

# Data Communications and Networking Fourth Edition

# **Forouzan**

# Chapter 17 广域网 SONET/SDH



# SONET 由 ANSI 制定; SDH 由 ITU-T 制定.

同步光纤网络 SONET (Synchronous Optical Network) 同步数字体系 SDH (Synchronous Digital Hierarchy)

# 17-1 体系结构

首先介绍 SONET 系统的体系结构:信号、设备和连接.

## **Topics discussed in this section:**

信号 Signals SONET 设备 SONET Devices 连接 Connections

#### Table 17.1 SONET/SDH 速率

STS	OC	Rate (Mbps)	STM
STS-1	OC-1	51.840	
STS-3	OC-3	155.520	STM-1
STS-9	OC-9	466.560	STM-3
STS-12	OC-12	622.080	STM-4
STS-18	OC-18	933.120	STM-6
STS-24	OC-24	1244.160	STM-8
STS-36	OC-36	1866.230	STM-12
STS-48	OC-48	2488.320	STM-16
STS-96	OC-96	4976.640	STM-32
STS-192	OC-192	9953.280	STM-64

同步传输信号 STS (Synchronous Transport Signal) 光载波 OC (Optical Carrier) 同步传输模块 STM (Synchronous Transport Module)

#### Figure 17.1 使用 SONET 设备的简单网络

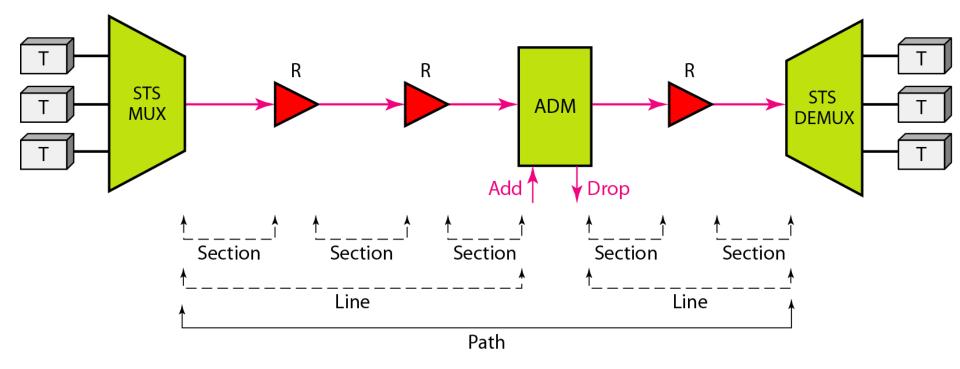
ADM: Add/drop multiplexer

STS MUX: Synchronous transport signal multiplexer

STS DEMUX: Synchronous transport signal demultiplexer

R: Regenerator

T: Terminal

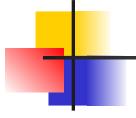


# 17-2 SONET 层

SONET 标准包括四个功能层:光子层 (photonic layer)、段层 (section layer)、线路层 (line layer)和路径层 (path layer),它们对应于物理层和数据链路层。

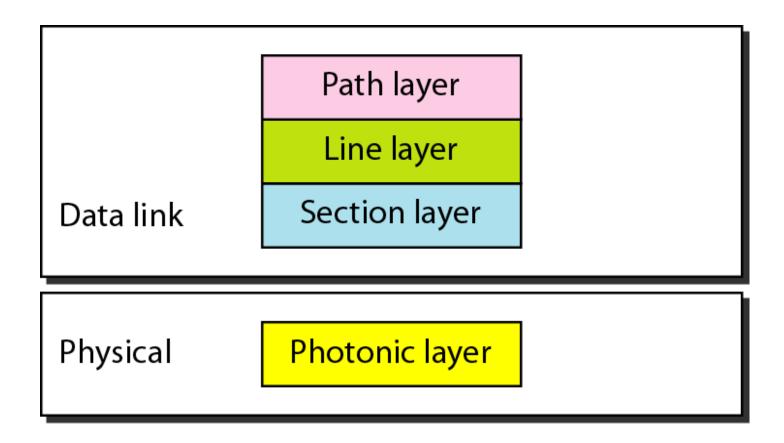
# **Topics discussed in this section:**

路径层 Path Layer 线路层 Line Layer 段层 Section Layer 光子层 Photonic Layer 设备 - 层之间的关系 Device-Layer Relationships

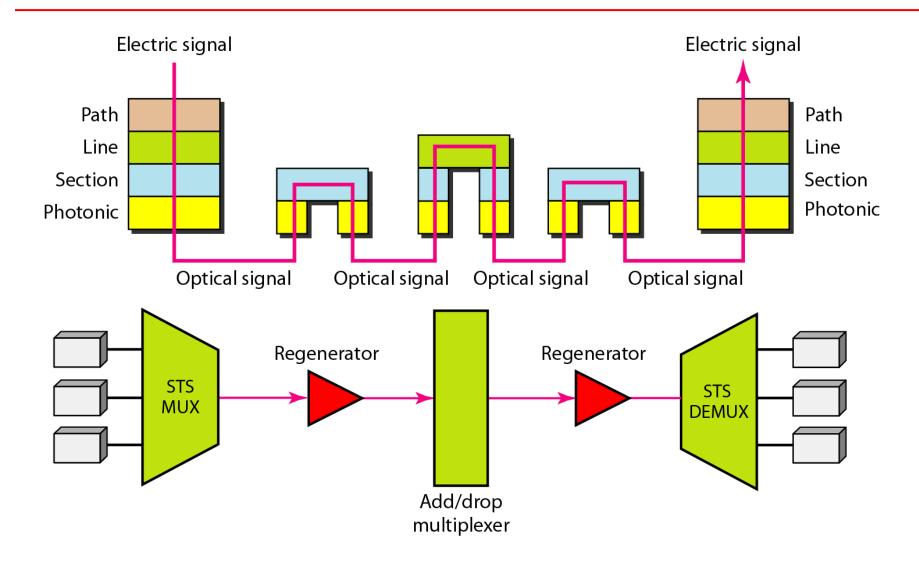


# SONET 定义了四层: 路径、线路、段和光子层。

## Figure 17.2 SONET 层与 OSI 或因特网层比较



## Figure 17.3 SONET 中的设备 - 层关系



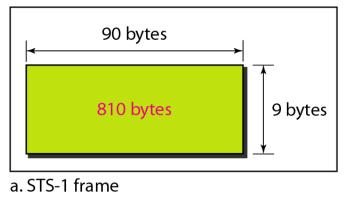
# 17-3 SONET 帧

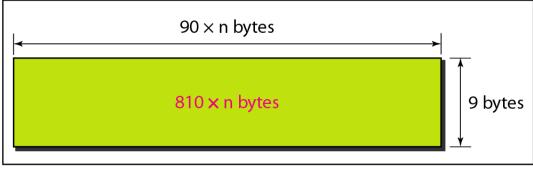
每个同步传输信号 STS-n 由 8000 个帧组成。每个帧是个  $90 \times n$  列、 9 行的二维矩阵。

## **Topics discussed in this section:**

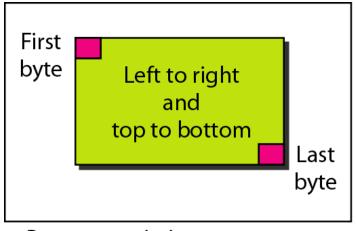
帧、字节和位传输 Frame, Byte, and Bit Transmission STS-1 帧格式 STS-1 Frame Format 封装 Encapsulation

# Figure 17.4 STS-1 和 STS-n 帧

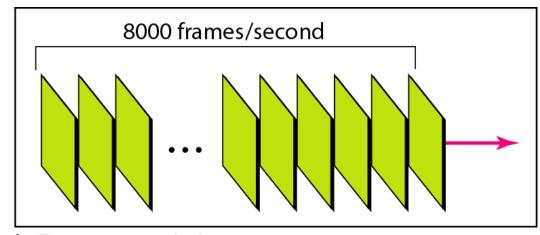




# Figure 17.5 传输中的 STS-1 帧



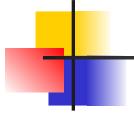
a. Byte transmission



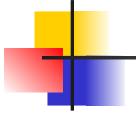
b. Frame transmission



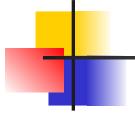
# SONET STS-n 信号 以每秒 8000 个帧传输。



# SONET 帧中的每一个字节 能承载一个数字化语音通道。



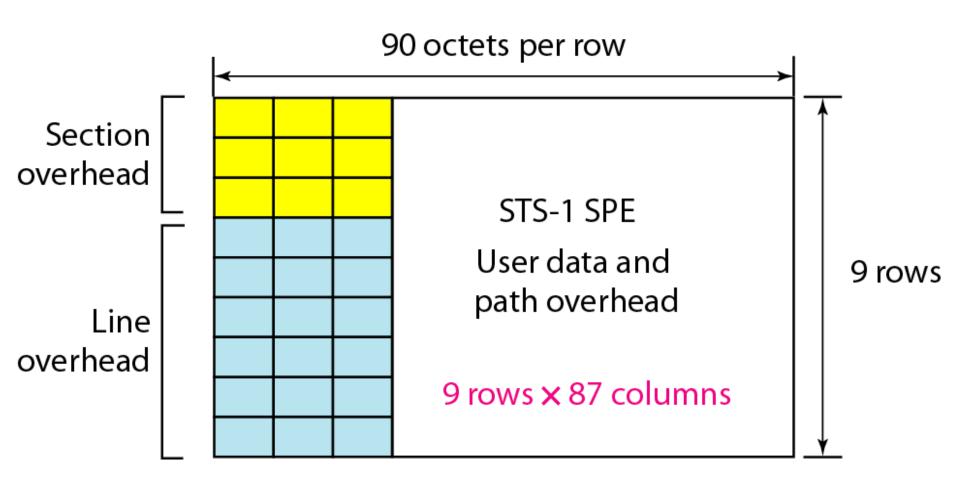
在 SONET 中, STS-n 信号的数据速率是 STS-1 信号数据速率的 n 倍。



# 在 SONET 中,任何帧的周期均为 125 μs

0

#### Figure 17.6 STS-1 帧开销



同步有效载荷封装 SPE (Synchronous Payload Envelop)

# 

A1, A2: Alignment D1, D2, D3: Management

B1: Parity byte E1: Order wire byte

C1: Identification F1: User

A1	A2	C1			
B1	E1	F1			STS-1 SPE
D1	D2	D3			

# 为每个 SONET 设备 (再生器和多路复用器)重新计算段开销。

#### Figure 17.8 STS-1 帧:线路开销

**B2**: Line parity byte

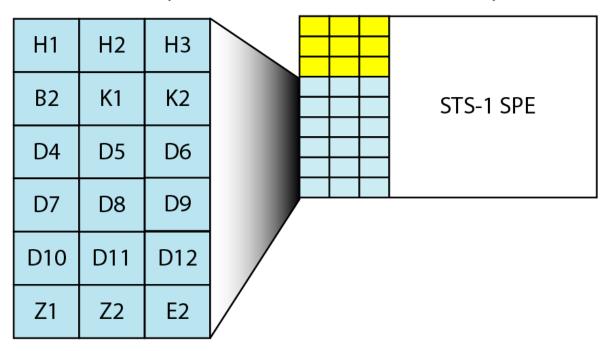
D4-D12: Management bytes

E2: Order wire byte

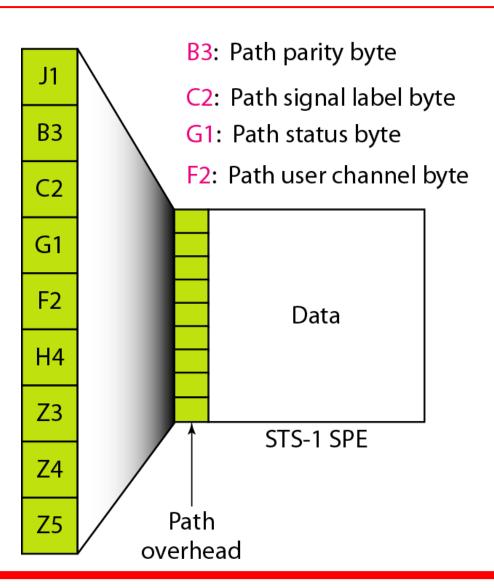
H1, H2, H3: Pointers

K1, K2: Automatic protection switching bytes

Z1, Z2: Growth bytes (reserved)



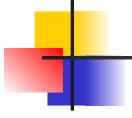
#### Figure 17.9 STS-1 帧:路径开销



H4: Virtual tributary indicator

J1: Path trace byte

Z3, Z4, Z5: Growth bytes (reserved)



# 路径开销只为端到端 (在STS多路复用器之间)计算。

# **Table 17.2** 开销

Byte Function	Section	Line	Path
Alignment	A1, A2		
Parity	B1	B2	В3
Identifier	C1		C2
OA&M	D1–D3	D4-D12	
Order wire	E1		
User	F1		F2
Status			G1
Pointers		H1– H3	H4
Trace			J1
Failure tolerance		K1, K2	
Growth (reserved for future)		Z1, Z2	Z3-Z5