SONET

Prerequisite Training

SONET-T

April 18, 2002

FUJITSU

THE POSSIBILITIES ARE INFINITE

Instructions

Task

This self-study Tutorial satisfies the prerequisite knowledge of Synchronous Optical Network (SONET) needed for attendance at Fujitsu Educational Services training.

Objectives

Upon completion of this lesson, the student should be able to define SONET terminology, discuss SONET interfaces and virtual tributaries, and describe SONET layers and overhead.

Standards

The student may complete the Tutorial and then finish by taking the Self Evaluation at the end of the Tutorial. If the student passes the Tutorial, they have completed the FNC pre-requisite qualification for SONET. If the student does not pass the Tutorial, they should review the questions they missed in the Questions Review section. Each student should be familiar with the concepts and terms of the Tutorial prior to attending class.

Distribution Method

The SONET Tutorial is available at the following Internet address:

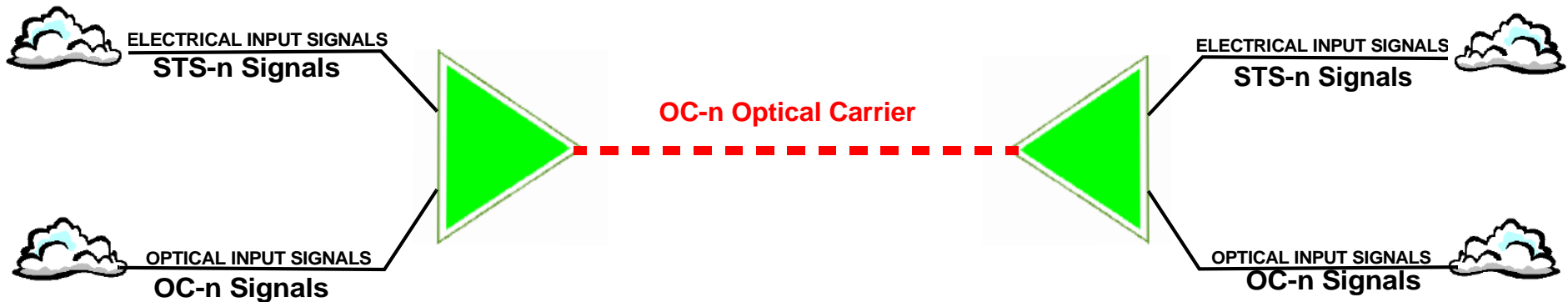 http://www.fnc.fujitsu.com/services/pdfs/ed_serv_sonet.pdf

The Tutorial may be viewed with Acrobat® Reader.

Optional Reading

Fujitsu Guide to SONET FJTU-320-500-500

The referenced Guide to SONET may be downloaded by going to the following URL:

http://www.fnc.fujitsu.com/services/pdfs/tech_pub_sonet.pdf

ELECTRICAL INPUT SIGNALS
STS-n Signals

OC-n Optical Carrier

OPTICAL INPUT SIGNALS
OC-n Signals

ELECTRICAL INPUT SIGNALS
STS-n Signals

OPTICAL INPUT SIGNALS
OC-n Signals

SONET

Synchronous Optical Network (SONET) is an optical interface standard that allows transmission equipment from multiple vendors to talk together over Fiber Optic lines. Some features of SONET include:

- Supervisory communication via embedded Section Data Communication Channel (SDCC)
- Automatic Protection Switching (APS)
- Synchronization Status Messaging (SSM)
- Orderwire (Reserved for voice communication between Section Terminating Network Elements [NE])

SONET Interfaces

Synchronous Transport Signals-n (STS-n) ("n" means "number") are binary electrical signals that carry user data and/or voice traffic. STS-1 is the basic building block of SONET signals which become a component of Optical Carriers (OC).

- An STS-1 signal, coded for electrical transmission is also called an Electrical Carrier One (EC-1)
- An STS-1 signal that has been converted to an optical signal for transmission over fiber is called an Optical Carrier One (OC-1)
- All OC-n rates are multiples of OC-1 (The "n" means any available SONET speed of OC-3, OC-12, OC-24, OC-48, OC-192 or OC-768 that is applicable)
- OC-n rates carry the number of STS-1 building blocks that is equal to the Optical Line Rate, such as an OC-3 will contain 3 STS-1 signals, some of which may not have active traffic in their payloads

  Note: *See Guide to SONET (FJTU-320-500-500) for more information.*

Next Let's learn how SONET is constructed:

How SONET Is Constructed

This discussion will help you understand what the standard SONET STS-n/OC-n packages include.

Note: *See the following pages for SONET Table of Rates and Rate discussion*

A standard size was established for the STS-1/OC-1 SONET payload and overhead packaging.

Payload

The payload is the information the customer wants to send over the network.

The STS-1/OC-1 Payload is the same as the DS-3 carrier system used for data and voice transmission many years before SONET became the standard transport method.

This Payload contains 44.736 Megabytes (Mb/s). Some of this payload includes addressing and signalling for the customer's traffic for information sent inside the payload that originates at a lower speed, called Sub-STS traffic.

Overhead

The overhead is the extra service provider signalling, timing and management information needed to ensure that the customer's traffic arrives at the right place in a timely manner.

 Each STS-1 has a fixed overhead of 2.304 Mb/s and space for "stuffing" bytes of 1.152 Mb/s to provide management information for the traffic contained in the STS-1 package.

Each STS-1 has an additional SONET overhead of 3.648 Mb/s for network operations that result in a total bandwidth of 51.84 Mb/s.

The SONET Envelope

The resulting STS-1/OC-1 envelope, sometimes called a frame or package, is used to generate all other size envelopes and speeds (Rates).

SONET Component	Payload	Overhead
DS-3	37.632 Mb/s	7.104 Mb/s
STS-1	44.736 Mb/s	2.304 Mb/s
STS-1 Stuffing Bytes	44.736 Mb/s	1.152 Mb/s
SONET Overhead	44.736 Mb/s	3.648 Mb/s
STS-1 Composite Package	**44.736 Mb/s**	**7.104 Mb/s**

DS-3 size Payloads contain overhead associated with the customer information. If the DS-3 contains only Plain Old Telephone Service (POTS) channels they are customarily carried in channels called DS-0 at 64 kb/s that results in 672 DS-0 Voice/data channels. Every 24 DS-0 channels are placed into a "DS-1" carrier facility, often called a T-1 as a 1.544 Mb/s signal. The overhead for each T-1/DS-1 is 200 Mb/s so the usable payload becomes 1.344 Mbs. 28 DS-1 signals are in each DS-3 as well as the Information payload that is 37.632 Mb/s and the overhead share of the DS-3 is 7.104 Mb/s.

The STS-1 envelope therefore contains the DS-3 as a payload value of 44.736 Mb/s, including the sub-STS-1 channel's overhead, and then adds 7.104 Mb/s additional for the STS-1 management of the payload for the total 51.84 Mb/s contained in the STS-1 rate package.

SONET RATES

Signal Level	Line Rate	Channels
North American Digital Hierarchy Signals		
DS0	64 kb/s*	1
DS1	1.544 Mb/s**	24
DS2	6.312 Mb/s	96
DS3	44.736 Mb/s	672
SONET Signals		
VT1.5	1.728 Mb/s	24
VTG	6.912 Mb/s	96
OC-1/STS-1	51.84 Mb/s	672
OC-3/STS-3	155.52 Mb/s	2,016
OC-12	622.08 Mb/s	8,064
OC-24	1244.16 Mb/s	16,128
OC-48	2488.32 Mb/s	32,256
OC-192	9953.28 Mb/s	129,024

*kb/s is the abbreviation for thousands (kilo) of bits per second.

**Mb/s is the abbreviation for Millions (Mega) of bits per second

SONET Rate Discussion

SONET is a well-documented transport technology in the USA and Canada.

The Official transport rates common in North America are OC-3, OC-12, OC-48, and OC-192. OC-24 also is a standard rate, however, is seldom used.

Some Customer Provided Equipment (CPE) does use the OC-1 rate, which is not supported in the USA and Canada SONET plan except for local connections. The electrical input rates consist of payload and overhead.

Payload

The customer's actual voice or data information that is transported over the network.

Overhead

Signal and control information needed to specify payload attributes outside of the payload content.

For Example:

- OC-3 = 155.52 Mb/s and is made up of three (3) STS-1 channels at 51.84 Megabits per second (Mb/s). overhead is 2.304 Mb/s per STS-1. (About 5% of the overall bandwidth.) Payload uses 48.384 Mb/s and is accompanied by "stuffing" bytes that use another 1.152 Mb/s of fixed space that result in 51.84 Mb/s

- OC-12 = 622.08 Mb/s and is made up of twelve (12) STS-1 channels at 51.84 Mb/s, or four (4) STS-3 channels at 155.52 Mb/s

- OC-48 = 2.5 (2.48832 actual speed) Gigabits per second (Gb/s) and is made up of 48 STS-1 channels or 16 STS-3 channels or four (4) STS-12 Channels

- OC-192 = 10 Gb/s (9.95328 actual speed) and is made up of 192 STS-1 or 4 STS-48 or 16 STS-12 or 64 STS-3 channels

What is important about these rates? Every one of them can be a mix of STS channels, so long as the aggregate is still the specified OC-n ("n" means 3 or 12 or 48 or 192) rate.

This functionality means that cross connects can be made down to the STS-1 level in all SONET circuits. Localities can connect to other locations so that specific routing at the STS-1 level can take place without requiring higher protocol support.

Many SONET NE's can also break the STS-1 channel down to the basic Virtual Tributary 1.5 level (VT1.5) so that 28 DS-1 channels can be directed to specific locations.

Good record keeping as to the VT1.5 and STS-1 channel connections is very important. SONET NEs can provide reports that help keep those records current.
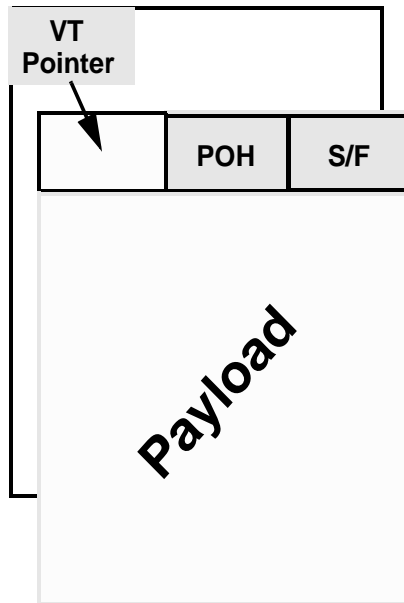
Used for DS-1s

VT Payload "floats"

Contains 27 bytes

3 bytes of VT Overhead

- VT Pointer

- VT Path Overhead (POH)

- Signaling byte (S/F)

24 bytes of Payload

Virtual Tributary

Virtual Tributary (VT) is designed for transport and switching of sub-STS-1 payloads comprised standard 1.544 Mb/s electrical signals (DS-1) without requiring SONET overhead.
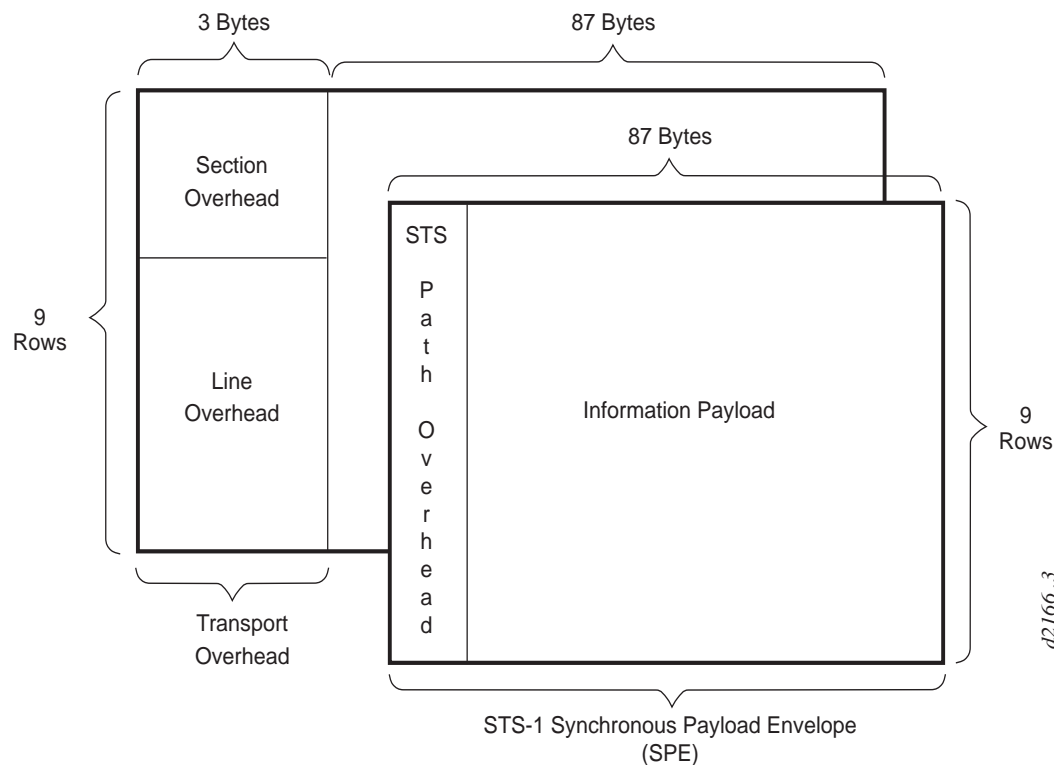
- Virtual Tributary (VT)
    - VT-1.5 (1.728 Mb/s)

    Note: *Virtual Tributaries are speeds less than the STS-1 rate.*

- Virtual Tributary Group (VTG)
    - Four VT-1.5
- Seven Virtual Tributary Groups
    - Fills one STS-1 Payload

    Note: *See Guide to SONET (FJTU-320-500-500) for more information.*

3 Bytes   87 Bytes

87 Bytes

Section Overhead

9 Rows

Line Overhead

STS

Path Overhead

Information Payload

9 Rows

Transport Overhead
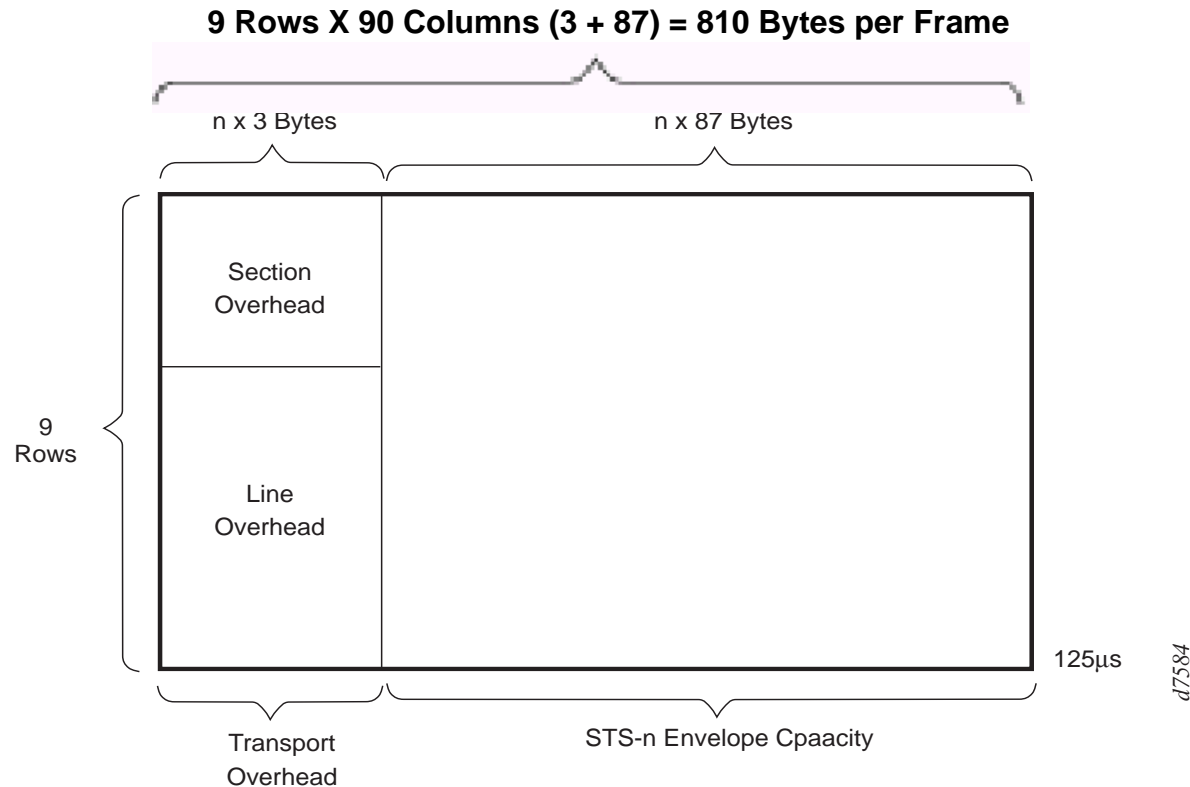
d2166.3

STS-1 Synchronous Payload Envelope (SPE)

Synchronous Payload Envelope (SPE)

STS-1 Signal Format

The STS-1 signal is divided into a portion assigned to transport overhead and a portion that carries the payload as shown above. The portion that carries the payload is called the Synchronous Payload Envelope (SPE) and also contains overhead for the STS-1 Path. When the SPE is used to transport VT (virtual tributary) signals, VT overhead is present in addition to the STS overhead. The uses of the various overhead bytes are defined in ANSI T1.105 and Telcordia's GR-253.

The SONET signal incorporates many different types of overhead channels. These include channels for maintenance, user channels, orderwire channels, and channels whose use is not yet fully defined. Overhead is layered and overhead bandwidth is allocated to each layer. Layers are assigned based on the functions performed by the different channels.

This layered approach permits equipment to access the overhead information carried in a specific layer without accessing information from higher layers. For example, some types of equipment process and use only the Section, or only the Line and Section overhead channels without demultiplexing the signal and without affecting the SPE.

9 Rows X 90 Columns (3 + 87) = 810 Bytes per Frame

n x 3 Bytes   n x 87 Bytes

9 Rows

Section Overhead

Line Overhead

Transport Overhead

STS-n Envelope Cpaacity

125μs

d7584

STS-n Signal Format Overview

An STS-n is a specific sequence of n x 810 bytes that can be depicted as the structure shown above. The Transport overhead of the individual STS-n modules is frame-aligned before transmission as depicted above. The associated STS STS-n Payload Envelopes (SPE) are not required to be aligned because each STS-n has a Payload Pointer to indicate the location of the SPE.

STS Concatenation

Super Rate payloads, such as some Broadband Integrated Services Digital Network (B-ISDN) and Asynchronous Transfer Mode (ATM) payloads require multiple STS-1 SPEs. To accommodate such a payload, an STS-nc (the "c" stands for "concatenation") module is formed by linking "n" constituent STS-1s together in a fixed alignment. This payload is then mapped into the resulting STS-nc SPE for transport. Concatenation is detailed on of this Tutorial.

```
SONET Network

                                    PATH
   |<----------------------------------------------------------------------->|

   |<---- LINE ---->|   |<-------------- LINE -------------->|   |<-- LINE -->|

   |<-- SECTION -->|   |<-- SECTION -->|<-- SECTION -->|<-- SECTION -->|   |<-- SECTION -->|

Path                Line                                        Line                Path
Terminating         Terminating                                 Terminating         Terminating
Equipment           Equipment                                   Equipment           Equipment

                              Lightwave
                              Regenerators
```
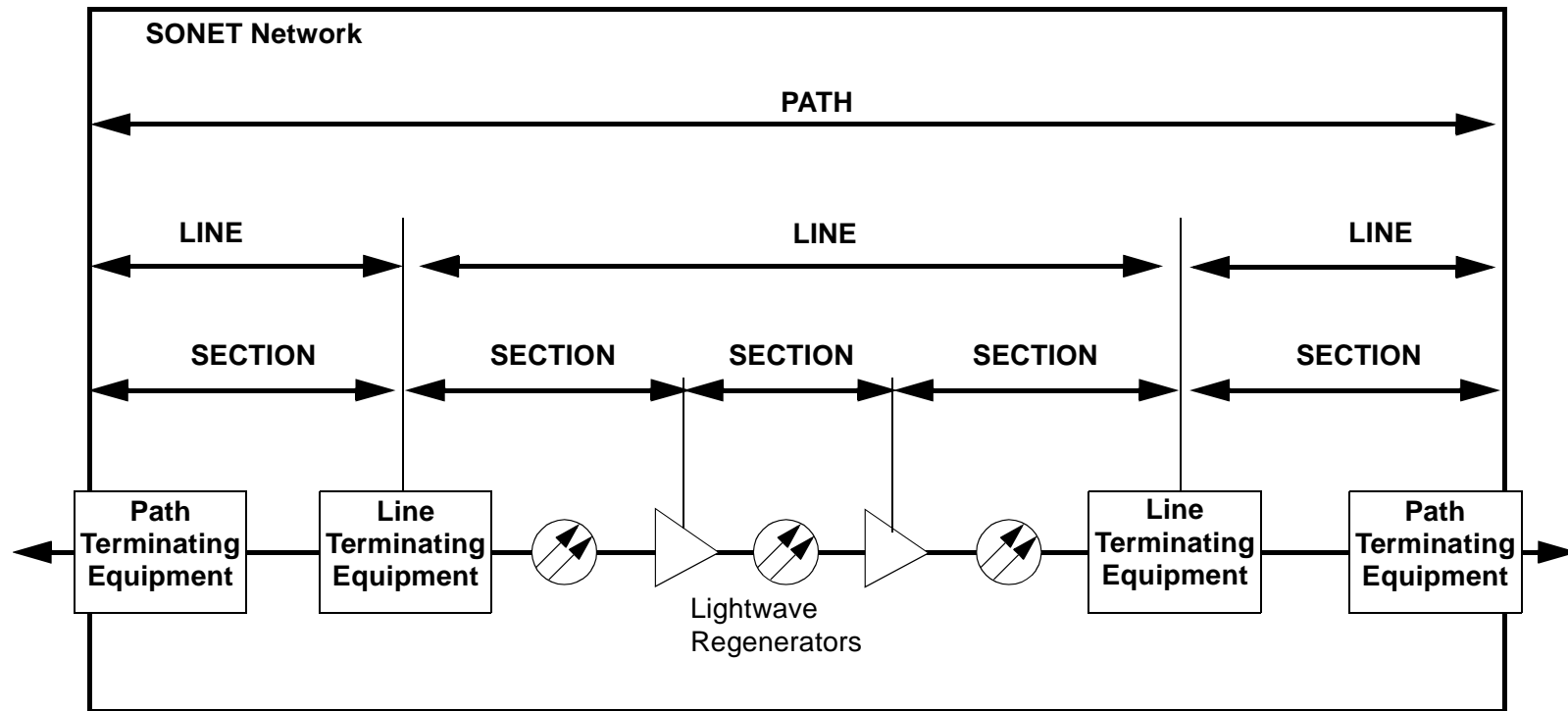
OSI's Relationship to SONET Layers

In 1978, the International Standards Organization (ISO) introduced the ISO model for Open Systems Interconnect (OSI) as a first step toward international standardization of the various protocols required for network communication.

The OSI model sets the following standards:

- Establishes data communications standards that promote multi-vendor interoperability

- Consists of seven layers, with a specific set of network functions allocated to each layer, and guidelines for implementation of the interfaces between layers

- Details a specific set of protocols and interfaces to implement at each layer. So far, only the lowest four layers have been explicitly defined

SONET contains versions of these 4 "Layers." These "Layers" are similar in function to the OSI model and are described on the following page.

SONET Layers

Physical Layer

The Physical layer deals with the transport of bits as optical or electrical pulses across the physical medium. There is no overhead associated with this layer.

The main function of this layer is conversion between the internal STS-n signals and external optical or electrical SONET signals. Issues dealt with at this layer include pulse shape, power levels, and line code.

Section Layer

The Section layer deals with the transport of an STS-n frame across the physical medium. This layer provides framing, scrambling, Section error monitoring, and Section level communications overhead (such as local orderwire). The overhead for this layer is read, interpreted, and modified or created by Section Terminating Equipment (STE).

Line Layer

The Line layer deals with the transport of the Path layer payloads across the physical medium. All lower layers provide transport for this layer.

The Line layer provides synchronization and multiplexing for the Path layer. The overhead associated with these functions includes overhead for maintenance and line protection purposes and is inserted into the Line overhead channels. The overhead for this layer is read, interpreted and modified or created by Line Terminating Equipment (LTE). The Section overhead must be terminated before accessing the Line overhead. Therefore, an NE that contains Line Terminating Equipment will also contain Section Terminating Equipment.

Path Layer

The Path layer maps the payloads into the format required by the Line layer. In addition, this layer communicates end-to-end via the Path overhead (POH). The Path layer provides signal labeling and tracing for end-to-end payload, and a user channel from end to end. The overhead for this layer is read, interpreted, and modified or created by Path Terminating Equipment. To access the POH, the Section and Line overhead must first be terminated. Therefore, an NE that contains Path Terminating Equipment will also contain Section and Line Terminating Equipment.

Section and Path overhead are part of Transport overhead

SONET Overhead

The overhead components of the SONET STS-n envelope are
shown below. Each of these parts are explained on the
following pages.

	Transport Overhead			Path Overhead
Section Overhead	Framing A1	Framing A2	Trace/Growth J0/Z0	Trace J1
	BIP-8 B1	Orderwire E1	User F1	BIP-8 B3
	Data Communications D1	Data Communications D2	Data Communications D3	Signal Label C2
Line Overhead	Pointer H1	Pointer H2	Pointer Action H3	Path Status G1
	BIP-8 B2	APS K1	APS K2	User Channel F2
	Data Communications D4	Data Communications D5	Data Communications D6	Indicator H4
	Data Communications D7	Data Communications D8	Data Communications D9	Growth Z3
	Data Communications D10	Data Communications D11	Data Communications D12	Growth Z4
	Sync Status/Growth S1/Z1	REI-L/Growth M0 or M1/Z2	Orderwire E2	Tandem Connection Z5

Section Overhead

Framing A1	Framing A2	STS-1 ID C1
BIP-8 B1	Orderwire E1	User F1
Data Com D1	Data Com D2	Data Com D3
Pointer H1	Pointer H2	Pointer Action H3
BIP-8 B2	APS K1	APS K2
Data Com D4	Data Com D5	Data Com D6
Data Com D7	Data Com D8	Data Com D9
Data Com D10	Data Com D11	Data Com D12
Sync Stat S1	FEBE Z2	Orderwire E2

This section describes each of the Section overhead bytes.

Framing (A1 and A2)

Two bytes which provide a frame alignment pattern (11110110 00101000).

Section Trace (J0)/Section Growth (Z0)

STS-1 Identification indicates the position of the STS-1 within a multiplexed STS-n signal. For example, STS-1 #1 is assigned (00000001). Also defined for Path Defect Indicator (PDI).

Section BIP-8 (B1)

The B1 byte provides Section error monitoring by means of a bit-interleaved parity 8 code (BIP-8). The BIP-8 is calculated over all the bytes of the previous STS-n frame.

Orderwire (E1)

Local Orderwire.

Section User Channel (F1)

Section User Channel is set aside for the network provider (currently undefined).

Section Data Communication Channel (D1, D2, and D3)

Provides a data communications channel (Section DCC) at 192 kb/s for message based monitoring, control or configuration.

> ***Note:*** *See Guide to SONET (FJTU-320-500-500) for more information.*

Line Overhead

Framing A1	Framing A2	STS-1 ID C1
BIP-8 B1	Orderwire E1	User F1
Data Com D1	Data Com D2	Data Com D3
Pointer H1	Pointer H2	Pointer Action H3
BIP-8 B2	APS K1	APS K2
Data Com D4	Data Com D5	Data Com D6
Data Com D7	Data Com D8	Data Com D9
Data Com D10	Data Com D11	Data Com D12
Sync Stat S1	FEBE Z2	Orderwire E2

The Line overhead bytes

> **Note:** A "byte" is the name for the eight bits that form the standard character used in communications.

STS Payload Pointer (H1 and H2)

Pointer indicating the offset in bytes between the pointer and the first byte of the STS SPE.

Pointer Action Byte (H3)

This byte can be used to carry an extra payload byte if needed during pointer justifications.

Line BIP-8 (B2)

The B2 byte provides "line" error monitoring. BIP-8 calculated over all Line overhead and STS-1 SPE of the previous frame.

APS Channel (K1 and K2)

Automatic Protection Switching bytes.

Line Data Communication Channel (DCC) (D4 through D12)

Provides a data communications channel for message based monitor, control and configuration at 576 kb/s.

Synchronization Status (S1)/Growth (Z1)

Synchronization Status Messaging.

STS-1 REI-L (M0 or M1)/Growth (Z2)

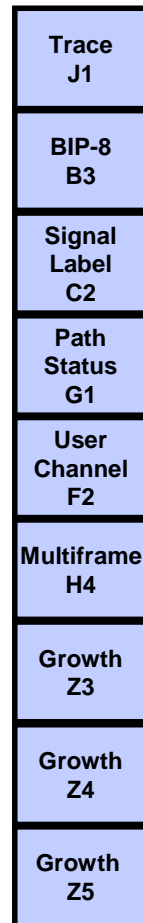Line Far End Block Error (FEBE) / Future growth.

Orderwire (E2)

Express Orderwire.

> **Note:** See Guide to SONET (FJTU-320-500-500) for more information.

STS Path Overhead

The STS Path overhead (POH) is assigned to the payload and will remain with the payload until it is demultiplexed. It is used for functions that are necessary in transporting STS SPEs. Telcordia (formally BellCore) defines the STS POH such that it supports the following classes of functions:

Trace J1
BIP-8 B3
Signal Label C2
Path Status G1
User Channel F2
Multiframe H4
Growth Z3
Growth Z4
Growth Z5

STS Path Trace (J1)

Path trace is used to repetitively transmit a 64-byte, fixed length string so that a Path receiving terminal can verify its continued connection to the intended transmitter.

STS Path BIP-8 (B3)

The B3 byte provides "path" error monitoring. BIP-8 calculated over SPE of the previous frame.

STS Path Signal Label (C2)

Path Signal Label defines the construction of the STS SPE.

Path Status (G1)

Path Status is allocated to convey back to an originating STS PTE the Path terminating status and performance.

Indicator Byte (H4)

Multi-frame indicator byte for VT payloads.

Path User Channel (F2)

User channel between PTE.

STS Path Growth (Z3, Z4)

Reserved for growth.

Tandem Connection (Z5)

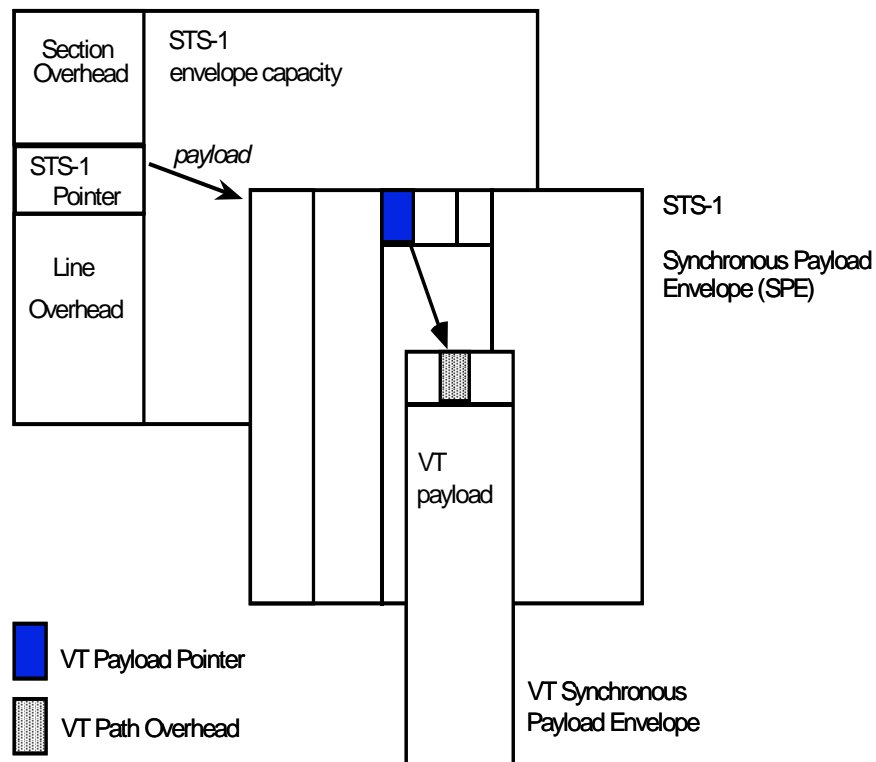The Z5 byte is allocated for Tandem Connection Maintenance and the Path Data Channel.

> ***Note:*** *See Guide to SONET (FJTU-320-500-500) for more information.*

VT Path Overhead

Four bytes (V5, J2, Z6, and Z7) are allocated for VT POH. The V5 byte is the first byte of the VT SPE (i.e., the byte pointed to by the VT Payload Pointer). The J2, Z6, and Z7 bytes occupy the corresponding location in the subsequent 125 microsecond frames of the VT superframe.
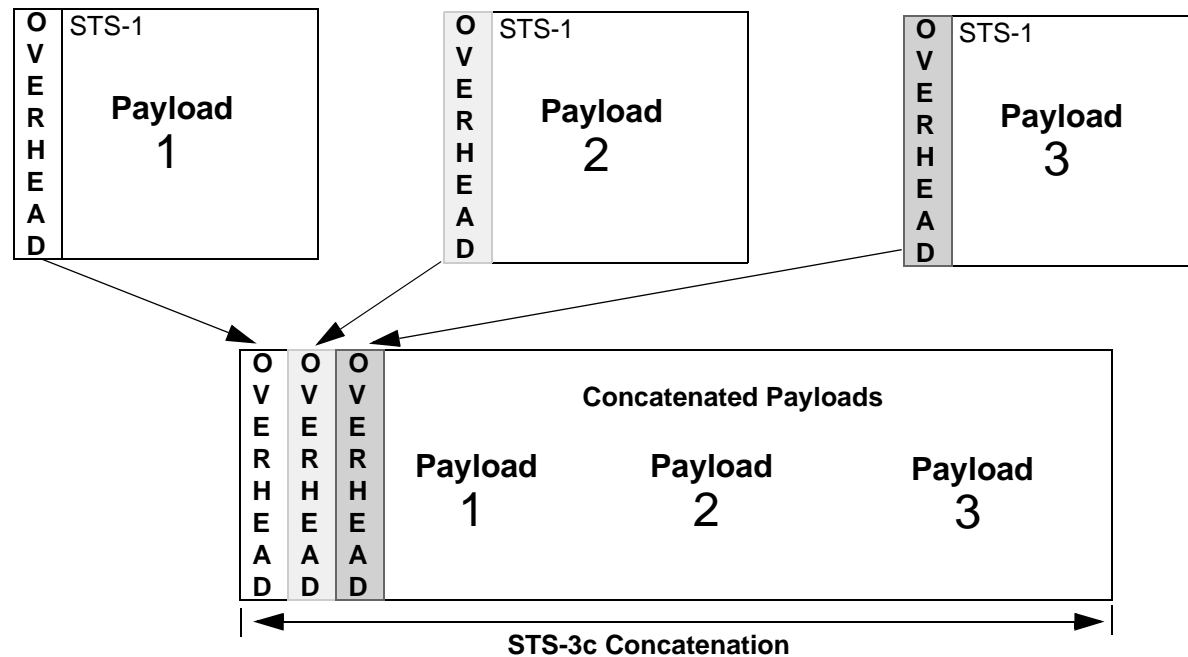
The bits within the V5 byte are assigned as follows:

- Bits 1 and 2 are used for BIP-2 error performance monitoring. Bit 1 is calculated to give even parity over all odd numbered bits in the previous VT SPE. Bit 2 is calculated to give even parity over all even bits in the previous VT SPE

- Bit 3 is a VT Path REI (REI-V) indication that is sent toward an originating VT PTE if one or more errors were detected by the BIP-2.

- Bit 4 is a VT Path Remote Failure Indication (RFI-V) in the byte-synchronous DS1 mapping.

- Bits 5 through 7 contain the VT Path Signal Label to indicate the content of the VT SPE. Of the eight possible binary values (000 to 111), only the codes defined for each VT size have been assigned. The remaining codes are reserved to be assigned as required for future VT payload mappings.

- Bit 8 (along with bits 5 through 7 of the Z7 byte) is a VT Path Remote Defect Indication (RDI-V) signal.

    Note: *See Guide to SONET (FJTU-320-500-500) for more information.*

VT Path Overhead (V5)

The V5 byte provides the same functions for the VT Path that the B3, C2, and G1 bytes provide for the STS Paths. It is used for error checking, signal label, and Path status.

STS-3c Concatenation

SONET Concatenation

Concatenation as defined in SONET is illustrated above. In easy to understand terms, "to concatenate" is to chain things from different places into the same "flow."

The best way to describe this process is to think about a traffic merge from three feeder highways into a super highway. Many of us see this merge (concatenation) of traffic into one steady stream as "drive time" during rush hours.

To make this work in principle over a SONET link, we have to put a "flagman" at each "on ramp" (STS-1) to ensure that all of the incoming traffic arrives at its destination, in the proper order and on time.

For payloads at above DS3 rates, the SONET standard provides for Super Rate Services using concatenation. Super Rate Services are services that require multiples of the STS-1 rate. These services are mapped into an concatenated STS-n, or STS-nc signal. The STS-nc is addressed as a single entity and multiplexed, switched, and transported through the network as a unit.

Note: *See Guide to SONET (FJTU-320-500-500) for more information.*

Summary

This lesson provided background SONET information. Topics included:

- SONET terminology

- SONET interfaces and virtual tributaries

- SONET layers and overhead

SONET Self Evaluation

FNC requires that the student pre-qualify before attending Fujitsu Educational Services Training.

The basics discussed in this prerequisite training course serves to prepare prospective students for the product specific training course so that time is not devoted to covering material that the student should already know.

The Self Evaluation requires a minimum of 12 correct responses. If fewer 12 answers are right, you should review and retake the Self Evaluation until you do reach 12 or more right answers. The answers to the Self Evaluation follow the questions, and contain links to the material used to develop the questions in your self study Tutorial.

Prospective students who wish to gain more in-depth SONET information are encouraged to download the Fujitsu Guide to SONET located at:

http://www.fnc.fujitsu.com/services/pdfs/tech_pub_sonet.pdf

SONET SELF EVALUATION (15 Questions)

Circle the Letter of your Choice and then compare your answers on the Self-Evaluation Answer Sheet on .

1 SONET consists of _____ and _____ signals

- (A) Electrical, Radio
- (B) Optical, Radio
- (C) Electrical, Optical
- (D) None of the Above

2 How many "VT 1.5s" are contained in a VTG?

- (A) 7
- (B) 4
- (C) 28
- (D) None of the Above

3 How many OC-3s can be carried in an OC-48 Link?

- (A) 12
- (B) 4
- (C) 16
- (D) 8

4 SONET is the standard in _____

- (A) USA
- (B) Canada
- (C) Both A and B
- (D) None of the Above

5 What is the format for transport of a DS-1 in a SONET Network?

- (A) DS-3
- (B) OC-3
- (C) EC-1
- (D) VT-1.5

6 Virtual Tributary (VT) is a structure designed for transport and switching of _____ payloads.

- (A) STS-1
- (B) Sub-STS-3
- (C) STS-3
- (D) Sub-STS-1

7 Path and Line Terminating Equipment is provided by _____

- (A) SONET Multiplexer
- (B) VTG
- (C) T-1 Carrier Systems
- (D) None of the Above

8 Electrical and Optical signals are contained in_____

- (A) Radio Transmissions
- (B) SONET
- (C) All of the Above
- (D) None of the Above

9   Orderwire is part of the _____ TRANSPORT overhead.

- (A) Line
- (B) Section
- (C) A and B
- (D) None of the Above

10   How many VT-1.5s can be transported in an STS-1?.

- (A) 30
- (B) 24
- (C) 28
- (D) 31

11   The B3 byte provides _____ error monitoring?

- (A) Path
- (B) Line
- (C) Section
- (D) None of the above

12   How many Virtual Tributary Groups are possible in an STS-1

- (A) 1
- (B) 7
- (C) 4
- (D) None of the above

13   What overhead Layer contains the SDCC

- (A) Physical
- (B) Section
- (C) Line
- (D) Presentation

14   APS signalling takes place in the _____ Layer

- (A) Physical
- (B) Section
- (C) Line
- (D) Presentation

15   What is the difference between STS-3 and STS-3c

- (A) Only non-voice data can pass over an STS-3
- (B) The STS-1 overhead is concatenated in an STS-3
- (C) STS-3 is made up of three independent signals and STS3c is made up of a single composite signal.
- (D) The STS-1 overhead is not concatenated in an STS-3c

Self Evaluation Sheet (Electronic)

Correctly answer 12 for a PASS. If you get fewer than 12 correct, we recommend that you review using the clickable Lookup Answer that lets you jump to the source of the information in the question missed.

Question	Correct Answer	Lookup Answer
1	C	**Review**
2	B	**Review**
3	C	**Review**
4	C	**Review**
5	D	**Review**
6	D	**Review**
7	A	**Review**
8	B	**Review**
9	C	**Review Part 1** **Review Part 2**
10	C	**Review**
11	A	**Review**
12	B	**Review**
13	B	**Review**
14	C	**Review**
15	C	**Review**

Self Evaluation Sheet (Print Version)

Correctly answer 12 for a PASS. If you get fewer than 12 correct, we recommend that you refer to the page of this tutorial under "Answer Location" for the source of the information in the question missed.

Question	Correct Answer	Answer Location
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