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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital transmission systems – Terminal equipments – General

Sub STM-0 network node interface for the synchronous digital hierarchy (SDH)

ITU-T Recommendation G.708

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION G.708

SUB STM-0 NETWORK NODE INTERFACE FOR THE SYNCHRONOUS DIGITAL HIERARCHY (SDH)

Summary

This Recommendation is an extension of Recommendation G.707. It provides the requirements for the sub STM-0 signals at the Network Node Interface of a synchronous digital network in terms of:

– bit rates;

– frames structures;

– formats for mapping and multiplexing elements;

– functionalities of the overheads.

FOREWORD

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NOTE

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As of the date of approval of this Recommendation, the ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation G.708

SUB STM-0 NETWORK NODE INTERFACE FOR THE SYNCHRONOUS DIGITAL HIERARCHY (SDH)

(Geneva, 1999)

1   Scope

Network node interface (NNI) specifications are necessary to enable interconnection of synchronous digital hierarchy (SDH) network elements for the transport of payloads.

Therefore, this Recommendation specifies:

–   the bit rates for sub STM-0 signals;

–   the frame structures for sub STM-0 signals;

–   the functionalities to be implemented in the different overheads of a sub STM-0 frame

at the NNI of a synchronous digital network.

Annex A specifies bit rates, frame structures and overhead functionalities to be used at radio interfaces to ensure consistent transport of SDH payloads and overhead functionalities when low/medium capacity (sub STM-0) radio systems are used.

2   References

The following UIT-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

–   ITU-T Recommendation G.707 (1996), *Network node interface for the synchronous digital hierarchy (SDH)*.

–   ITU-T Recommendation G.861 (1996), *Principles and guidelines for the integration of satellite and radio systems in SDH transport networks*.

This Recommendation is an extension of Recommendation G.707 (1996), *Network node interface for the synchronous digital hierarchy (SDH)*. It must be used in conjunction with Recommendation G.707 and thus all the relevant references in Recommendation G.707 are also references of this Recommendation.

3   Definitions

This Recommendation defines the following terms:

3.1   tributary unit group-2: A 9-row by 12-column structure (108 bytes) that carries one or more TUs of the same size, as defined by Recommendation G.707.

3.2   sSTM-2n interface: A SDH transmission interface which transports one or more TU Group(s)-2, as defined by Recommendation G.707, with Section overhead (9 bytes per frame). sSTM-2n interfaces may be defined for optical, electrical or radio transport technologies.

The number (n) of TUG in sSTM-2n interfaces provided by this Recommendation is limited to n = 1, 2 and 4.

3.3 **sSTM-1k interface**: A SDH transmission interface which transports one or more TU-12, as defined by Recommendation G.707, with Section overhead (9 bytes per frame). sSTM-1k interfaces are defined for radio transport technologies (sSTM-1k interfaces are defined in Annex A), and the sSTM-11 interface may also be used for reduced functionality, intra-station connections, as defined in Annex B.

The number (k) of TU-12 in sSTM-1k interfaces provided by this Recommendation is limited to k = 1, 2, 4, 8 and 16.

4 sSTM interface rates

As illustrated in Figure 1, for the n = 1 case, the sSTM-2n frame consists of nine overhead bytes and 108 payload bytes (i.e. one column of overhead and 12 columns of payload). The frame duration is 125 µs, for a resulting signal rate of 7.488 Mbit/s. For the other rates, see Table 1.
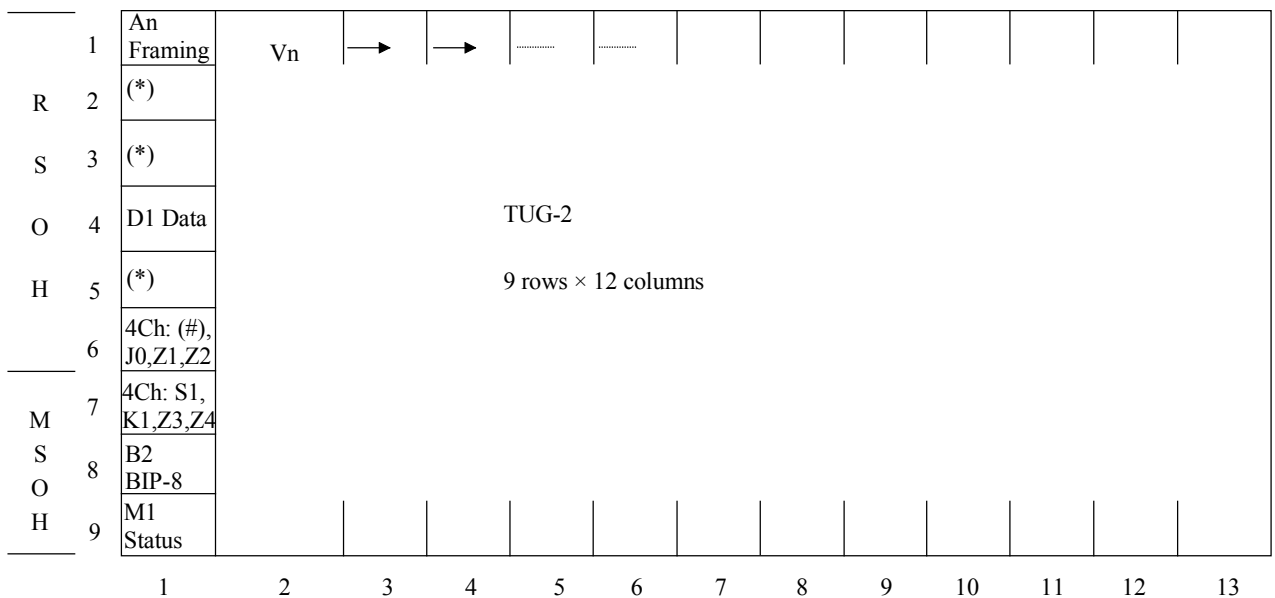
(*) Media-dependent bytes
(#) Media-specific error indicator byte (see 6.2.1.4)

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Figure 1/G.708 – sSTM interface frame format

Table 1/G.708 – Interface rates for sSTM systems

TU structure	#	Overhead	Payload envelope	Bit rate
TUG 2	1	9 bytes	108	7.488 Mbit/s
	2		216	14.400 Mbit/s
	4		432	28.224 Mbit/s
TU12	1	9 bytes	36	2.88 Mbit/s
	2		72	5.184 Mbit/s
	4		144	9.792 Mbit/s
	8		288	19.008 Mbit/s
	16		576	37.44 Mbit/s

5 Transport formats

5.1 Section overhead
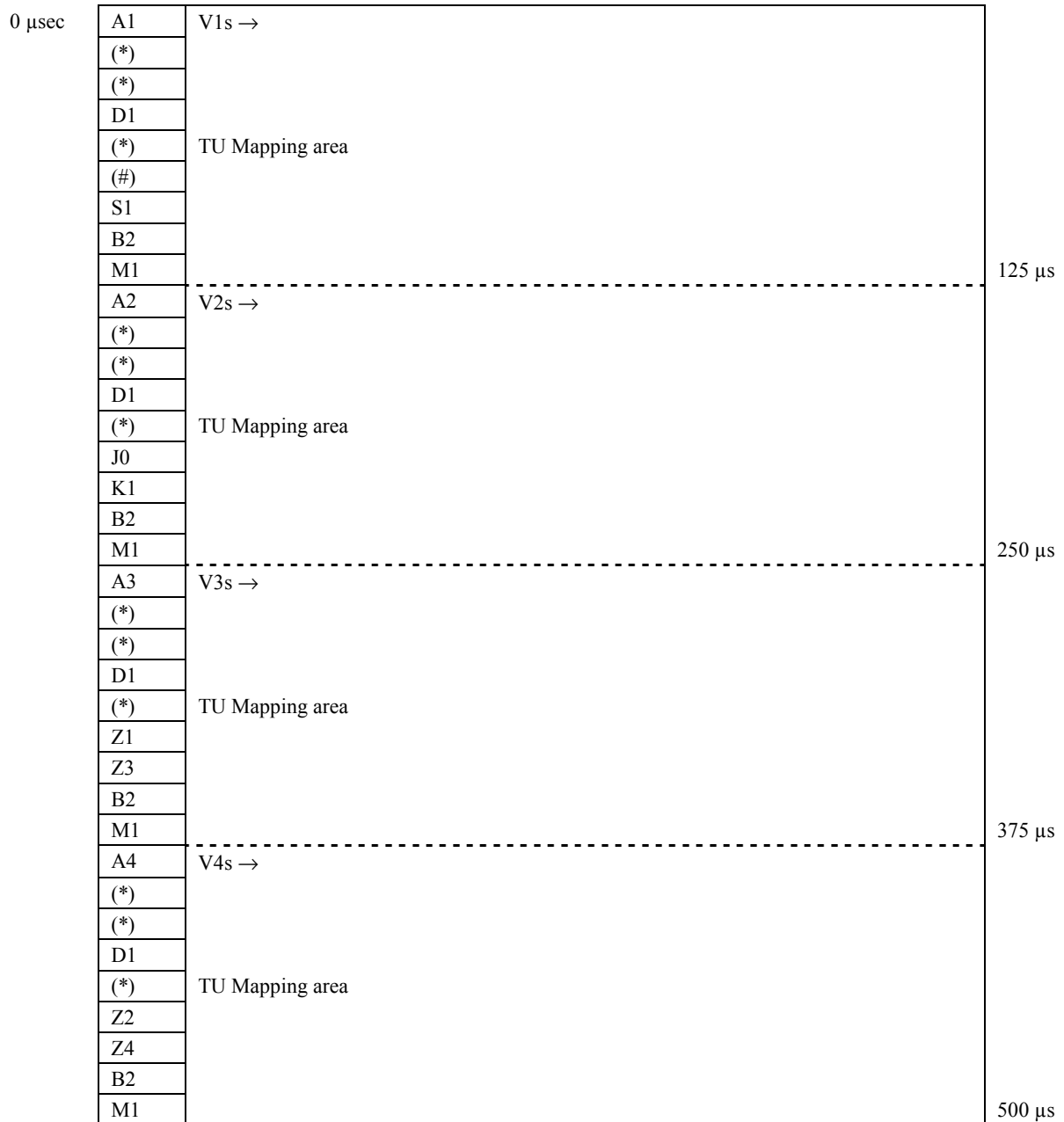
The sSTM interface has an associated Section overhead of 9 bytes. The location of the Section overhead bytes within the sSTM frame is shown in Figure 1.

Some of these bytes are further subdivided into separated 16 kbit/s transmission capacity, using the multiframe structure, as shown in Figure 2.

The detailed definitions and functions of these nine overhead bytes are described in clause 6.

0 μsec	A1	V1s →		
	(*)			
	(*)			
	D1			
	(*)	TU Mapping area		
	(#)			
	S1			
	B2			
	M1			125 μs
	A2	V2s →		
	(*)			
	(*)			
	D1			
	(*)	TU Mapping area		
	J0			
	K1			
	B2			
	M1			250 μs
	A3	V3s →		
	(*)			
	(*)			
	D1			
	(*)	TU Mapping area		
	Z1			
	Z3			
	B2			
	M1			375 μs
	A4	V4s →		
	(*)			
	(*)			
	D1			
	(*)	TU Mapping area		
	Z2			
	Z4			
	B2			
	M1			500 μs

(*)   Media-dependent bytes

(#)   Media-specific error detection code byte (see 6.2.1.4)

Figure 2/G.708 – sSTM multiframe format

5.2   Scrambling

A frame synchronous scrambler equal to that recommended in Recommendation G.707 for STM-N frame should be used to prevent long sequences of "1"s or "0"s. The frame alignment byte An should be excluded from the scrambling. The scrambler shall be reset to "1111111" on the most significant bit of the byte following the An.

5.3 Frame structure for the sSTM-2n interface

The sSTM-2n interface frame structure, for the N = 1 case as illustrated in Figure 1, consists of thirteen columns and nine rows of 8-bit bytes for a total of 117 bytes (936 bits). The frame duration is 125 μs (i.e. 8000 frames per second), which results in a bit rate of 7.488 Mbit/s. As with the STM-1 signal, the order of transmission bytes is row by row, from left to right. In each byte, the most significant bit is transmitted first.

5.4 n × TUG-2 payloads

The payload portion of the sSTM-2n interface follows the TUG structure and interleaving format of the STM-1 signal described in Recommendation G.707. Specifically, the TUG payload may consist of four TU-11s, three TU-12s, or a single TU-2.

6 Overhead functions

6.1 Interface layers

6.1.1 Physical layer

Physical layer specifications are defined in other Recommendations.

6.1.2 Section layer

The Section overhead deals with the reliable transport of the TU or sSTM frame and overhead across the physical medium.

6.1.3 Path layer

The VC Path layer for the sSTM interface is specified in Recommendation G.707.

6.2 sSTM section overhead

The Section overhead is subdivided into regenerator section overhead (RSOH) and multiplex section overhead (MSOH) as shown in Figure 1.

Any bytes or bits in the SOH defined as reserved or not required should be coded as all "0" and receivers should be able to ignore their content.

6.2.1 Regenerator section overhead

6.2.1.1 Framing and multiframe indicator (An)

This byte combines the framing and multiframe alignment functions for the sSTM signal. The byte values alternate between F6, 28, F7, and 29 Hex (11110110, 00101000, 11110111, and 00101001) as shown in Figure 3. The multiframe alignment function is required to identify the phase of the V1-V4 bytes of the TUs. The first byte transmitted directly after A1 is the V1 byte associated with the first TU; similarly the V2, V3 and V4 bytes, associated with the first TU, are transmitted directly after A2, A3 and A4 bytes, respectively.

NOTE – The byte An values in sSTM frames 1 and 2 are the same as the STM-1 byte A1 and A2 values, respectively. The seven MSBs of the byte alternate between the two patterns, and the LSB is used to provide the additional multiframe information.

Frame	An	Value	Hex	V byte
1	A1	11110110	F6	V1
2	A2	00101000	28	V2
3	A3	11110111	F7	V3
4	A4	00101001	29	V4

Figure 3/G.708 – Framing pattern for the sSTM interface (byte An)

6.2.1.2 Section trace (J0)

This byte is used for the same purpose and with the same codes provided for J0 byte in Recommendation G.707.

6.2.1.3 Data communications channel (D1)

A 64 kbit/s channel is defined using byte D1 as a section data communication channel (DCC).

6.2.1.4 Media-dependent error detection code

This byte is reserved for implementation-dependent methods of error detection for operation and maintenance purposes.

6.2.1.5 Growth (Z1, Z2)

These bytes are reserved for overhead functions.

6.2.1.6 Media-dependent bytes

These bytes are reserved for media-specific use.

6.2.2 Multiplex section overhead

6.2.2.1 Multiplex section status (M1)

This byte provides a combination of performance status, and maintenance functions. The partitioning of the byte is shown in Figure 4. The four-bit REI field (bits 1-4) shall be set to convey the count of interleaved bit blocks that have been detected in error by the BIP-8 in the range of [0, 8] received in the B2 byte from the opposite direction of transmission, thus allowing the terminals at each end of the span to monitor the section error performance with the same precision. The value in these bits shall be interpreted as shown in Table 2. Remote defects are indicated with MS-RDI in bit 5. The code 7 (111) in the three bits 6 to 8 is used for MS-AIS indication; the other codes (0 to 6) are reserved for future standardization.

MS-REI				MS-RDI	MS-AIS & Reserved		
1	2	3	4	5	6	7	8

Figure 4/G.708 – sSTM section status byte (M1)

Table 2/G.708 – M1 (bits 1 to 4) interpretation

M1[1-4] code, bits 1234	Interpretation
0000	0 BIP violations
0001	1 BIP violation
0010	2 BIP violations
0011	3 BIP violations
0100	4 BIP violations
0101	5 BIP violations
0101	6 BIP violations
0111	7 BIP violations
1000	8 BIP violations
1001	0 BIP violations
1010	0 BIP violations
. . .	. . .
1111	0 BIP violations

6.2.2.2 Multiplex Section BIP-8

Byte B2 is allocated for Multiplex Section error monitoring function. This function shall be a Bit Interleaved Parity-8 code using even parity. The Section BIP-8 is calculated over all payload bytes and excludes all 9 Section overhead bytes.

6.2.2.3 Synchronization status message (S1)

Bits 5-8 of the S1 byte are for synchronization status messages. These messages provide an indication of the quality level of the synchronization source of the SDH signal. Synchronization messages that are currently defined, and their bit coding, are listed Recommendation G.707. Bits 1-4 of byte S1 are reserved for future use. The byte subdivision is shown in Figure 5.

Reserved				Synchronization quality			
1	2	3	4	5	6	7	8

Figure 5/G.708 – Synchronization status message (S1)

6.2.2.4 APS channel (K1)

This byte is reserved for those applications where 1+1 multiplex section bidirectional protection is required.

6.2.2.5 Growth (Z3, Z4)

These bytes are reserved for overhead functions that may be defined in the future. The receiver is required to be able to ignore the values contained in these bytes.

6.3 sSTM maintenance signals

6.3.1 VC-n Path layer maintenance signals

VC-n Path layer maintenance signals are defined in Recommendation G.707.

6.3.2 sSTM multiplex section remote defect indication (MS-RDI)

MS-RDI shall be generated by setting bit 5 of the M1 byte to one, and shall be deactivated by setting bit 5 of the M1 byte to zero.

NOTE – If MS-RDI is active, the four-bit REI field is to operate as normal if a valid frame is received; otherwise it is to be set to 0000.

6.3.3 sSTM multiplex section alarm indication signal (MS-AIS)

MS-AIS is set by using a valid RSOH and placing all 1s in the MSOH and payload. MS-AIS is detected by all 1s in bits 6-8 of the M1 byte

7 sSTM-2n interface APS

The sSTM-2n automatic protection switching scheme may support both 1+1 bidirectional and unidirectional switching, hence there is need for overhead (K1 byte) to coordinate switch action for the bidirectional case.

8 Multiplexing and numbering structure

8.1 Multiplexing structure

Figure 6 shows, within the general G.707 multiplexing scheme, the additional multiplexing routes provided by this Recommendation.

Multiplexing routes of specific sSTM-1k and sSTM-2n sSTM (of order $k = 1, 2, ... 16$ or $n = 1, 2, 4$).

The actual mapping of TUG-2s into the sSTM-2n is shown in Figure 7 while that of TU-12s into the sSTM-1k is shown in Annex A.
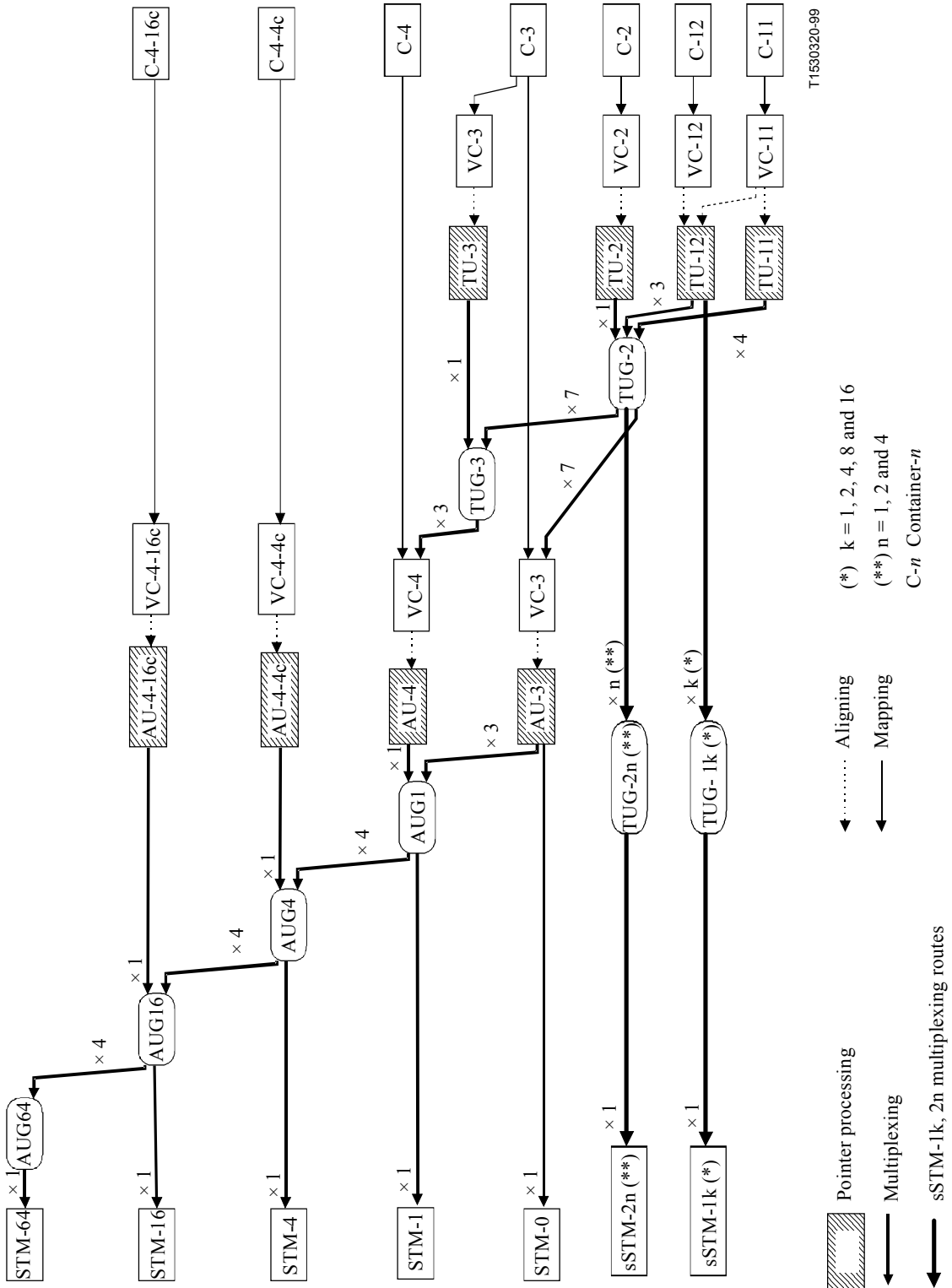
Figure 6/G.708 – Integration of sSTM formats into the G.707 multiplexing structure

NOTE – STM-0 at 51 Mbit/s with frame structure provided by Recommendation G.707 (also defined in Recommendation G.861 and referred as Radio specific reference point and equipment interface in ITU-R Recommendation F.750).
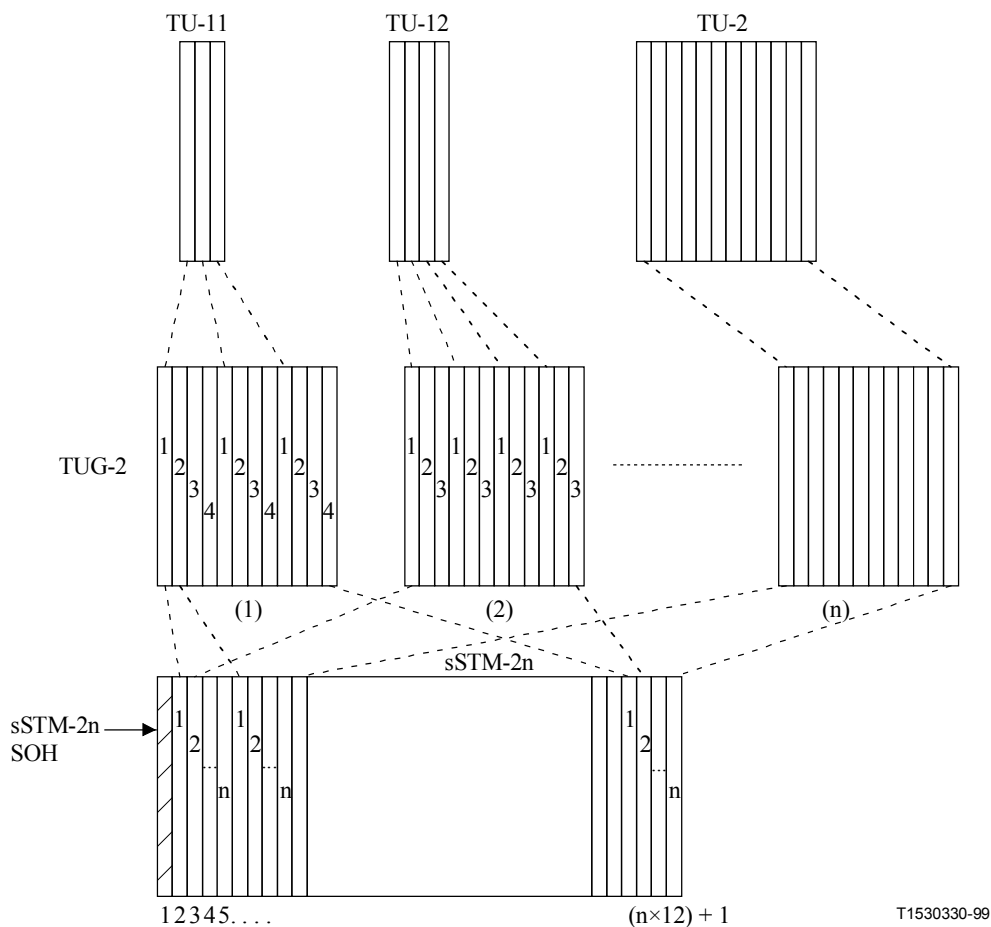

Figure 7/G.708 – Arrangement of n × TUG-2s multiplexed into a sSTM-2n (n = 1, 2, 4)

8.2   Numbering structure

The numbering structure of the TU-n in the sSTM formats is described in Annex C.

ANNEX A

Structures for radio-relay applications

A.1 Scope

This annex should be used in conjunction with Recommendation G.861, *Principles and guidelines for the integration of satellite and radio systems in SDH transport networks*. This annex specifies SDH bit rates, frame structures and media-specific overhead functionalities for use in low/medium capacity radio systems.

A.2 Interface rates

Radio spectral allocations vary in different regions of the world requiring a wider range of bit rates in order to efficiently utilize the spectrum. Some areas of the world use frequency allocations based on increments of 5 MHz, typically for transmission of T1-based (1544 kbit/s) payload rates. For these areas, the bit rates and frame structures specified in the main body of this Recommendation are suitable, i.e. sSTM-2n. Some areas of the world use frequency allocations based on 7 MHz increments, typically for transmission of E1-based (2048 kbit/s) payload rates. For these areas, sub STM-0 radio systems need to use the sSTM-1k rates, with k = 1, 2, 4, 8 and 16 in order to maintain comparable spectrum efficiency. The complete list of rates is in Table 1.

A.3 k × TU-12 payloads

The payload portion of the sSTM-1k interface is derived by the TUG structure and interleaving format of the STM-1 signal described in Recommendation G.707. Specifically, the k × TU-12 payload may consist of one, two, four, eight or sixteen TU-12.

A.4 Media-dependent overhead functions

Bytes 2, 3 and 5 of RSOH may be used for radio specific uses.

They can be used for system-specific control signals [examples are adaptive transmit power control (ATPC) to reduce nodal interference] and Early-Warning Switch information (to activate in the terminals 1+1 a real-time "hitless" protection for propagation-induced degradation in the RS in between); other examples are reported in ITU-R Recommendation F.751.

Alternatively they can be used for other optional SDH functionalities such as E1 and F1 or as an additional D2 byte to be combined with D1 to create up to 128 kbit/s channel where subSTM-0 subnetwork complexity require more capacity for management protocols transmission.

A.5 Multiplexing and numbering structure

A.5.1 Multiplexing structure

The mapping of TU-12s into sSTM-1k is shown in Figure A.1.
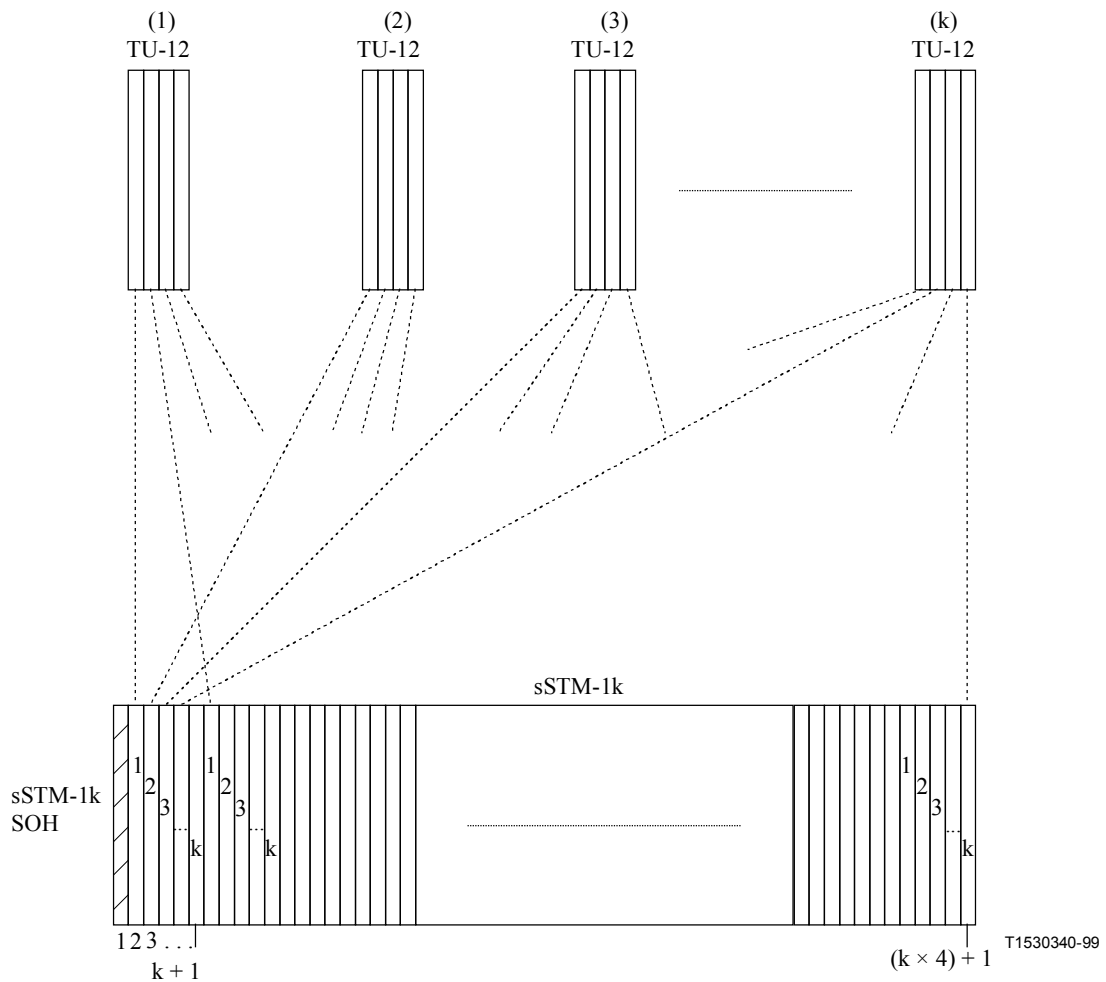
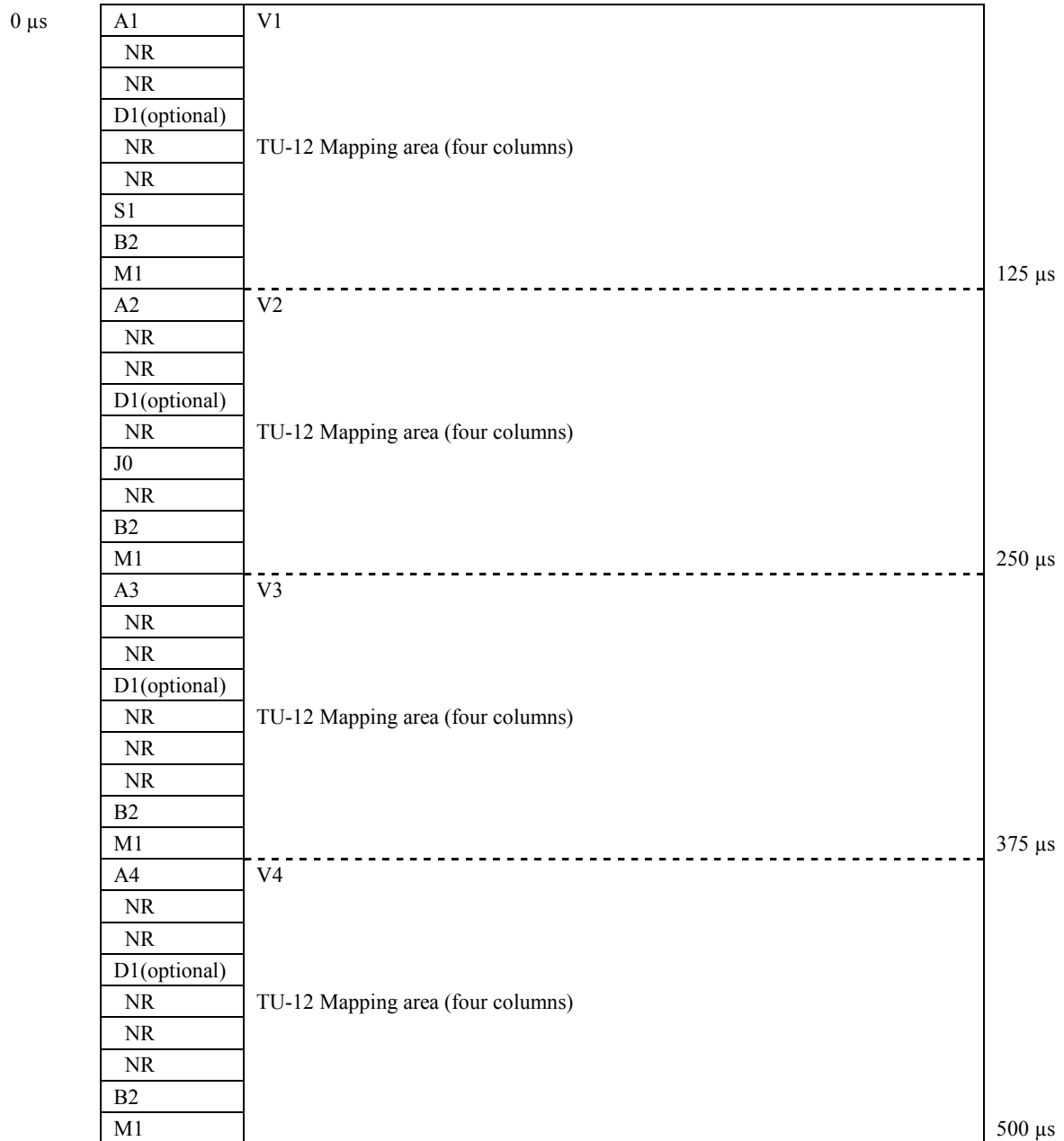**Figure A.1/G.708 – Arrangement of k × TU-12s multiplexed into a sSTM-1k (k = 1, 2, 4, 8 and 16)**

A.5.2 Numbering structure

The numbering structure of the TU-12s in the sSTM-1k formats is described in Annex C.

ANNEX B

Frame format of a reduced functionality sSTM-11 for intra-station crossconnects of TU-12 using existing office wiring

The sSTM-11 format of Annex A may also be used to support in-station cross-connects using existing 2048 kbit/s wiring. For this application, the only overhead functionality that is necessary is the An, J0, B2, M1 and S1 as described in the main body of this specification (see Figure B.1). Byte D1 may optionally be used.

0 μs			
	A1	V1	
	NR		
	NR		
	D1(optional)		
	NR	TU-12 Mapping area (four columns)	
	NR		
	S1		
	B2		
	M1		125 μs
	A2	V2	
	NR		
	NR		
	D1(optional)		
	NR	TU-12 Mapping area (four columns)	
	J0		
	NR		
	B2		
	M1		250 μs
	A3	V3	
	NR		
	NR		
	D1(optional)		
	NR	TU-12 Mapping area (four columns)	
	NR		
	NR		
	B2		
	M1		375 μs
	A4	V4	
	NR		
	NR		
	D1(optional)		
	NR	TU-12 Mapping area (four columns)	
	NR		
	NR		
	B2		
	M1		500 μs

NR   Not required

Figure B.1/G.708 – Frame format for reduced functionality TU-12 interface

ANNEX C

Numbering structure of TUs into sSTM frame formats

C.1 Numbering of TU-2s in a sSTM-2n

As shown in Figure C.1 a), a sSTM-2n can comprise "n" TUG-2s which shall be numbered from #1 to #n (n = 1, 2 and 4). Each TUG-2 can comprise a TU-2.

Thus, any TU-2 can be allocated a two-figure address in the form #L, #M, where L designates the TUG-2 number (1 to n) and M is always 0. The location of the columns in the sSTM-2n occupied by TU-2(L, 0) is given by the formula:

$$\text{xth column} = 2 + [L - 1] + n \times [x - 1], \text{ for } x = 1 \text{ to } 12$$

Thus, TU-2(1, 0) resides in columns 2, 4, … and 24 of the sSTM-22, and TU-2(2, 0) resides in columns 3, 7, ..., and 47 of the sSTM-24.

C.2 Numbering of TU-12s in a sSTM-2n

As shown in Figure C.1 b), each TUG-2 can comprise three TU-12s which shall be numbered #1 to #3.

Thus, any TU-12 can be allocated a two-figure address in the form #L, #M, where L designates the TUG-2 number (1 to n) and M designates the TU-12 number (1 to 3). The location of the columns in the sSTM-2n occupied by TU-12(L, M) is given by the formula:

$$\text{xth column} = 2 + [L - 1] + n \times [M - 1] + 3n \times [x - 1], \text{ for } x = 1 \text{ to } 4$$

Thus, TU-12(1, 1) resides in columns 2, 8, 14 and 20 of the sSTM-22 and TU-12(3, 3) resides in columns 12, 24, 36 and 48 of the sSTM-24.

C.3 Numbering of TU-11s in a sSTM-2n

As shown in Figure C.1 c), each TUG-2 can comprise four TU-11s which shall be numbered #1 to #4.

Thus, any TU-11 can be allocated a two-figure address in the form #L, #M, where L designates the TUG-2 number (1 to n) and M designates the TU-11 number (1 to 4). The location of the columns in the VC-3 occupied by TU-11(L, M) is given by the formula:

$$\text{xth column} = 2 + [L - 1] + n \times [M - 1] + 4n \times [x - 1], \text{ for } x = 1 \text{ to } 3$$

Thus, TU-11(1, 1) resides in columns 2, 10 and 18 of the sSTM-22, and TU-11(3, 4) resides in columns 16, 32 and 48 of the sSTM-24.

C.4 Numbering of TU-12s in a sSTM-1k

As shown in Figure C.1 d), each sSTM-1k can comprise k TU-12s which shall be numbered #1 to #k.

Thus, any TU-12 can be allocated a figure address in the form #M, where M designates the TU-12 number (1 to k). The location of the columns of any TU-12 in the sSTM-1k is given by the formula:

$$\text{xth column} = 2 + [M - 1] + k \times [x - 1], \text{ for } x = 1 \text{ to } 4$$

Thus, TU-12(1) resides in columns 2, 10, 18 and 26 of the sSTM-18, and TU-12(4) resides in columns 5, 9, 13 and 17 of the sSTM-14.

NOTE – The time-slot number contained in Figure C.1 should not be interpreted as the tributary port number.

An external tributary signal may be assigned to a particular payload capacity using a connection function.
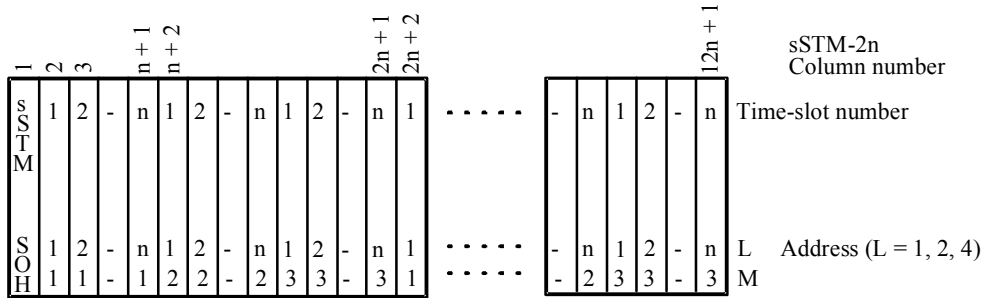
For example, at the VC-12 level mapped into sSTM-2n assigned to a specific coupling of L(TUG-2) and M(TU-1) address:

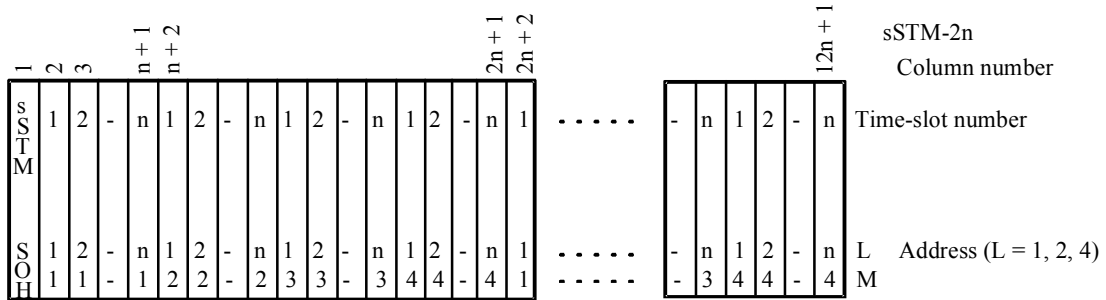| Tributary number	TU-12(L, M)
Tributary #1	TU-12(1, 1)
Tributary #2	TU-12(1, 2)
Tributary #3	TU-12(1, 3)
Tributary #4	TU-12(2, 1)
. . .	
Tributary #3 $\times$ n	TU-12(n, 3)

while, when mapped into sSTM-1k, a single address M #1 to #k is sufficient.
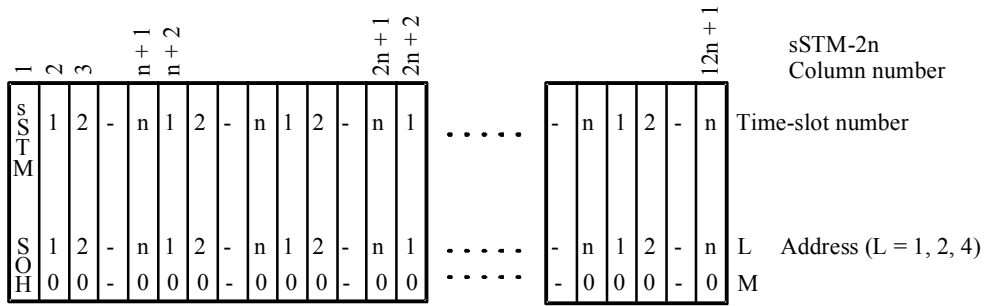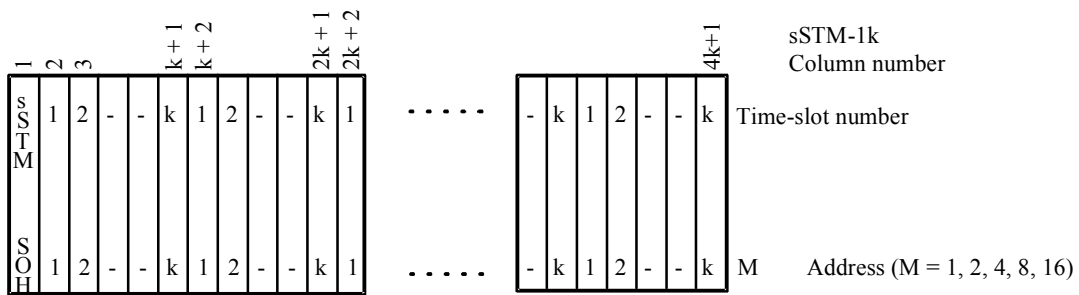
a) TU-2 numbering scheme into sSTM-2n

b) TU-12 numbering scheme into sSTM-2n

c) TU-11 numbering scheme into sSTM-2n

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d) TU-12 numbering scheme into sSTM-1k

Figure C.1/G.708 – TU-2, TU-12 and TU-11 numbering scheme within a sSTM-2n and a sSTM-1k

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Series K   Protection against interference

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Series S   Telegraph services terminal equipment

Series T   Terminals for telematic services

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Series V   Data communication over the telephone network

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Series Y   Global information infrastructure and Internet protocol aspects

Series Z   Languages and general software aspects for telecommunication systems