Level 3 protocol data unit (PDU). SIP Level 3 PDUs then are passed to SIP Level 2.

SIP Level 2, which operates at the Media Access Control (MAC) sublayer of the data link layer, begins operating when it receives SIP Level 3 PDUs. The PDUs then are segmented into uniformly sized (53-octet) Level 2 PDUs, called cells. The cells are passed to SIP Level 1 for placement on the physical medium.

SIP Level 1 operates at the physical layer and provides the physical-link protocol that operates at DS-1 or DS-3 rates between CPE devices and the network. SIP Level 1 consists of the transmission system and Physical Layer Convergency Protocol (PLCP) sublayers. The transmission system sublayer defines the characteristics and method of attachment to a DS-1 or DS-3 transmission link. The PLCP specifies how SIP Level 2 cells are to be arranged relative to the DS-1 or DS-3 frame. PLCP also defines other management information.

Distributed Queue Dual Bus

The *Distributed Queue Dual Bus (DQDB)* is a data link layer communication protocol designed for use in metropolitan-area networks (MANs). DQDB specifies a network topology composed of two unidirectional logical buses that interconnect multiple systems. It is defined in the IEEE 802.6 DQDB standard.

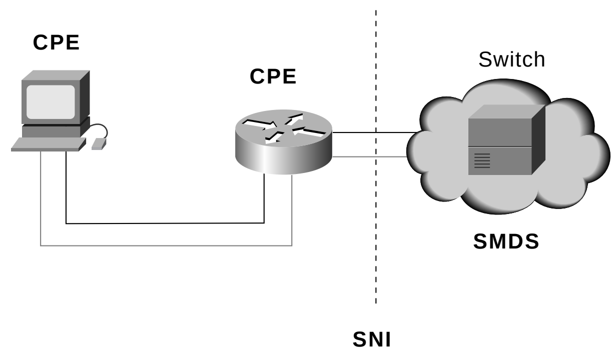
An access DQDB describes just the operation of the DQDB protocol (in SMDS, SIP) across a user-network interface (in SMDS, across the SNI). Such operation is distinguished from the operation of a DQDB protocol in any other environment (for example, between carrier equipment within the SMDS PDN).

The access DQDB is composed of the basic SMDS network components:

- **Carrier equipment**—A switch in the SMDS network operates as one station on the bus.
- **CPE**—One or more CPE devices operate as stations on the bus.
- **SNI**—The SNI acts as the interface between the CPE and the carrier equipment.

Figure 14-4 depicts a basic access DQDB, with two CPE devices and one switch (carrier equipment) attached to the dual bus.

Figure 14-4 A Basic Access DQDB May Consist of an End Node, a Router, and a Switch



An SMDS access DQDB typically is arranged in a single-CPE configuration or a multi-CPE configuration.

A single-CPE access DQDB configuration consists of one switch in the carrier SMDS network and one CPE station at the subscriber site. Single-CPE DQDB configurations create a two-node DQDB subnetwork. Communication occurs only between the switch and the one CPE device across the SNI. No contention is on the bus because no other CPE devices attempt to access it.

A multi-CPE configuration consists of one switch in the carrier SMDS network and a number of interconnected CPE devices at the subscriber site (all belonging to the same subscriber). In multi-CPE configurations, local communication between CPE devices is possible. Some local communication will be visible to the switch serving the SNI, and some will not.

Contention for the bus by multiple devices requires the use of the DQDB distributed queuing algorithm, which makes implementing a multi-CPE configuration more complicated than implementing a single-CPE configuration.

SMDS Access Classes

SMDS access classes enable SMDS networks to accommodate a broad range of traffic requirements and equipment capabilities. Access classes constrain CPE devices to a sustained or average rate of data transfer by establishing a maximum sustained information transfer rate and a maximum allowed degree of traffic burstiness. (Burstiness, in this context, is the propensity of a network to experience sudden increases in bandwidth demand.) SMDS access classes sometimes are implemented using a credit-management scheme. In this case, a credit-management algorithm creates and tracks a credit balance
for each customer interface. As packets are sent into the network, the credit balance is decremented. New credits are allocated periodically, up to an established maximum. Credit management is used only on DS-3-rate SMDS interfaces, not on DS-1-rate interfaces.

Five access classes are supported for DS-3-rate access (corresponding to sustained information rates). Data rates supported are 4, 10, 16, 25, and 34 Mbps.

SMDS Addressing Overview

SMDS *protocol data units (PDUs)* carry both a source and a destination address. SMDS addresses are 10-digit values resembling conventional telephone numbers.

The SMDS addressing implementation offers group addressing and security features.

SMDS group addresses allow a single address to refer to multiple CPE stations, which specify the group address in the Destination Address field of the PDU. The network makes multiple copies of the PDU, which are delivered to all members of the group. Group addresses reduce the amount of network resources required for distributing routing information, resolving addresses, and dynamically discovering network resources. SMDS group addressing is analogous to multicasting on LANs.

SMDS implements two security features: source address validation and address screening. *Source address validation* ensures that the PDU source address is legitimately assigned to the SNI from which it originated. Source address validation prevents address spoofing, in which illegal traffic assumes the source address of a legitimate device. *Address screening* allows a subscriber to establish a private virtual network that excludes unwanted traffic. If an address is disallowed, the data unit is not delivered.

SMDS Reference: SIP Level 3 PDU Format

Figure 14-5 illustrates the format of the SMDS Interface Protocol (SIP) Level 3 protocol data unit (PDU).

The following descriptions briefly summarize the function of the SIP Level 3 PDU fields illustrated in Figure 14-5.

Figure 14-5 A SIP Level 3 Protocol Data Unit Consists of 15 Fields

Field length, in bytes

1	1	2	8	8	1	4 bits	4 bits	2	12	9188	0,4	1	1	2
RSVD	BEtag	BAsize	DA	SA	X+ HLPI	X+	HEL	X+	HE	Info+ Pad	CRC	RSVD	BEtag	Length

RSVD	=	Reserved
BEtag	=	Beginning-end tag
BAsize	=	Buffer allocation size
DA	=	Destination address
SA	=	Source address
HLPI	=	Higher-layer protocol identifier
X+	=	Carried across network unchanged
HEL	=	Header extension length
HE	=	Header extension
Info+Pad	=	Information + padding (to ensure that this field ends on a 32-bit boundary)
CRC	=	Cyclic redundancy check

- **X+**—Ensures that the SIP PDU format aligns with the DQDB protocol format. SMDS does not process or change the values in these fields, which may be used by systems connected to the SMDS network.
- **RSVD**—Consists of zeros.
- **BEtag**—Forms an association between the first and last segments of a segmented SIP Level 3 PDU. Both fields contain identical values and are used to detect a condition in which the last segment of one PDU and the first segment of the next PDU are both lost, which results in the receipt of an invalid Level 3 PDU.
- **BAsize**—Contains the buffer allocation size.
- **Destination address (DA)**—Consists of two parts:
  - **Address type**—Occupies the 4 most significant bits of the field. The Address Type can be either 1100 or 1110. The former indicates a 60-bit individual address, while the latter indicates a 60-bit group address.
  - **Address**—Gives the individual or group SMDS address for the destination. SMDS address formats are consistent with the North American Numbering Plan (NANP).

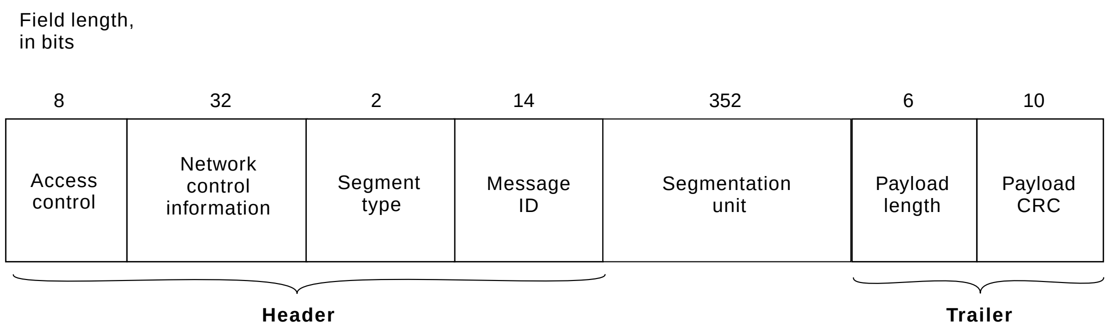
  The 4 most significant bits of the Destination Address subfield contain the value 0001 (the internationally defined country code for North America). The next 40 bits contain the binary-encoded value of the 10-digit SMDS address. The final 16 (least significant) bits are populated with ones for padding.
- **Source address (SA)**—Consists of two parts:
  - **Address type**—Occupies the 4 most significant bits of the field. The Source Address Type field can indicate only an individual address.
  - **Address**—Occupies the individual SMDS address of the source. This field follows the same format as the Address subfield of the Destination Address field.
- **Higher layer protocol identifier (HLPI)**—Indicates the type of protocol encapsulated in the Information field. The value is not important to SMDS, but it can be used by certain systems connected to the network.

- **Header extension length (HEL)**—Indicates the number of 32-bit words in the Header Extension (HE) field. Currently, the field size for SMDS is fixed at 12 bytes. (Thus, the HEL value is always 0011.)
- **Header extension (HE)**—Contains the SMDS version number. This field also conveys the carrier-selection value, which is used to select the particular interexchange carrier to carry SMDS traffic from one local carrier network to another.
- **Information and Padding (Info + Pad)**—Contains an encapsulated SMDS service data unit (SDU) and padding that ensures that the field ends on a 32-bit boundary.
- **Cyclic redundancy check (CRC)**—Contains a value used for error checking.
- **Length**—Indicates the length of the PDU.

SMDS Reference: SIP Level 2 Cell Format

Figure 14-6 illustrates the format of the SMDS Interface Protocol (SIP) Level 2 cell format.

Figure 14-6 Seven Fields Comprise the SMDS SIP Level 2 Cell



The following descriptions briefly summarize the functions of the SIP Level 2 PDU fields illustrated in Figure 14-6:

- **Access control**—Contains different values, depending on the direction of information flow. If the cell was sent from a switch to a CPE device, only the indication of whether the Level 3 protocol data unit (PDU) contains information is important. If the cell was sent from a CPE device to a switch, and if the CPE configuration is multi-CPE, this field can carry request bits that indicate bids for cells on the bus going from the switch to the CPE device.
- **Network control information**—Contains a value indicating whether the PDU contains information.
- **Segment type**—Indicates whether the cell is the first, the last, or a middle cell from a segmented Level 3 PDU. Four possible segment type values exist:
  - **00**—Continuation of message
  - **01**—End of message
  - **10**—Beginning of message
  - **11**—Single-segment message

- **Message ID**—Associates Level 2 cells with a Level 3 PDU. The message ID is the same for all the segments of a given Level 3 PDU. In a multi-CPE configuration, Level 3 PDUs originating from different CPE devices must have a different message ID. This allows the SMDS network receiving interleaved cells from different Level 3 PDUs to associate each Level 2 cell with the correct Level 3 PDU.
- **Segmentation unit—**Contains the data portion of the cell. If the Level 2 cell is empty, this field is populated with zeros.
- **Payload length—**Indicates how many bytes of a Level 3 PDU actually are contained in the Segmentation Unit field. If the Level 2 cell is empty, this field is populated with zeros.
- **Payload cyclic redundancy check (CRC)**—Contains a CRC value used to detect errors in the following fields:
  - Segment Type
  - Message ID
  - Segmentation Unit
  - Payload Length
  - Payload CRC

  The Payload CRC value does not cover the Access Control or the Network Control Information fields.

Summary

SMDS is a high-speed, packet-switched, datagram-based WAN networking technology used for communication over public data networks (PDNs). SMDS can use fiber- or copper-based media. It supports speeds of 1.544 Mbps over DS-1 transmission facilities, or 44.736 Mbps over DS-3 transmission facilities.

The following devices comprise SMDS networks:

- Customer premises equipment (CPE)
- Carrier equipment
- Subscriber network interface (SNI)

The SNI is the interface between the CPE and carrier equipment; it transparently enables data transmission between the two networks.

- SMDS uses SIP to communicate between CPE and the carrier site using the DQDB standard for cell relay across MANs.
- SIP consist of the following three levels:
  - SIP Level 3, which operates at the MAC sublayer of the data link layer of the OSI reference model
  - SIP Level 2, which also operates at the MAC sublayer of the data link layer of the OSI reference model
  - SIP Level 1, which operates at the physical layer of the OSI reference model
- SMDS PDUs carry both a source and a destination address, and offer both group addressing and security features.

Review Questions

Q—*Where does the SNI interface exist?*

A—Between the CPE and the carrier equipment—where the customer network ends and the carrier network begins.

Q—*What does SIP stand for?*

A—SMDS Interface Protocol.

Q—*At which layers of the OSI reference model do each of the three SIP levels operate?*

A—SIP Level 3 and Level 2 operate at the MAC sublayer of the data link layer; SIP Level 1 operates at the physical layer.

Q—*How do multiple devices reconcile usage of a DQDB?*

A—By using a distributed queuing algorithm, which makes implementing a multi-CPE configuration much more complicated than implementing a single-CPE configuration.

Q—*A credit-management scheme is sometimes used to implement SMDS access classes on which SMDS interfaces only?*

A—DS-3 rate SMDS interfaces.