

## Glossary

### Add/Drop

The process where a part of the information carried in a transmission system is extracted (dropped) at an intermediate point and different information is inserted (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.

### Administrative Unit (AU)

An Administrative Unit is the information structure which provides adaptation between the Higher-Order path layer and the Multiplex Section layer. The Virtual Container (VC) plus the pointers (H1, H2, H3 bytes) is called the Administrative Unit (AU).

### AIS (Alarm Indication Signal)

A code sent downstream indicating an upstream failure has occurred.

### 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 standards-setting, non-government organization, which develops and publishes standards for “voluntary” use in the United States.

### Asynchronous

A network where transmission system payloads are not synchronised 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.

### Backhauling

Cumbersome traffic management technique used to reduce the expense of multiplexing/demultiplexing.

### 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.

### Bi-directional

Operating in both directions. Bi-directional 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 clock recovery. N is typically 3, 6, or 8.

## Don't Confuse The Terms

Three sets of terms are often used interchangeably to describe SDH 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 extracted (dropped) at an intermediate point

and different information is inserted (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 (MUX) allows the transmission of two or more signals over a single channel. Demultiplex (DEMUX) is the process of separating two or more signals previously combined by compatible multiplexing equipment to recover signals combined within it and for restoring the distinct individual channels of the signals.

# SDH Telecommunications Standard

► Primer

## BIP-8 (Bit Interleaved Parity-8)

A method of error checking in SDH which allows in-service performance monitoring. 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.

## B-ISDN (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 bit errors detected in a unit of time, usually one second. Bit Error rate (BER) is calculated with the formula:

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

## Block Error rate (BLER)

One of the underlying concepts of error performance is the notion of Errored Blocks; i.e., 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-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 the group.

## Bit-Stuffing

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

## Bits per second (bit/s)

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

## Broadband

Services requiring over 2 Mbit/s transport capacity.

## CCITT

Former name of ITU.

## 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 line code and that expected at the receive end by the logical coding rules.

## Concatenation

The linking together of various data structures, for example two channels joined to form a single channel. In SDH, a number (M) of TUs can be linked together to produce a concatenated container, M times the size of the TU. An example of this is the concatenation of five TU-2s to carry a 32 Mbit/s video signal, known as VC-2-5c. Once assembled, any concatenated VC structure is multiplexed, switched, and transported through the network as a single entity.

## Cyclic Redundancy Check (CRC)

A technique for using overhead bits to detect transmission errors.

## Data Communications Channel (DCC)

Data channels in SDH that enable OAM communications between intelligent controllers and individual network nodes as well as inter-node communications.

## Defect

A limited interruption in the ability of an item to perform a required function. Persistence of a defect can cause a failure.

## Demultiplex (DEMUX)

To separate two or more signals previously combined by compatible multiplexing equipment to recover 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 fibre-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.

## 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.

**ETSI (European Telecommunications Standards Institute)**

Organization responsible for defining and maintaining European standards, including SDH.

**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)**

See Remote Error Indication (REI).

**FERF (Far End Receive Failure)**

See Remote Defect Indication (RDI).

**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 tributary mode that allows the synchronous payload to begin anywhere in the VC. Pointers identify the starting location of the LO-VC. LO-VCs in different multiframes 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.

**HDB3**

High Density Bipolar 3. A bipolar coding method that does not allow more than three consecutive zeros.

**ITU (International Telecommunication Union)**

An agency of the United Nations responsible for the regulation, standardization, coordination, and development of international telecommunications as well as the harmonization of national policies. It functions through international committees of telecommunications administrations, operators, manufacturers, and scientific/industrial organizations.

**Jitter**

The short-term variations of the significant instants of a timing signal from their ideal positions in time (where short term implies that these variations are of frequency greater than or equal to 10 Hz).

**Locked Mode**

A virtual tributary mode that fixes the starting location of the VC. 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 SDH payload structure that carries the service. For example, mapping an E1 service into an SDH VC-12 associates each bit of the E1 with a location in the VC-12.

**Multiframe**

Any structure made up of multiple frames. SDH has facilities to recognize multiframes at the E1 level and at the VC-N level.

**Multiplex Section Alarm Indication Signal (MS-AIS)**

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

**Multiplex Section Remote Defect Indication (MS-RDI)**

A signal returned to the transmitting equipment upon detecting a Loss of Signal, Loss of Frame, or MS-AIS defect. MS-RDI was previously known as Multiplex Section FERF.

**Multiplex Section Overhead (MSOH)**

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

**Multiplex (MUX)**

To transmit two or more signals over a single channel.

**Multiplexer**

A device for combining several channels to be carried by a single physical channel.

**Narrowband**

Services requiring up to 2 Mbit/s transport capacity.

# SDH Telecommunications Standard

## ► Primer

### Network Element (NE)

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

In SDH, the five basic network elements are:

- Add/drop multiplexer
- Broadband digital cross-connect
- Wideband digital cross-connect
- Flexible multiplexer
- Regenerator

### OAM

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.

### 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 fibre amplifiers (EDFAs), which amplify with a laser pump diode and a section of erbium-doped fibre, and semiconductor laser amplifiers.

### Orderwire

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

### OS (Operations System)

Sophisticated applications software that manages operation of 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 of "one." For even parity, an overhead parity bit is set to either one or zero to make the total number of transmitted ones in the data block plus parity bit an even number. For odd parity, the parity bit is set to make the total number of ones in the block an odd number.

### Path

A logical connection between a point where a service in a VC is multiplexed to the point where it is demultiplexed.

### Path Overhead (POH)

Overhead accessed, generated, and processed by path-terminating equipment.

### Path Terminating Equipment (PTE)

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

### Payload

The portion of the SDH signal available to carry service signals such as E1 and E3. The contents of a VC.

### Payload Pointer

Indicates the beginning of a Virtual Container.

### Payload Capacity

The number of bytes the payload of a single frame can carry.

### Plesiochronous

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

### Pointer

A part of the SDH overhead that locates a floating payload structure. AU-N pointers locate the payload. TU-M pointers locate floating mode tributaries. All SDH frames use AU pointers; only floating mode virtual containers use TU pointers.

### POP (Point-of-Presence)

A point in the U.S. network where inter-exchange carrier facilities meet with access facilities managed by telephone companies or other service providers.

### PRC (Primary Reference Clock)

In a synchronous network, all the clocks are traceable to one highly stable reference supply, the Primary Reference Clock (PRC). The accuracy of the PRC is better than  $\pm 1$  in  $10^{11}$  and is derived from a cesium atomic standard.

**Remote Alarm Indication (RAI)**

A code sent upstream on an En circuit 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 when the receiving Terminating Equipment detects a Loss of Signal, Loss of Frame, or AIS defect. RDI was previously known as Far End Receive Failure (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). REI was previously 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-defined international networking standard whose base transmission level is 155 Mbit/s (STM-1). SDH standards were first published in 1989 to address interworking between the ITU and ANSI transmission hierarchies.

**SEC (Synchronous Equipment Clock)**

G.813 slave clock contained within an SDH network element.

**Section**

The span between two SDH network elements capable of accessing, generating, and processing only SDH Section overhead.

**Section Overhead**

Nine columns of SDH 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 SDH 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 in the United States, Canada, Korea, and Hong Kong 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.

**SSM (Synchronisation Status Message)**

Bits 5 to 8 of SDH overhead byte S1 are allocated for Synchronisation Status Messages. For further details on the assignment of bit patterns for byte S1, see the section of this primer on Multiplex Section Overhead.

**Stuffing**

See bit-stuffing.

**Synchronous**

A network where transmission system payloads are synchronised to a master (network) clock and traceable to a reference clock. A network where all clocks have the same long term accuracy under normal operating conditions.

**Synchronisation Supply Unit (SSU)**

A G.812 network equipment clock.

**Synchronous Transport Module (STM)**

A structure in the SDH transmission hierarchy. STM-1 is SDH's base-level transmission rate equal to 155.52 Mbit/s. Higher rates of STM-4, STM-16, and STM-64 are also defined.

**Tributary Unit (TU)**

A Tributary Unit is an information structure which provides adaptation between the Lower-Order path layer and the Higher-Order path layer. It contains the Virtual Container (VC) plus a tributary unit pointer.

**Tributary Unit Group (TUG)**

Contains several Tributary Units.

**Virtual Container (VC)**

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

**Wander**

The long-term variations of the significant instants of a digital signal from their ideal position in time (where long term implies that these variations are of frequency less than 10 Hz).

**Wavelength Division Multiplexing (WDM)**

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

**Yellow Signal**

See Remote Alarm Indication (RAI).