

## SDH Reference

Following development of the SONET standard by ANSI, the CCITT undertook to define a synchronization standard that would address interworking between the CCITT and ANSI transmission hierarchies. That effort culminated in 1989 with CCITT's publication of the Synchronous Digital Hierarchy (SDH) standards. Synchronous Digital Hierarchy is a world standard, and as such, SONET can be considered a subset of SDH.

Transmission standards in the U.S., Canada, Korea, Taiwan, and Hong Kong (ANSI) and the rest of the world (ITU-T, formerly CCITT) evolved from different basic-rate signals in the non-synchronous hierarchy. ANSI Time Division Multiplexing (TDM) combines twenty four 64-kb channels (DS0s) into one 1.54-Mb/s DS1 signal. ITU-T TDM multiplexes thirty-two 64-kb channels (E0s) into one 2.048 Mb/s E-1 signal.

The issues between ITU-T and ANSI standards-makers involved how to efficiently accommodate both the 1.5-Mb/s and the 2-Mb/s non-synchronous hierarchies in a single synchronization standard. The agreement reached specifies a basic transmission rate of 52 Mb/s for SONET and a basic rate of 155 Mb/s for SDH.

Synchronous and non-synchronous line rates and the relationships between each are shown in Tables 10 and 11.

## Convergence of SONET and SDH Hierarchies

SONET and SDH converge at SONET's 52-Mb/s base level, defined as STM-0 or "Synchronous Transport Module-0". The base level for SDH is STM-1 which is equivalent to SONET's STS-3 (3 x 51.84 Mb/s = 155.5 Mb/s). Higher SDH rates are STM-4 (622 Mb/s) and STM-16 (2.5 Gb/s). STM-64 (10 Gb/s) has also been defined.

Multiplexing is accomplished by combining – or interleaving – multiple lower-order signals (1.5 Mb/s, 2 Mb/s, etc.) into higher-speed circuits (52 Mb/s, 155 Mb/s, etc.). By changing the SONET standard from bit-interleaving to byte-interleaving, it became possible for SDH to accommodate both transmission hierarchies.

## Asynchronous and Synchronous Tributaries

SDH does away with a number of the lower multiplexing levels, allowing non-synchronous 2-Mb/s tributaries to be multiplexed to the STM-1 level in a single step. SDH recommendations define methods of subdividing the payload area of an STM-1 frame in various ways so that it can carry combinations of synchronous and asynchronous tributaries. Using this method, synchronous transmission systems can accommodate signals generated by equipment operating from various levels of the non-synchronous hierarchy.

**Table 10. SONET/SDH Hierarchies**

SONET Signal	Bit Rate	SDH Signal	SONET Capacity	SDH Capacity
STS-1, OC-1	51.840 Mb/s	STM-0	28 DS1s or 1 DS3	21 E1s
STS-3, OC-3	155.520 Mb/s	STM-1	84 DS1s or 3 DS3s	63 E1s or 1 E4
STS-12, OC-12	622.080 Mb/s	STM-4	336 DS1s or 12 DS3s	252 E1s or 4 E4s
STS-48, OC-48	2488.320 Mb/s	STM-16	1344 DS1s or 48 DS3s	1008 E1s or 16 E4s
STS-192, OC-192	9953.280 Mb/s	STM-64	5376 DS1s or 192 DS3s	4032 E1s or 64 E4s
STS-768, OC-768	39813.12 Mb/s	STM-256	21504 DS1s or 768 DS3s	16128 E1s or 256 E4s

**NOTE:** Although an SDH STM-1 has the same bit rate as the SONET STS-3, the two signals contain different frame structures.

STM = Synchronous Transport Module (ITU-T)

STS = Synchronous Transfer Signal (ANSI)

OC = Optical Carrier (ANSI)

**Table 11. Non-Synchronous Hierarchies**

ANSI Rate			ITU-T Rate		
Signal	Bit Rate	Channels	Signal	Bit Rate	Channels
DS0	64 kb	1 DS0	64-kb	64 kb	1 64-kb
DS1	1.544 Mb/s	24 DS0s	E1	2.048 Mb/s	1 E1
DS2	6.312 Mb/s	96 DS0s	E2	8.45 Mb/s	4 E1s
DS3	44.7 Mb/s	28 DS1s	E3	34 Mb/s	16 E1s
	not defined		E4	144 Mb/s	64 E1s