This chapter describes packet-over-SONET/SDH (POS) and its implementation on ONS Ethernet cards.

This chapter contains the following major sections:

- POS Overview
- POS Interoperability
- POS Encapsulation Types
- POS Framing Modes
- POS Characteristics of Specific ONS Ethernet Cards
- Ethernet Clocking Versus SONET/SDH Clocking

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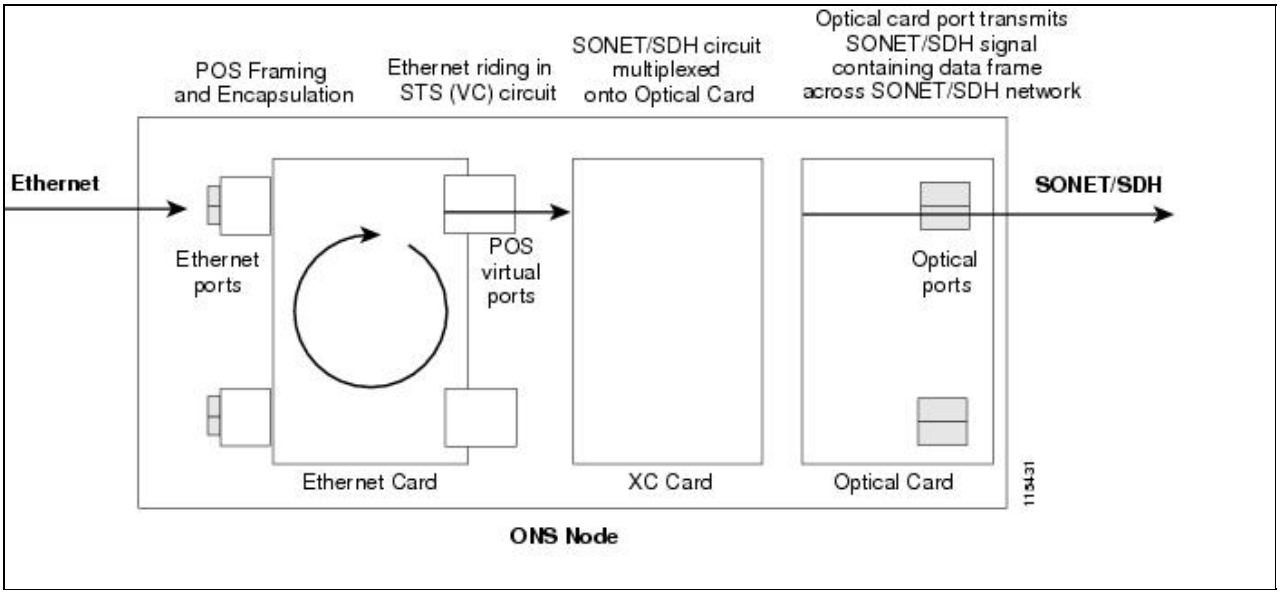
POS Overview

Unlike Asynchronous Transfer Mode (ATM) and Frame Relay, Ethernet was not originally designed for interfacing with SONET/SDH. Ethernet data packets need to be framed and encapsulated into a SONET/SDH frame for transport across the SONET/SDH network. This framing and encapsulation process is known as POS.

Figure 22-1: Ethernet to POS Process on ONS Node



ONS Ethernet cards all use POS. The Ethernet frame comes into the card on a standard Fast Ethernet or Gigabit Ethernet port and is processed through the ONS Ethernet card's framing mechanism and encapsulated into a POS frame. When the POS frame exits, the ONS Ethernet card in a POS circuit, this circuit is treated as any other SONET circuit (STS) or SDH circuit (VC) in the ONS node. It is cross-connected and rides the SONET/SDH signal out the port of an optical card and across the SONET/SDH network.

The destination of the POS circuit is an ONS Ethernet card or other device that supports a POS interface. The POS frames received by the destination card have the data packets stripped out and processed into Ethernet frames. The Ethernet frames are then sent to a standard Ethernet port of the ONS Ethernet card and transmitted onto an Ethernet network.

The G-Series, CE-Series, and E-Series (configured in port-mapper mode) ONS Ethernet cards map this SONET/SDH or POS circuit directly to one of the card's Ethernet ports. The ML-Series and E-Series (configured in EtherSwitch mode) cards include the POS port as a switchport in a switching fabric that includes the standard Ethernet ports on the card.

POS Interoperability

In addition to POS circuits between Ethernet cards of the same family, POS circuits between some Ethernet cards of different families are possible. The Cisco Transport Controller (CTC) circuit creation wizard shows available interoperable Ethernet cards under the destination card options, when a specific Ethernet card type is chosen as the circuit creation source card. You cannot mix circuits from an SDH node with circuits from a SONET node. POS circuits can be created between the mapper-type cards and the switch-type ONS Ethernet cards.

For Ethernet card POS interoperability, three main POS port characteristics must match:

- POS encapsulation
- CRC size
- Framing Mode

The CRC size option does not need to match on the two endpoints when using GFP-F framing mode.

All Ethernet cards do not interoperate or support all the POS port characteristic options. The following two tables list the interoperable Ethernet cards and characteristics. Table 22-1 lists this information for cards supporting and configured with high-level data link control (HDLC) framing mode.

Table 22-2 lists this information for cards supporting and configured with frame-mapped generic framing procedure (GFP-F) framing mode. With Table 22-2 and GFP-F framing, the word LEX is used to represent standard mapped Ethernet over GFP-F according to ITU-T G.7041. Under GFP-F framing, the Cisco IOS CLI also uses this lex keyword to represent standard mapped Ethernet over GFP-F according to ITU-T G.7041.

Table 22-1: ONS SONET/SDH Ethernet Card Interoperability under HDLC Framing with Encapsulation Type and CRC

	Port-mapped E-Series (ONS 15454 SONET/SDH)	**G-Series (All Platforms)**	**ML-Series** (ONS 15454 SONET/SDH)	**ML-Series (ONS 15310-CL/ONS 15310-MA)**	**CE-Series (All Platforms)**
Port-mapped E-Series (ONS 15454 SONET/SDH)	Proprietary	Not compatible	Not compatible	Not compatible	Not compatible
G-Series (All Platforms)	Not compatible	LEX (CRC 16) LEX (CRC 32)	LEX (CRC 16) LEX (CRC 32)	LEX (CRC 32)	LEX (CRC 32)
ML-Series (ONS 15454 SONET/SDH)	Not compatible	LEX (CRC 16) LEX (CRC 32)	LEX (CRC 16) LEX (CRC 32) Cisco HDLC PPP/BCP	LEX (CRC 32)	LEX (CRC 32)
ML-Series (ONS 15310-CL/ ONS 15310-MA)	Not compatible	LEX (CRC 32)	LEX (CRC 32)	LEX (CRC 32)	LEX (CRC 32)
CE-Series (All Platforms)	Not compatible	LEX (CRC 32)	LEX (CRC 32)	LEX (CRC 32)	LEX (CRC 32)

Table 22-2: ONS SONET/SDH Ethernet Card Interoperability under GFP-F Framing with Encapsulation Type

	ML-Series (ONS 15454)	**ML-Series** (ONS 15310)	**CE-Series(All Platforms)**
ML-Series (ONS 15454 SONET/SDH)	LEX (CRC 32)	LEX (CRC 32) Cisco HDLC (CRC 32)	LEX (CRC 32)

	Cisco HDLC (CRC 32) PPP/BCP (CRC 32) IEEE 802.17b	PPP/BCP (CRC 32)	
ML-Series (ONS 15310-CL/ ONS 5310-MA)	LEX (CRC 32) Cisco HDLC (CRC 32) PPP/BCP (CRC 32)	LEX (CRC 32 or None) Cisco HDLC (CRC 32 or None) PPP/BCP (CRC 32 or None)	LEX (CRC 32 or None)
CE-Series(All Platforms)	LEX (CRC 32)	LEX (CRC 32 or None)	LEX (CRC 32 or None)

Note: Cisco proprietary RPR requires LEX encapsulation on all ML-Series cards. IEEE 802.17 RPR is not configurable and uses IEEE 802.17b encapsulation.

Note: When over GFP-F, it is standard Mapped Ethernet over GFP-F according to ITU-T G.7041.

GFP-F framing is only supported on nodes running Software Release 5.0 and later. The ML100T-12 and ML1000-2 cards also require field programmable gate array (FPGA) version 4.0 or later for GFP-F framing.

POS Encapsulation Types

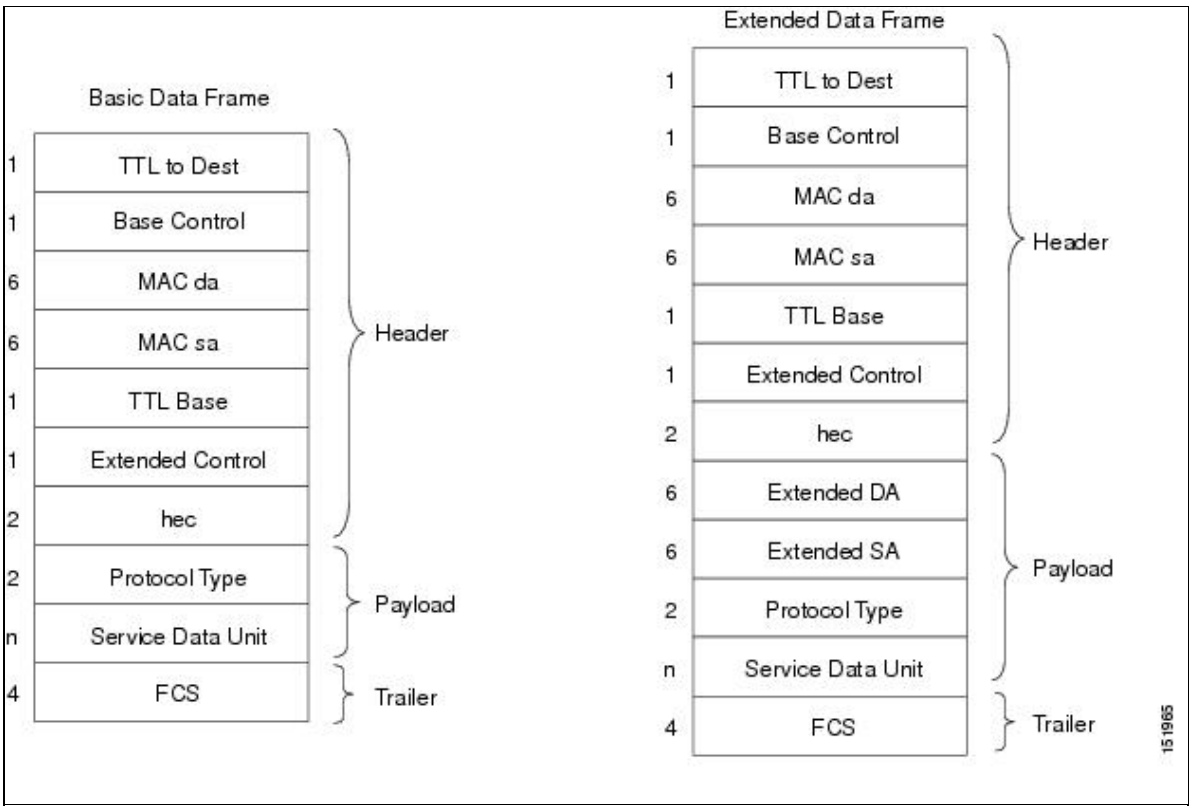
The ONS Ethernet cards support five POS encapsulation methods: Cisco Ethernet-over-SONET LEX (LEX), Cisco HDLC, Point-to-Point Protocol/Bridging Control Protocol (PPP/BCP), IEEE 802.17b, and E-Series proprietary. The ONS Ethernet source card and destination card must be configured with the same POS encapsulation to interoperate. All ONS Ethernet cards do not interoperate or support all types of encapsulation.

IEEE 802.17b

IEEE 802.17b encapsulation is the set encapsulation when the ML-Series card mode is 802.17. It is only supported on the ONS 15454 and ONS 15454 SDH ML-Series cards in Release 7.2 and later.

Figure 22-2 illustrates the IEEE 802.17b extended data frame used by the ML-Series card. It is used with bridging. For comparison, the IEEE 802.17 basic data frame for IP only networks is also shown. The extended data frame adds an extended destination address and extended source address to the basic data frame.

Figure 22-2: RPR Data Frames



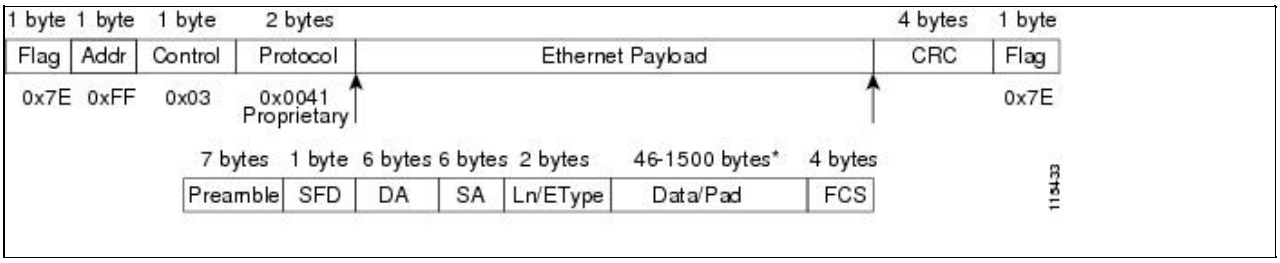
LEX

The Cisco EoS LEX is the primary encapsulation of ONS Ethernet cards. This encapsulation is used under HDLC framing, and the protocol field is set to the values specified in Internet Engineering Task Force (IETF) Request For Comments (RFC) 1841. Under GFP-F framing, the Cisco IOS CLI also uses the keyword lex. With GFP-F framing, the lex keyword is used to represent standard mapped Ethernet over GFP-F according to ITU-T G.7041.

Figure 22-3 illustrates EoS LEX under HDLC framing.

LEX is supported by all the ONS Ethernet cards, except the ONS 15454 and ONS 15454 SDH E-Series cards.

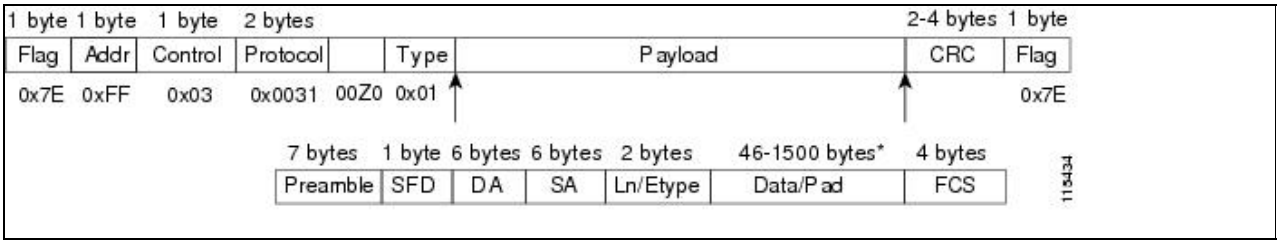
Figure 22-3: LEX Under HDLC Framing



PPP/BCP

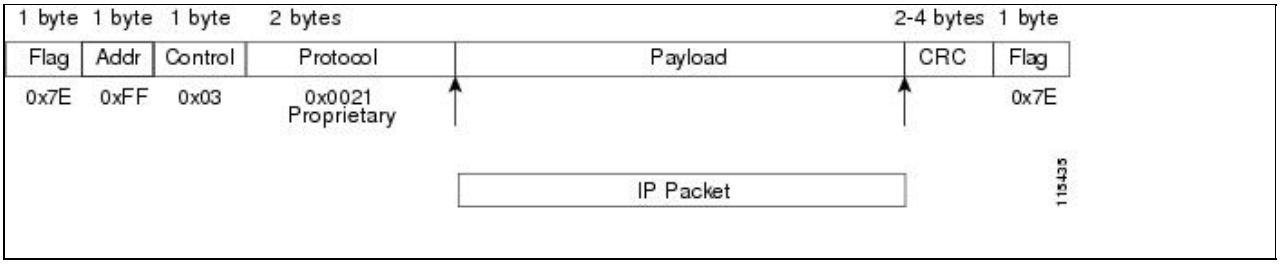
The PPP encapsulation is a standard implementation of RFC 2615 (PPP-over-SONET/SDH), and provides a standard implementation of RFC 3518 (BCP) to provide the transmission of 802.1Q tagged and untagged Ethernet frames over SONET. Figure 22-4 illustrates BCP.

Figure 22-4: BCP Under HDLC Framing



In some framing modes, the ONS 15454/ONS 15454 SDH ML-Series card supports routing functions. When this card POS port is configured to support routing with the PPP encapsulation, the IP packets are mapped into the HDLC frames that use the standard 0x0021 protocol code point. Figure 22-5 illustrates PPP.

Figure 22-5: PPP Frame Under HDLC Framing

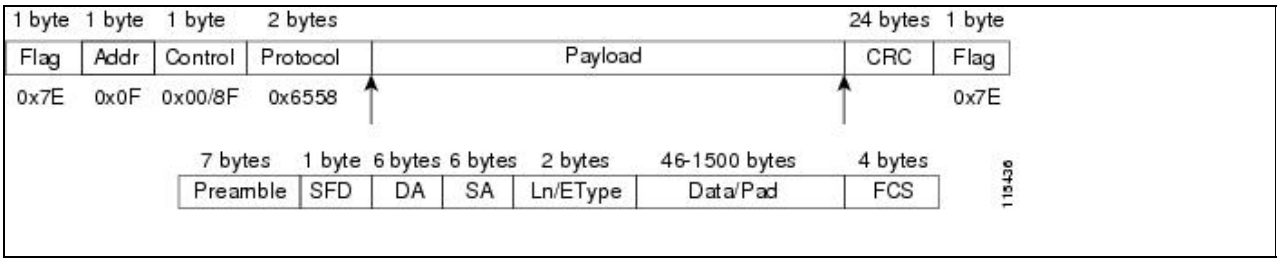


Cisco HDLC

Cisco HDLC is a Cisco-standard mapping of packets into a serial interface. This encapsulation can be used to connect the interface on an ML-Series card to a POS interface on Cisco HDLC-compliant routers and switches.

When used to carry IP packets, the same HDLC frame structure is used, however the protocol field is set to 0x0800, and the payload contains the IP packet. Figure 22-6 illustrates Cisco HDLC.

Figure 22-6: Cisco HDLC Under HDLC Framing



E-Series Proprietary

The E-Series uses a proprietary HDLC-like encapsulation that is incompatible with LEX, Cisco HDLC, or PPP/BCP. This proprietary encapsulation prevents the E-Series from interoperating with other ONS Ethernet cards.

POS Framing Modes

The framing mode is the type of framing mechanism employed by the ONS Ethernet card to frame and encapsulate data packets into a POS signal. These data packets were originally encapsulated in Ethernet

frames that entered the standard Fast Ethernet or Gigabit Ethernet interfaces of the ONS Ethernet card. All ONS Ethernet cards support HDLC framing. ML-Series and CE-Series cards also offer GFP-F framing mode.

HDLC Framing

HDLC is one of the most popular Layer 2 protocols. The framing mechanism used by the HDLC protocol, HDLC framing, is employed by a variety of other protocols, including POS on the ONS Ethernet cards. The HDLC framing mechanism is detailed in the IETF's RFC 1662, "PPP in HDLC-like Framing."

The HDLC frame uses the zero insertion/deletion process (commonly known as bit stuffing) to ensure that the bit pattern of the delimiter flag does not occur in the fields between flags. The HDLC frame is synchronous and therefore relies on the physical layer to provide a method of clocking and synchronizing the transmission and reception of frames.

GFP-F Framing

GFP defines a standard-based mapping of different types of services onto SONET/SDH. The ML-Series and CE-Series support frame-mapped GFP (GFP-F), which is the PDU-oriented client signal adaptation mode for GFP. GFP-F maps one variable length data packet onto one GFP packet.

GFP is composed of common functions and payload specific functions. Common functions are those shared by all payloads. Payload-specific functions are different depending on the payload type. GFP is detailed in the ITU recommendation G.7041.

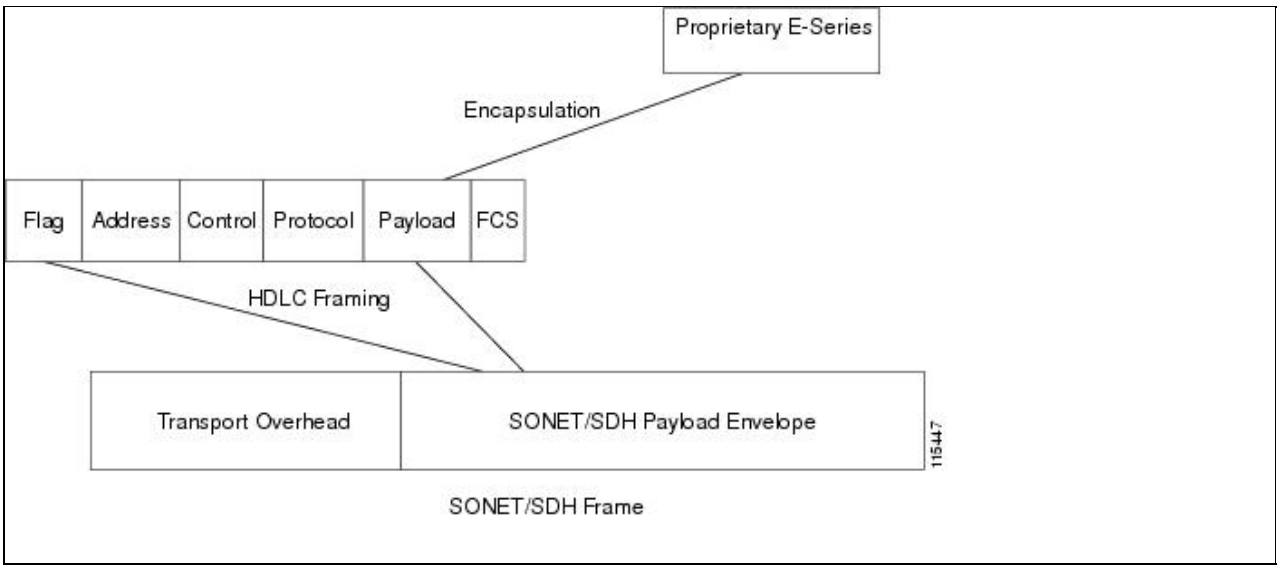
POS Characteristics of Specific ONS Ethernet Cards

The following sections list and illustrate the various framing and encapsulation options supported by specific ONS Ethernet cards.

ONS 15454 and ONS 15454 SDH E-Series Framing and Encapsulation Options

LEX is not available on the ONS 15454 or ONS 15454 SDH E-Series cards. These cards are limited to the original proprietary E-Series encapsulation, which does not allow POS interoperability with non E-Series cards. Figure 22-7 illustrates ONS 15454 and ONS 15454 SDH E-Series framing and encapsulation.

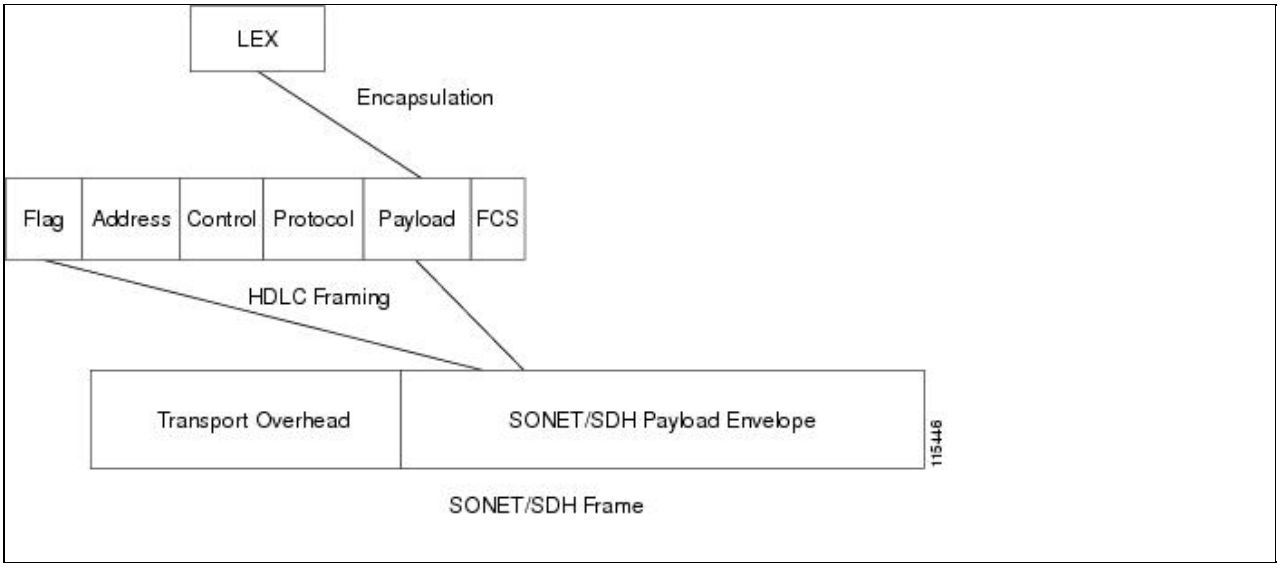
Figure 22-7: ONS 15454 and ONS 15454 SDH E-Series Encapsulation and Framing Options



G-Series Encapsulation and Framing

The G-Series cards are supported on the ONS 15454 and ONS 15454 SDH platforms. They support LEX encapsulation and HDLC framing. There are no other POS framing modes or encapsulation options on this card. Figure 22-8 illustrates G-Series encapsulation and framing.

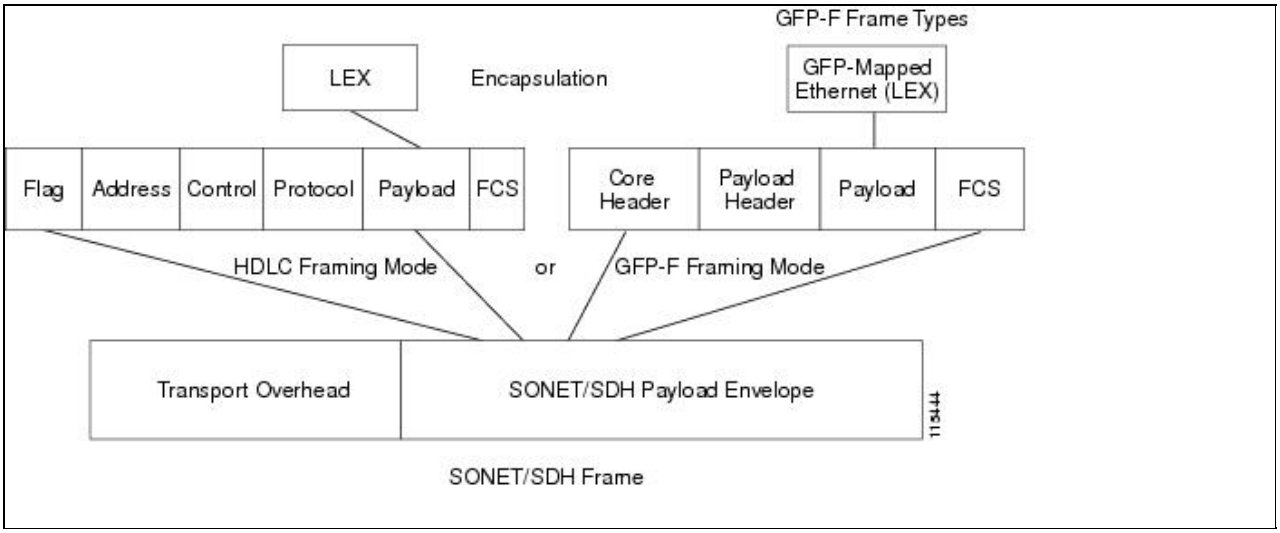
Figure 22-8: ONS G-Series Encapsulation and Framing Options



ONS 15454, ONS 15454 SDH, ONS 15310-CL, and ONS 15310-MA CE-Series Cards Encapsulation and Framing

CE-100T-8 cards are available for the ONS 15454, ONS 15454 SDH, ONS 15310-CL, and ONS 15310-MA platforms. CE-1000-4 cards are available for the ONS 15454 and ONS 15454 SDH platforms. They support HDLC Framing and GFP-F framing. Under the GFP-F or HDLC framing mode, only LEX encapsulation is supported. Figure 22-9 illustrates CE-Series framing and encapsulation.

Figure 22-9: ONS CE-100T-8 and ONS CE-1000-4 Encapsulation and Framing Options



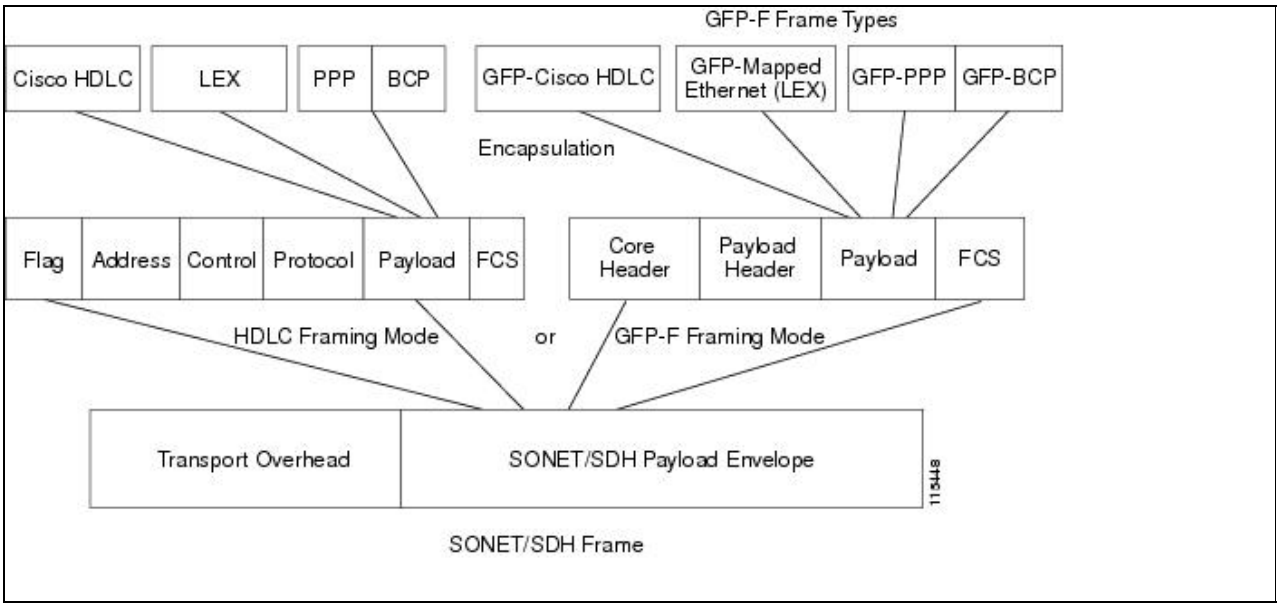
ONS 15310-CL and ONS 15310-MA ML-100T-8 Encapsulation and Framing

The ML-100T-8 card on the ONS 15310 supports HDLC framing and GFP-F framing. Under the HDLC framing mode, LEX is supported. Under the GFP-F framing mode, LEX, Cisco HDLC, and PPP/BCP encapsulation are supported. LEX encapsulation is also the encapsulation for Cisco proprietary RPR on the ML-Series card. Cisco proprietary RPR requires LEX encapsulation in either framing mode.

ONS 15454 and ONS 15454 SDH ML-Series Protocol Encapsulation and Framing

The ML-Series card on the ONS 15454 and ONS 15454 SDH supports HDLC framing and GFP-F framing. Under both the HDLC framing mode and the GFP-F framing mode, LEX, Cisco HDLC, and PPP/BCP encapsulation is supported. LEX encapsulation is also the encapsulation for Cisco proprietary RPR on the ML-Series card. Cisco proprietary RPR requires LEX encapsulation in either framing mode. 802.17b encapsulation is the set encapsulation in IEEE 802.17b compliant RPR, which is only supported in GFP-F framing. Figure 22-10 illustrates the ONS 15454 and ONS 15454 SDH framing and encapsulation options.

Figure 22-10: ML-Series Card Framing and Encapsulation Options



Ethernet Clocking Versus SONET/SDH Clocking

Ethernet clocking is asynchronous. IEEE 802.3 clock tolerance allows some links in a network to be as much as 200 ppm (parts or bits per million) slower than other links (0.02%). A traffic stream sourced at line rate on one link may traverse other links which are 0.02% slower. A fast source clock, or slow intermediate clocks, may limit the end-to-end throughput to only 99.98% of the source link rate.

Traditionally, Ethernet is a shared media that is under utilized except for brief bursts which may combine from multiple devices to exceed line-rate at an aggregation point. Due to this utilization model, the asynchronous clocking of Ethernet has been acceptable. Some Service Providers accustomed to loss-less TDM transport may find the 99.98% throughput guarantee of Ethernet surprising.

Clocking enhancements on ONS Ethernet cards, excluding the E-Series cards, ensure Ethernet transmit rates that are at worst 50 ppm slower than the fastest compliant source clock, ensuring a worst-case clocking loss of 50 ppm - a 99.995% throughput guarantee. In many cases, the card's clock will be faster than the source traffic clock, and line-rate traffic transport will have zero loss. Actual results will depend on clock variation of the traffic source transmitter.