

Glossary

Add/ Drop

The process where a part of the information carried in a transmission system is demultiplexed (dropped) at an intermediate point and different information is multiplexed (added) for subsequent transmission. The remaining traffic passes straight through the multiplexer without additional processing.

Add/Drop Multiplexer (ADM)

A multiplexer capable of extracting and inserting lower-rate signals from a higher-rate multiplexed signal without completely demultiplexing the signal.

AIS (Alarm Indicating Signal)

A code sent downstream indicating an upstream failure has occurred. SONET defines four categories of AIS: Line AIS, STS Path AIS, VT Path AIS, DS_n AIS.

AMI

Alternate Mark Inversion. The line-coding format in transmission systems where successive ones (marks) are alternatively inverted (sent with polarity opposite that of the preceding mark).

ANSI (American National Standards Institute)

A membership organization which develops U.S. industry standards and coordinates U.S. participation in the International Standards Organization (ISO).

Asynchronous

A network where transmission system payloads are not synchronized and each network terminal runs on its own clock.

Asynchronous Transfer Mode (ATM)

A multiplexing/switching technique in which information is organized into fixed-length cells with each cell consisting of an identification header field and an information field. The transfer mode is asynchronous in the sense that the use of the cells depends on the required or instantaneous bit rate.

Attenuation

Reduction of signal magnitude or signal loss, usually expressed in decibels.

Automatic Protection Switching (APS)

The ability of a network element to detect a failed working line and switch the service to a spare (protection) line. 1+1 APS pairs a protection line with each working line. 1:n APS provides one protection line for every n working lines.

Bandwidth

Information-carrying capacity of a communication channel. Analog bandwidth is the range of signal frequencies that can be transmitted by a communication channel or network.

Bidirectional

Operating in both directions. Bidirectional APS allows protection switching to be initiated by either end of the line.

Binary N-Zero Suppression (BNZS)

Line coding system that replaces N number of zeros with a special code to maintain pulse density required for synchronization. N is typically 3, 6, or 8.

BIP-8 (Bit Interleaved Parity-8)

A method of error checking in SONET which allows a full set of performance statistics to be generated. For example, a BIP-8 creates eight-bit (one-byte) groups, then does a parity check for each of the eight bit positions in the byte.

BISDN (Broadband Integrated Services Digital Network)

A single ISDN network which can handle voice, data, and eventually video services.

Bit

One binary digit; a pulse of data.

Bit Error Rate (BER)

The number of coding violations detected in a unit of time, usually one second. Bit Error rate (BER) is calculated with this formula:

$$BER = \text{errored bits received} / \text{total bits sent}$$

Don't Confuse The Terms

Three sets of terms are often used interchangeably to describe SONET processes. However, it's important to recognize that these terms are not equivalent; each has a distinct meaning:

Add/Drop – The process where a part of the information carried in a transmission system is demodulated (dropped) at an intermediate

point and different information is entered (added) for subsequent transmission. The remaining traffic passes straight through the multiplexer without additional processing.

Map/Demap – A term for multiplexing, implying more visibility inside the resultant multiplexed bit stream than available with conventional asynchronous techniques.

Multiplex/Demultiplex – Multiplex allows the transmission of two or more signals over a single channel. Demultiplex is the process of separating previously combined signals and restoring the distinct individual channels of the signals.

Block Error Rate (BLER)

One of the underlying concepts of error performance is the notion of Errored Blocks, that is, blocks in which one or more bits are in error. A block is a set of consecutive bits associated with the path or section monitored by means of an Error Detection Code (EDC), such as Bit Interleaved Parity (BIP). Block Error rate (BLER) is calculated with the formula:

$$BLER = \text{errored blocks received} / \text{total blocks sent}$$

Bit Error vs. Block Error

Error rate statistics play a key role in measuring the performance of a network. As errors increase, user payload (especially data) must be re-transmitted. The end effect is creation of more (non-revenue) traffic in the network.

Bit-Interleaved Parity (BIP)

A parity check that groups all the bits in a block into units (such as byte), then performs a parity check for each bit position in a group.

Bit Stuffing

In asynchronous systems, a technique used to synchronize asynchronous signals to a common rate before multiplexing.

Bit Synchronous

A way of mapping payload into virtual tributaries that synchronizes all inputs into the VTs, but does not capture any framing information or allow access to subrate channels carried in each input. For example, bit synchronous mapping of a channeled DS1 into a VT1.5 does not provide access to the DS0 channels carried by the DS1.

Bits Per Second (bps)

The number of bits passing a point every second. The transmission rate for digital information.

Broadband

Services requiring 50-600 Mb/s transport capacity.

Byte Interleaved

Bytes from each STS-1 are placed in sequence in a multiplexed or concatenated STS-N signal. For example, for an STS-3, the sequence of bytes from contributing STS-1s is 1,2,3,1,2,3, ...

Byte Synchronous

A way of mapping payload into virtual tributaries that synchronizes all inputs into the VTs, captures framing information, and allows access to subrate channels carried in each input. For example, byte synchronous mapping of a channeled DS1 into a VT1.5 provides direct access to the DS0 channels carried by the DS1.

CCITT

The technical organs of the United Nations specialized agency for telecommunications, now the International Telecommunications Union – Telecom. They function through international committees of telephone administrations and private operating agencies.

CEPT

European Conference of Postal and Telecommunications Administrations. The CEPT format defines the 2.048-Mb/s European E1 signal made up of 32 voice-frequency channels.

Channel

The smallest subdivision of a circuit that provides a type of communication service; usually a path with only one direction.

Circuit

A communications path or network; usually a pair of channels providing bi-directional communication.

Circuit Switching

Basic switching process whereby a circuit between two users is opened on demand and maintained for their exclusive use for the duration of the transmission.

Coding Violation (CV)

A transmission error detected by the difference between the transmitted and the locally calculated bit-interleaved parity.

Concatenate

The linking together of various data structures, for example two bandwidths joined to form a single bandwidth.

Concatenated STS-Nc

A signal in which the STS Envelope Capacities from the N STS-1s have been combined to carry an STS-Nc Synchronous Payload Envelope (SPE). It's used to transport signals that don't fit into an STS-1 (52 Mb/s) payload.

Concatenated VT

A virtual tributary (VT x Nc) which is composed of N x VTs combined. Its payload is transported as a single entity rather than separate signals.

Cyclic Redundancy Check (CRC)

A technique for using overhead bits to detect transmission errors.

Data Communications Channels v

OAM&P channels in SONET that enable communications between intelligent controllers and individual network nodes as well as internode communications.

Defect

A limited interruption in the ability of an item to perform a required function.

Demultiplexing

A process applied to a multiplex signal for recovering signals combined within it and for restoring the distinct individual channels of the signals.

Dense Wavelength Division Multiplexing (DWDM)

DWDM is the higher capacity version of WDM, which is a means of increasing the capacity of fiber-optic data transmission systems through the multiplexing of multiple wavelengths of light. Commercially available DWDM systems support the multiplexing of from 8 to 40 wavelengths of light.

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Digital Cross-Connect (DCS)

An electronic cross-connect which has access to lower-rate channels in higher-rate multiplexed signals and can electronically rearrange (cross-connect) those channels.

Digital Signal

An electrical or optical signal that varies in discrete steps. Electrical signals are coded as voltages, optical signals are coded as pulses of light.

DSX-1

May refer to either a cross-connect for DS1 rate signals or the signals cross-connected at DSX-1.

DSX-3

May refer to either a cross-connect for DS3 rate signals or the signals cross-connected at DSX-3.

ECSA (Exchange Carrier Standards Association)

An organization that specifies telecommunications standards for ANSI.

Envelope Capacity

The number of bytes the payload envelope of a single frame can carry. The SONET STS payload envelope is the 783 bytes of the STS-1 frame available to carry a signal. Each virtual tributary has an envelope capacity defined as the number of bytes in the virtual tributary less the bytes used by VT overhead.

Failure

A termination of the ability of an item to perform a required function. A failure is caused by the persistence of a defect.

FEBE (Far End Block Error)

A message sent back upstream that a receiving network element is detecting errors, usually a coding violation. See Remote Error Indication (REI).

FERF (Far End Receive Failure)

A signal to indicate to the transmit site that a failure has occurred at the receive site.

Fixed Stuff

A bit or byte whose function is reserved. Fixed stuff locations, sometimes called reserved locations, do not carry overhead or payload.

Floating Mode

A virtual tributary mode that allows the VT synchronous payload envelope to begin anywhere in the VT. Pointers identify the starting location of the VT SPE. VT SPEs in different superframes may begin at different locations.

Framing

Method of distinguishing digital channels that have been multiplexed together.

Frequency

The number of cycles of periodic activity that occur in a discrete amount of time.

Grooming

Consolidating or segregating traffic for efficiency.

Interleave

The ability of SONET to mix together and transport different types of input signals in an efficient manner, thus allowing higher-transmission rates.

Isochronous

All devices in the network derive their timing signal directly or indirectly from the same primary reference clock.

Jitter

Short waveform variations caused by vibration, voltage fluctuations, control system instability, etc.

Line

One or more SONET sections, including network elements at each end, capable of accessing, generating, and processing Line Overhead.

Line Alarm Indication Signal (AIS-L)

AIS-L is generated by Section Terminating Equipment (STE) upon the detection of a Loss of Signal or Loss of Frame defect, on an equipment failure. AIS-L maintains operation of the downstream regenerators, and therefore prevents generation of unnecessary alarms. At the same time, data and orderwire communication is retained between the regenerators and the downstream Line Terminating Equipment (LTE).

Line Remote Defect Indication (RDI-L)

A signal returned to the transmitting Line Terminating Equipment (LTE) upon detecting a Loss of Signal, Loss of Frame, or AIS-L defect. RDI-L was previously known as Line FERF.

Line Overhead (LOH)

18 bytes of overhead accessed, generated, and processed by line terminating equipment. This overhead supports functions such as locating the SPE in the frame, multiplexing or concatenating signals, performance monitoring, automatic protection switching, and line maintenance.

Line Terminating Equipment (LTE)

Network elements such as add/drop multiplexers or digital cross-connect systems which can access, generate, and process Line Overhead.

Locked Mode

A virtual tributary mode that fixes the starting location of the VT SPE. Locked mode has less pointer processing than floating mode.

Map/Demap

A term for multiplexing, implying more visibility inside the resultant multiplexed bit stream than available with conventional asynchronous techniques.

Mapping

The process of associating each bit transmitted by a service into the SONET payload structure that carries the service. For example, mapping a DS1 service into a SONET VT1.5 associates each bit of the DS1 with a location in the VT1.5.

Multiplex (MUX)

To transmit two or more signals over a single channel.

Multiplexer

A device for combining several channels to be carried by one line or fiber.

Mesochronous

A network whereby all nodes are timed to a single clock source, thus all timing is exactly the same (truly synchronous).

Narrowband

Services requiring up to 1.5 Mb/s transport capacity.

Network Element (NE)

Any device which is part of a SONET transmission path and serves one or more of the section, line and path-terminating functions.

In SONET, the five basic network elements are:

- ▶ Add/drop multiplexer
- ▶ Broadband digital cross-connect
- ▶ Wideband digital cross-connect
- ▶ Digital loop carrier
- ▶ Switch interface

OA&M

Operations, Administration, and Maintenance. Also called OAM&P.

OAM&P (Operations, Administration, Maintenance, and Provisioning)

Provides the facilities and personnel required to manage a network.

OC-1 (Optical Carrier Level 1)

The optical equivalent of an STS-1 signal.

OC-N (Optical Carrier Level N)

The optical equivalent of an STS-N signal.

Optical Amplifier

A device to amplify an optical signal without converting the signal from optical to electrical and back again to optical energy. The two most common optical amplifiers are erbium-doped fiber amplifiers (EDFAs), which amplify with a laser pump diode and a section of erbium-doped fiber, and semiconductor laser amplifiers.

Orderwire

A channel used by installers to expedite the provisioning of lines.

OS (Operations System)

Sophisticated applications software that overlooks the entire network.

OSI Seven-layer Model

A standard architecture for data communications. Layers define hardware and software required for multi-vendor information processing equipment to be mutually compatible. The seven layers from lowest to highest are: physical, link, network, transport, session, presentation, and application.

Overhead

Extra bits in a digital stream used to carry information besides traffic signals. Orderwire, for example, would be considered overhead information.

Packet Switching

An efficient method for breaking down and handling high-volume traffic in a network. A transmission technique that segments and routes information into discrete units. Packet switching allows for efficient sharing of network resources as packets from different sources can all be sent over the same channel in the same bitstream.

Parity Check

An error-checking scheme which examines the number of transmitted bits in a block which hold the value one. For even parity, an overhead parity bit is set to either one or zero to make the total number of transmitted ones an even number. For odd parity, the parity bit is set to make the total number of ones transmitted an odd number.

Path

A logical connection between a point where an STS or VT is multiplexed to the point where it is demultiplexed.

Path Overhead (POH)

Overhead accessed, generated, and processed by path-terminating equipment. Path overhead includes nine bytes of STS Path Overhead and, when the frame is VT-structured, five bytes of VT Path Overhead.

Path Terminating Equipment (PTE)

Network elements, such as fiber-optic terminating systems, which can access, generate, and process Path Overhead.

Payload

The portion of the SONET signal available to carry service signals such as DS1 and DS3. The contents of an STS SPE or VT SPE.

Payload Pointer

Indicates the beginning of the Synchronous Payload Envelope.

Photon

The basic unit of light transmission used to define the lowest (physical) layer in the OSI seven-layer model.

Plesiochronous

A network with nodes timed by separate clock sources with almost the same timing.

Pointer

A part of the SONET overhead that locates a floating payload structure. STS pointers locate the SPE. VT Pointers locate floating mode virtual tributaries. All SONET frames use STS pointers; only floating mode virtual tributaries use VT pointers.

Poll

An individual control message from a central controller to an individual station on a multipoint network inviting that station to send.

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POP (Point-of-Presence)

A point in the network where inter-exchange carrier facilities like DS3 or OC-N meet with access facilities managed by telephone companies or other service providers.

Remote Alarm Indication (RAI)

A code sent upstream in a DS_n network as a notification that a failure condition has been declared downstream. (RAI signals were previously referred to as Yellow signals.)

Remote Defect Indication (RDI)

A signal returned to the transmitting Terminating Equipment upon detecting a Loss of Signal, Loss of Frame, or AIS defect. RDI was previously known as FERF.

Remote Error Indication (REI)

An indication returned to a transmitting node (source) that an errored block has been detected at the receiving node (sink). This indication was formerly known as Far End Block Error (FEBE).

Remote Failure Indication (RFI)

A failure is a defect that persists beyond the maximum time allocated to the transmission system protection mechanisms. When this situation occurs, an RFI is sent to the far end and will initiate a protection switch if this function has been enabled.

Regenerator

Device that restores a degraded digital signal for continued transmission; also called a repeater.

SDH (Synchronous Digital Hierarchy)

The ITU-T defined world standard of transmission whose base transmission rate is 52 Mb/s (STM-0) and is equivalent to SONET's STS-1 or OC-1 transmission rate. SDH standards were published in 1989 to address interworking between the ITU-T and ANSI transmission hierarchies.

Section

The span between two SONET network elements capable of accessing, generating, and processing only SONET Section overhead. This is the lowest layer of the SONET protocol stack with overhead.

Section Overhead

Nine bytes of overhead accessed, generated, and processed by section terminating equipment. This overhead supports functions such as framing the signal and performance monitoring.

Section Terminating Equipment (STE)

Equipment that terminates the SONET Section layer. STE interprets and modifies or creates the Section Overhead.

Slip

An overflow (deletion) or underflow (repetition) of one frame of a signal in a receiving buffer.

SONET (Synchronous Optical Network)

A standard for optical transport that defines optical carrier levels and their electrically equivalent synchronous transport signals. SONET allows for a multi-vendor environment and positions the network for transport of new services, synchronous networking, and enhanced OAM&P.

Stratum

Level of clock source used to categorize accuracy.

Superframe

Any structure made up of multiple frames. SONET recognizes superframes at the DS1 level (D4 and extended superframe) and at the VT (500 μ s STS superframes).

Synchronous

A network where transmission system payloads are synchronized to a master (network) clock and traced to a reference clock.

Synchronous Transfer Module (STM)

An element of the SDH transmission hierarchy. STM-1 is SDH's base-level transmission rate equal to 155 Mb/s. Higher rates of STM-4, STM-16, and STM-48 are also defined.

SPE (Synchronous Payload Envelope)

The major portion of the SONET frame format used to transport payload and STS path overhead. A SONET structure that carries the payload (service) in a SONET frame or virtual tributary. The STS SPE may begin anywhere in the frame's payload envelope. The VT SPE may begin anywhere in a floating mode VT, but begins at a fixed location in a locked-mode VT.

STS Path Overhead (STS POH)

Nine evenly distributed Path Overhead bytes per 125 microseconds starting at the first byte of the STS SPE. STS POH provides for communication between the point of creation of an STS SPE and its point of disassembly.

STS Path Remote Defect Indication (RDI-P)

A signal returned to the transmitting STS Path Terminating Equipment (PTE) upon detection of certain defects on the incoming path.

STS Path Terminating Equipment (STS PTE)

Equipment that terminates the SONET STS Path layer. STS PTE interprets and modifies or creates the STS Path Overhead. An NE that contains STS PTE will also contain LTE and STE.

STS-1 (Synchronous Transport Signal Level 1)

The basic SONET building block signal transmitted at 51.84 Mb/s data rate.

STS-N (Synchronous Transport Signal Level N)

The signal obtained by multiplexing integer multiples (N) of STS-1 signals together.

T1X1 Subcommittee

A committee within ANSI that specifies SONET optical interface rates and formats.

VT (Virtual Tributary)

A signal designed for transport and switching of sub-STS-1 payloads.

VT Group

A 9 row x 12 column structure (108 bytes) that carries one or more VTs of the same size. Seven VT groups can be fitted into one STS-1 payload.

VT Path Overhead (VT POH)

Four evenly distributed Path Overhead bytes per VT SPE starting at the first byte of the VT SPE. VT POH provides for communication between the point of creation of an VT SPE and its point of disassembly.

VT Path Remote Defect Indication (RDI-V)

A signal returned to the transmitting VT PTE upon detection of certain defects on the incoming path.

VT Path Remote Failure Indication (RFI-V)

A signal, applicable only to a VT1.5 with the byte-synchronous DS1 mapping, that is returned to the transmitting VT PTE upon declaring certain failures. The RFI-V signal was previously known as the VT Path Yellow signal.

VT Path Terminating Equipment (VT PTE)

Equipment that terminates the SONET VT Path layer. VT PTE interprets and modifies or creates the VT Path Overhead. An NE that contains VT PTE will also contain STS PTE, LTE, and STE.

Wander

Long-term variations in a waveform.

Wavelength Division Multiplexing (WDM)

WDM is a means of increasing the capacity of fiber-optic data transmission systems through the multiplexing of multiple wavelengths of light. WDM systems support the multiplexing of as many as four wavelengths.

Wideband

Services requiring 1.5 to 50 Mb/s transport capacity.

Yellow Signal

See Remote Alarm Indication (REI) and VT Path Remote Failure Indication (RFI-V).

SONET Reference Materials

Bellcore GR-253-CORE, SONET Transport Systems: Common Generic Criteria

Consult this document for an up-to-date listing of:

- ▶ Generic Requirements (GR)
- ▶ Technical References (TR)
- ▶ Technical Advisories (TA)
- ▶ Special Reports (SR)
- ▶ EIA/TIA Documents
- ▶ American National Standards Institute (ANSI) documents
- ▶ ITU-T and CCITT Recommendations
- ▶ ISO documents
- ▶ IEEE documents