* Multiplex and Framing.

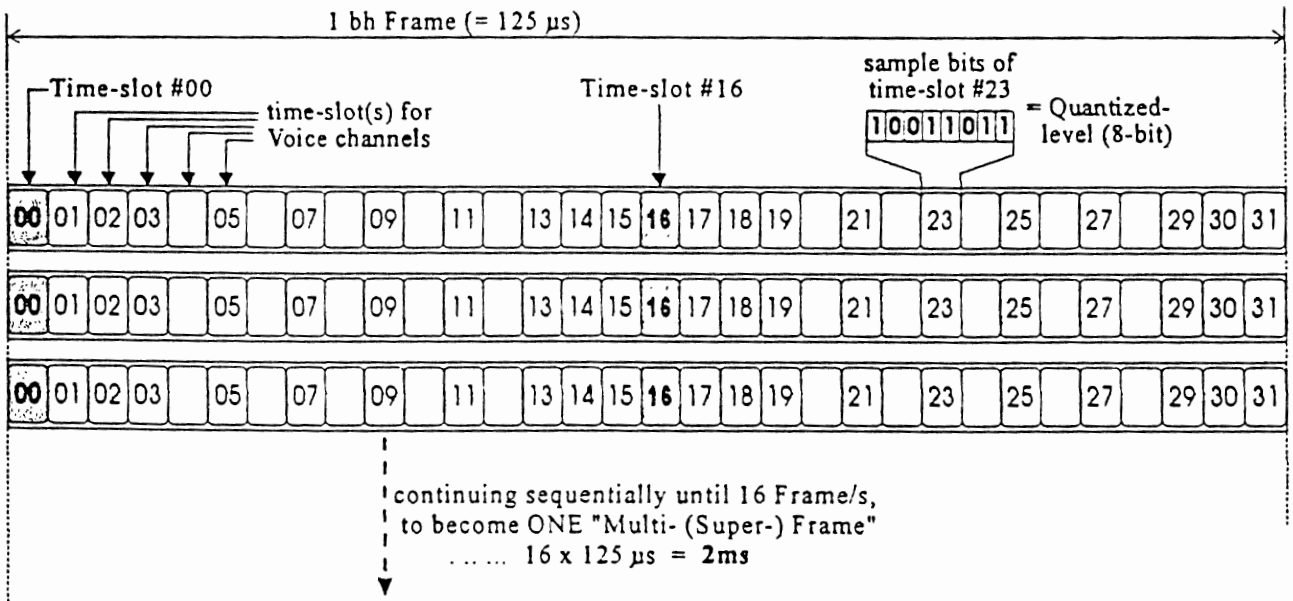
As we know already in PCM system :
With "sampling-rate" = 8000 per second . ... then "quantized" to become code of level/s, which are "8-bit" digital words.
Therefore : 1 digitised Voice Chnl needs Bit-Rate of (8000 X 8=) 64 kbps.

The PCM EnCoding for that 1 Voice-Chnl is for the purpose of "starting" of combining/grouping process of many, many Voice-Channels, to become a bundle or something like a packet or "Trunk", thus easier for Transmission.

Because all Channel/s are "digital" , thus the easy packaging/grouping (=Multipxing) system applied is Time Division Multiplexing (=TDM).
The PCM-Multiplexing utilised most is the European Standard (=CEPT), where a "Frame" duration must be 125 uS , containing 32 Time-slots , each with 8 bits (CCITT G.704 Specification) namely :

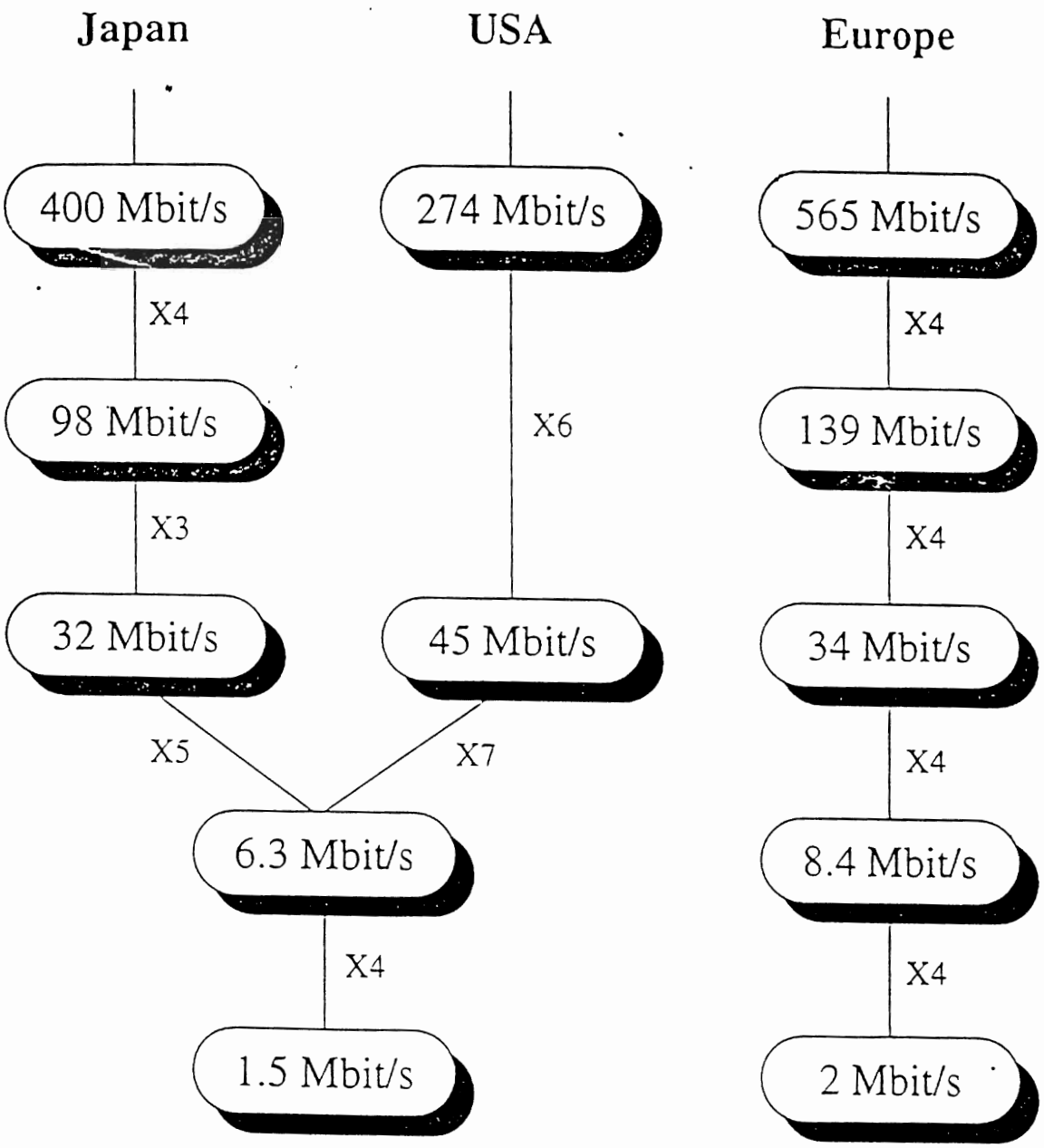
* 1 special Time-slot #00 , alocated for Frame Alignment (Synchronisation), also for link management/householding and Alarm indications ;
* 30 Time-slots , namely #01 ... #15 and #17 ... #31 for Voice/Data Chnls;
  Note : Voice Chnl number = 01 . .. ... 15, then continue 16 . .. ... 30 (!).
* 1 Time-slot #16 , specially alocated for (Voice) Channel Signalling.

Drawing below will help us see more about the "framing" process and standard :



Note : As the G.704 Specification says , TIME for 1 Frame = 125 µs.
Therefore within 1 sec. (= 1000 ms or = 1000000 µs) we will find a total of 8000 Frames , each containing 32 X 8-bits ;
In other words : 32 x 8 x 8000 bits per sec., or = 2 048 000 bps ; in Telecom language usually is named : E-1 Rate, or (PCM) Trunk Rate = 2.048 Mbps.
Above Chnl grouping/trunking is also called : First Order Multiplex.

Plesiochronous Digital Hierarchy (PDH)



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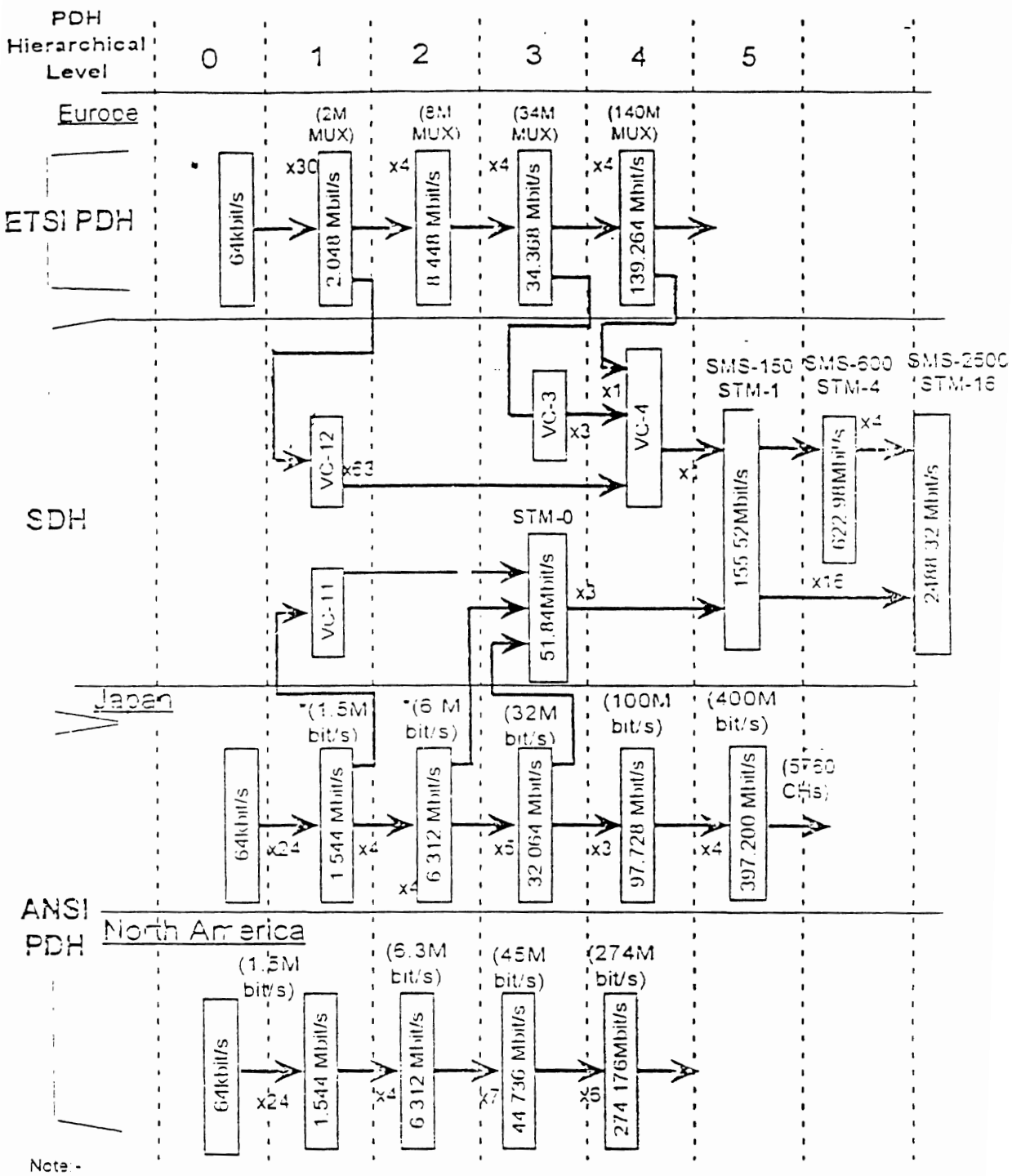
PDH & SDH Digital Hierarchy

a) PDH Three Digital & SDH Digital Hierarchy



Note :-

Plesiochronous digital hierarchies(PDH)

Synchronous Digital Hierarchy(SDH)

Synchronous Transfer Mocule Level One (STM-1)

The figure in parentheses indicate capacity in number of 64 kbit/s/s time slots.

* indicates that synchronization system

No synchronization system

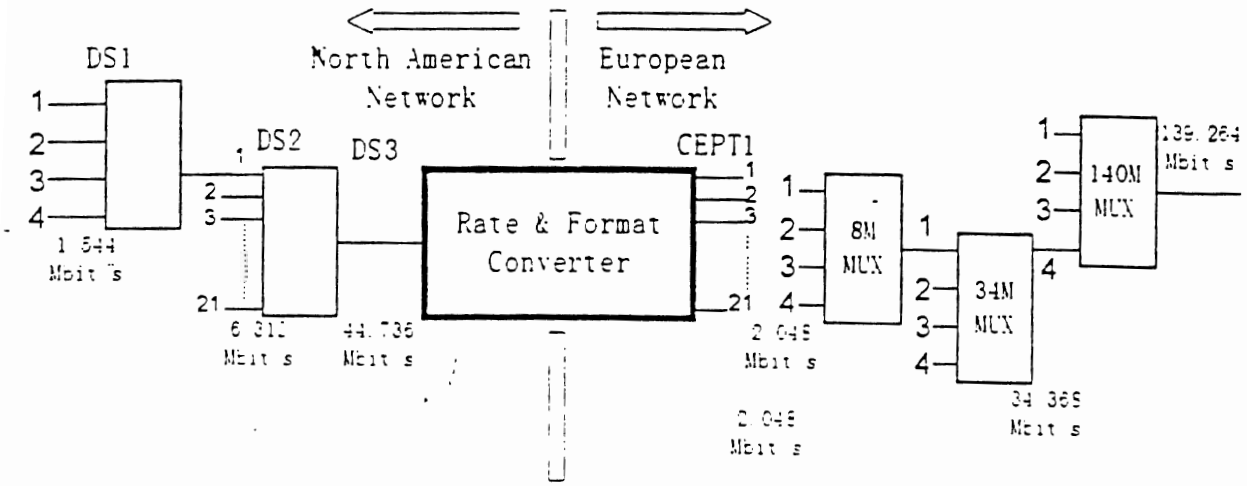
ITU(International Telecommunication Unit)

CCITT is changed ITU-TS (ITU- Telecommunication Standard Sector)

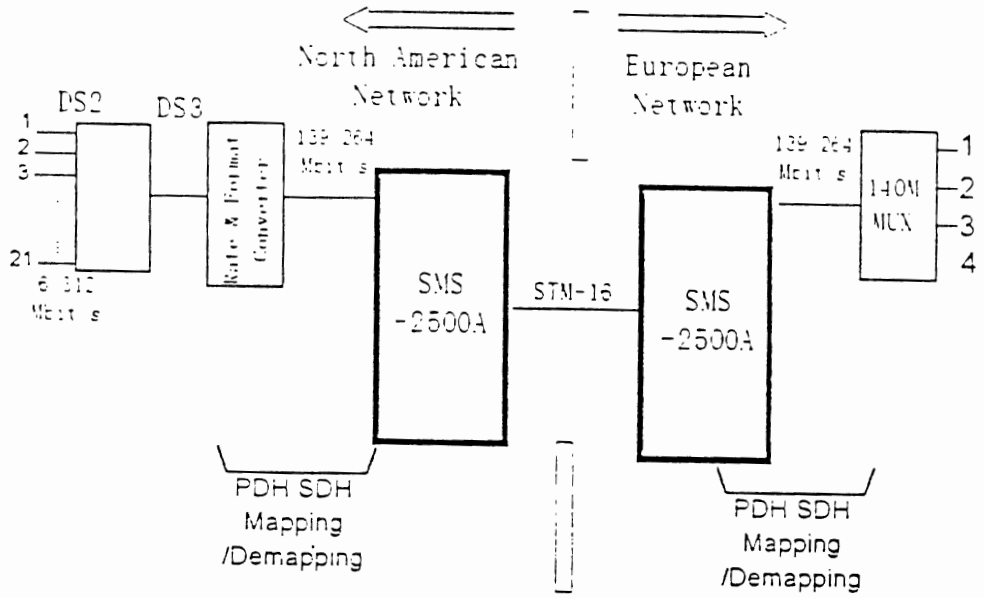
(Ex. CCITT Rec. G703 to ITU-T G703)

Global Interconnectivity

a) Global Interconnection(DS-n/CEPT-m)

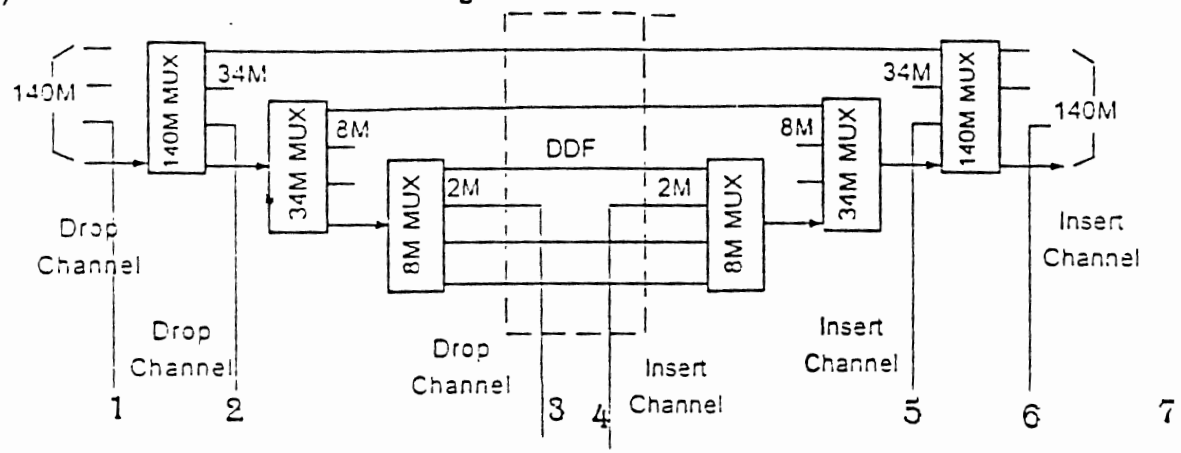


b) Global Interconnection (PDH & SDH)



Simple Access to Tributary

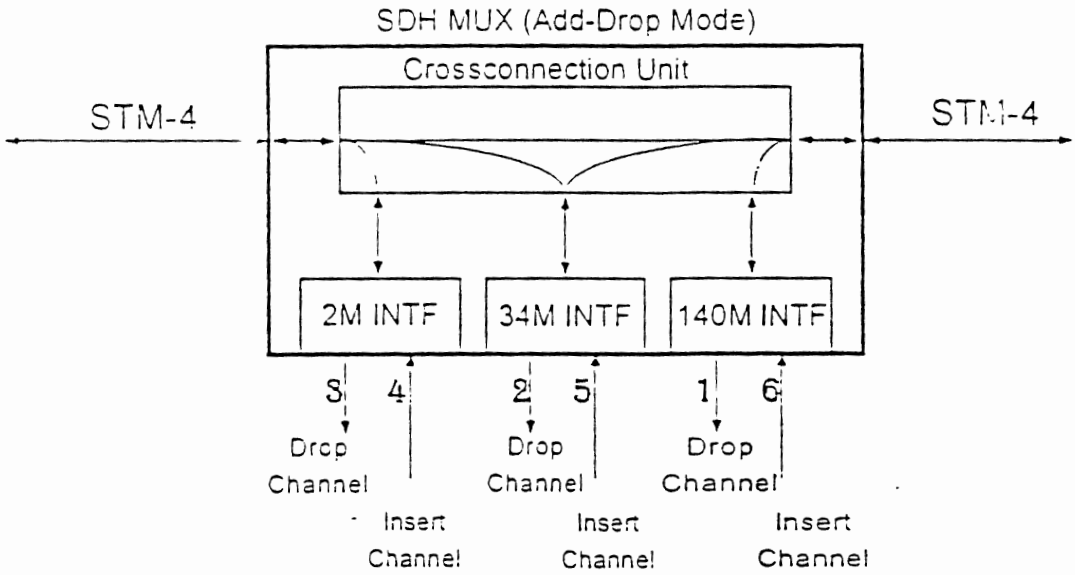
a) PDH Connection Block Diagram



Add/drop of constituent signals;

A back-to-back multiplexer arrangement is applied in order to achieve add/drop function for the PDH networks. This example indicates that a 140M signals carrier four 34M signals. If one or more 34M signals need to be added afterwards, the 140M signal must be demultiplexed by one equipment, and then must be multiplexed by another equipment for performing the drop/add functionality.

b) SDH Connection Block Diagram (Add-Drop Mode)



SDH multiplexer can perform add/drop functionality without the need of suing back-to-back multiplexer arrangement as shown in figure below.

Note:-

Plesiochronous digital hierarchies(PDH)

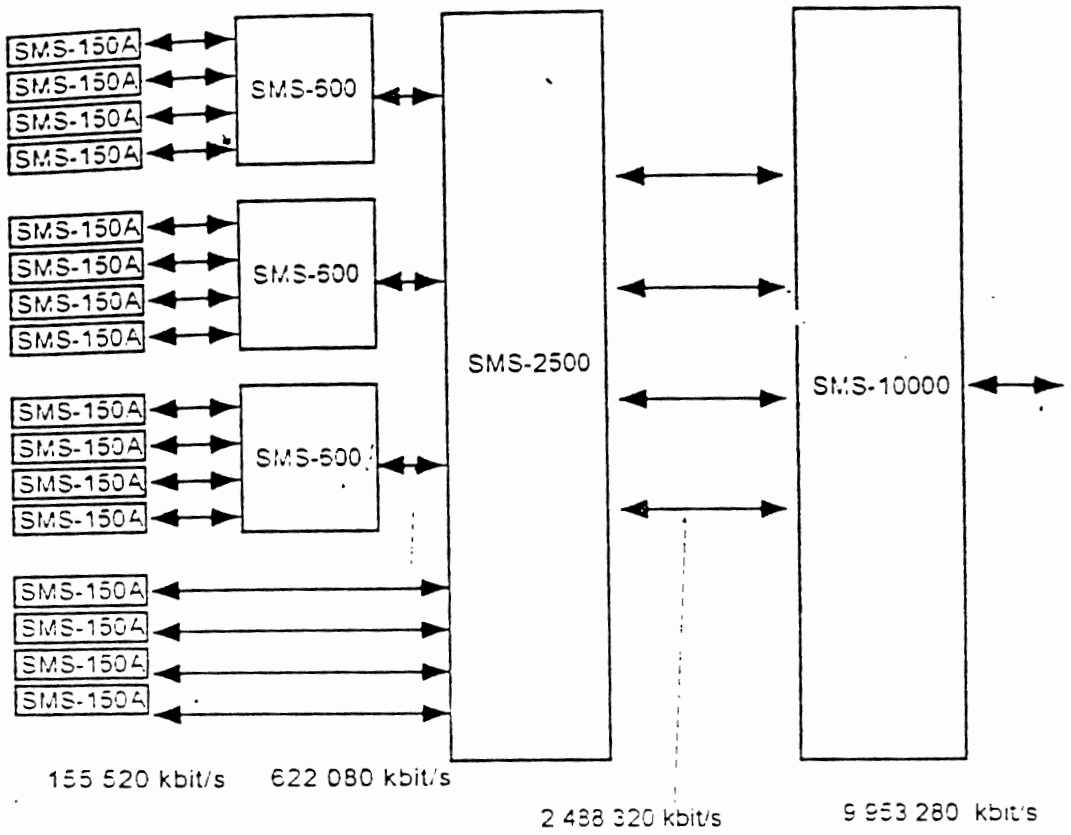
Synchronous Digital Hierarchy(SDH)

Synchronous Transfer Module Level One (STM-1)

The figures in each box indicates bit rates in kbit/s

Synchronous Digital Hierarchy Bit Rates (ITU-T G.707)

a) SDH Hierarchy Block Diagram (N = 1, 4, 16 & 64)



b) SDH Bit Rate (N = 1, 4, 16 & 64)

Synchronous digital hierarchy Level	Hierarchical bit rate kbit/s	Total 64 bit/s Channels	
		30 TS	32 TS
STM - 0	51 840	630 CHs	672 CHs
STM - 1	155 520	1890 CHs	2016 CHs
STM - 4	622 080	7560 CHs	8064 CHs
STM - 16	2 488 320	30240 CHs	32256 CHs
STM - 64	9 953 280	120960 CHs	129024 CHs

STM
: Synchronous Transfer Mode
30 CH/trib x 63 CHs
= 1890 CHs
32 CH/trib x 63 CHs
= 2016 CHs

a) The first level of the synchronous digital hierarchy shall be 155.520 Mbit/s.
b) Higher synchronous digital hierarchy levels should be obtained as integer multiplexes of the first level bit rate.

Rate of an STM-N signal = N x Rate an STM-1 Signal
= N x 155.520 Mbit/s

c) Higher synchronous digital hierarchy levels should be denoted by the corresponding multiplications factor of the first level rate.
d) This specification of levels than 64 requires further study.
e) SMS stands for " Synchronous Multiplexing System ".