INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
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G.7043/Y.1343

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Digital terminal equipments – General

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT GENERATION NETWORKS

Internet protocol aspects – Transport

Virtual concatenation of plesiochronous digital hierarchy (PDH) signals

ITU-T Recommendation G.7043/Y.1343

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ITU-T Recommendation G.7043/Y.1343

Virtual concatenation of plesiochronous digital hierarchy (PDH) signals

Summary

This Recommendation specifies the virtual concatenation of 1544, 2048, 34 368 and 44 736 kbit/s PDH signals. This Recommendation makes use of the frame structures defined in ITU-T Recs G.704 and G.832.

Source

ITU-T Recommendation G.7043/Y.1343 was approved on 22 July 2004 by ITU-T Study Group 15 (2001-2004) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not 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

Introduction

The basic PDH signal frame structures for 1544, 2048 and 44 736 kbit/s signals are defined in ITU-T Rec. G.704 and the octet structured 34 368 kbit/s is defined in ITU-T Rec. G.832. This Recommendation enhances the functions of these frame structures to support the virtual concatenation of these frame structures to form larger transport entities (containers). Only frame structures of the same type can be virtually concatenated together. This virtual concatenation supports the Link Capacity Adjustment Scheme (LCAS) specified in ITU-T Rec. G.7042/Y.1305.

ITU-T Recommendation G.7043/Y.1343

Virtual concatenation of plesiochronous digital hierarchy (PDH) signals

1 Scope

This Recommendation enhances the frame structures of PDH signals of 1544, 2048 and 44 736 kbit/s, as defined in ITU-T Rec. G.704, and the octet structured 34 368 kbit/s, as defined in ITU-T Rec. G.832 to support virtual concatenation. Specifically, frame structures of the same type may be virtually concatenated together to form larger transport entities (containers). This virtual concatenation supports the Link Capacity Adjustment Scheme (LCAS) specified in ITU-T Rec. G.7042/Y.1305.

2 References

The following ITU-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; 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. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation G.702 (1988), *Digital hierarchy bit rates*.

– ITU-T Recommendation G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels*.

– ITU-T Recommendation G.707/Y.1322 (2003), *Network node interface for the synchronous digital hierarchy (SDH)*.

– ITU-T Recommendation G.832 (1998), *Transport of SDH elements on PDH networks – Frame and multiplexing structures*.

– ITU-T Recommendation G.7041/Y.1303 (2003), *Generic framing procedure (GFP)*.

– ITU-T Recommendation G.7042/Y.1305 (2004), *Link capacity adjustment scheme (LCAS) for virtual concatenated signals*.

– ITU-T Recommendation G.8040/Y.1340 (2004), *GFP frame mapping into plesiochronous digital hierarchy (PDH)*.

3 Definitions

This Recommendation defines the following term:

3.1 **nibble**: A group of four bits.

4 Abbreviations

This Recommendation uses the following abbreviations:

CTRL	Control field sent from source to sink
DNU	Do Not Use
EOS	End of Sequence
GFP	Generic Framing Procedure

GID	Group Identification
LCAS	Link Capacity Adjustment Scheme
MFI	MultiFrame Indicator
MST	Member Status
NORM	Normal Operating Mode
PDH	Plesiochronous Digital Hierarchy
RS-Ack	Re-sequence Acknowledge
SQ	Sequence Indicator
VCG	Virtual Concatenation Group
VLI	Virtual concatenation and LCAS Information

5 Conventions

The order of transmission of information in all the diagrams in this Recommendation is first from left to right and then from top to bottom. Within each byte or nibble the most significant bit is transmitted first. The most significant bit (bit 1) is illustrated at the left in all the diagrams.

6 Specification of the virtually concatenated interfaces

6.1 Interface at *N* × 1544 kbit/s with virtual concatenation of a clear channel payload

6.1.1 Frame and multiframe format

The multiframe structure for the 24-frame multiframe as described in ITU-T Rec. G.704 shall be used. The first octet following the first framing bit of the multiframe is used to carry the concatenation overhead for each 1544 kbit/s signal, as illustrated in Figure 6-1. This octet is reserved for all values of *N* (*N* = 1…16).

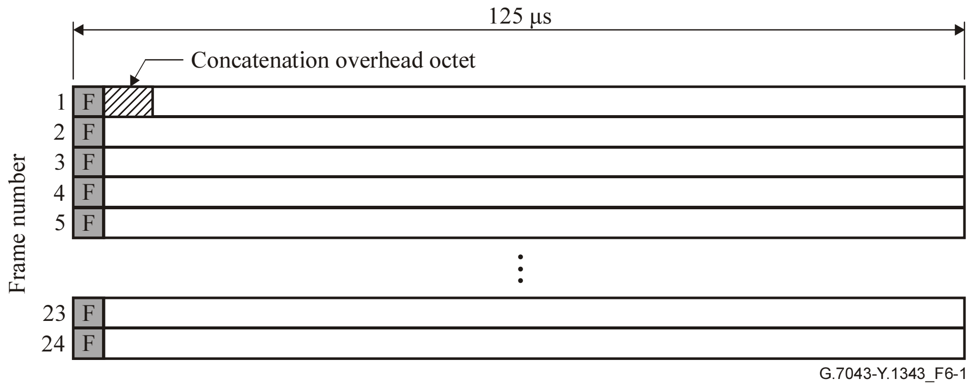

Figure 6-1/G.7043/Y.1343 – Concatenation overhead location for the *N* × 1544 kbit/s signal

6.1.2 Concatenation of *N* 1544 kbit/s signals

The concatenation overhead octet allows the virtual concatenation of *N* 1544 kbit/s signals to form a single channel referred to as a virtual concatenation group (VCG). The payload container bandwidth of the resulting VCG is $N \times [1536 - (64/24)]$ kbit/s ≈ $N \times 1533$ kbit/s. Client signals are mapped into the *N* 1544 kbit/s signal members of the VCG on an octet-wise, round robin basis. The round robin sequence follows the ascending order of the per-member sequence numbers that are communicated in each member's concatenation overhead octet. For example, if a data packet's octet 1 is mapped into the 1544 kbit/s signal with sequence number 0, the next packet octet is mapped into the 1544 kbit/s signal with sequence number 1, etc. Up to sixteen 1544 kbit/s signals can be virtually concatenated into a single VCG.

In general, the virtual concatenation and associated Link Capacity Adjustment Scheme (LCAS) functionality and definitions are the same as those specified for SDH virtual containers in ITU-T Rec. G.707/Y.1322. The areas in which they differ are specified in this Recommendation.

6.1.2.1 Concatenation overhead octet definition

The concatenation overhead octet is time-multiplexed to carry the overhead required for virtual concatenation. This time multiplexing takes the form of a 16-nibble VLI that is transmitted one nibble per concatenation overhead octet. The concatenation overhead octet contains one nibble for the VLI and one nibble for the MFI1. The contents and format of the concatenation overhead octet and VLI are shown in Figure 6-2.

Concatenation overhead octet definition							
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
Control packet				MFI1			
MST (bits 1-4)				1	0	0	0
MST (bits 5-8)				1	0	0	1
0	0	0	RS-ACK	1	0	1	0
Reserved (0000)				1	0	1	1
Reserved (0000)				1	1	0	0
Reserved (0000)				1	1	0	1
Reserved (0000)				1	1	1	0
SQ bits 1-4				1	1	1	1
MFI2 MSBs (bits 1-4)				0	0	0	0
MFI2 LSBs (bits 5-8)				0	0	0	1
CTRL				0	0	1	0
0	0	0	GID	0	0	1	1
Reserved (0000)				0	1	0	0
Reserved (0000)				0	1	0	1
C_1	C_2	C_3	C_4	0	1	1	0
C_5	C_6	C_7	C_8	0	1	1	1

Figure 6-2/G.7043/Y.1343 – Virtual concatenation control packet format for *N* × 1544/2048 kbit/s signals

The definitions of the fields within the control packet are given in ITU-T Rec. G.7042/Y.1305. MFI1 is the least significant four bits of the concatenation multiframe count and is incremented once per concatenation overhead octet with its LSB located in bit 8.

The C_n bits are the CRC check over the control packet, with C_1 being the MSB of the CRC. CRC generator polynomial is $x^8 + x^2 + x + 1$, and the calculation method is specified in ITU-T Rec. G.7042/Y.1305.

The member status (MST) information is time-multiplexed across multiple control packets as determined by the MFI2 LSB value. This time-sharing forms a member status multiframe that is specified in Figure 6-3.

MFI2 bit 8 (LSB) value	VLI octet				
	Bit 1	Bit 2	Bit 3	Bit 4	
0	0	1	2	3	Member numbers
	4	5	6	7	
1	8	9	10	11	
	12	13	14	15	

Figure 6-3/G.7043/Y.1343 – Member status bit assignments for *N* × 1544/2048 kbit/s signals

6.1.2.2 Differential delay detection

All *N* 1544 kbit/s member signals that constitute a VCG are aligned at their transmission from the VCG source with respect to their 1544 kbit/s clock frequency, PDH signal frame and multiframe, MFI1 and MFI2. The VCG sink can determine the differential delay that the different members encountered in the network by comparing their respective MFI1 and MFI2 values, and performing the proper realignment. Note that the four MSBs of MFI2 are not used for differential delay compensation. The maximum differential delay that can be detected is ±(256)(24)(125µs)/2 = ±384 ms.

6.2 Interface at *N* × 2048 kbit/s with virtual concatenation of a clear channel payload

6.2.1 Frame and multiframe format

The basic frame and 16-frame multiframe structure at 2048 kbit/s as described in ITU-T Rec. G.704 shall be used. The time slot 1 of the first frame of the multiframe is used to carry the concatenation overhead for each 2048 kbit/s signal, as illustrated in Figure 6-4. This octet is reserved for all values of *N* (*N* = 1…16).

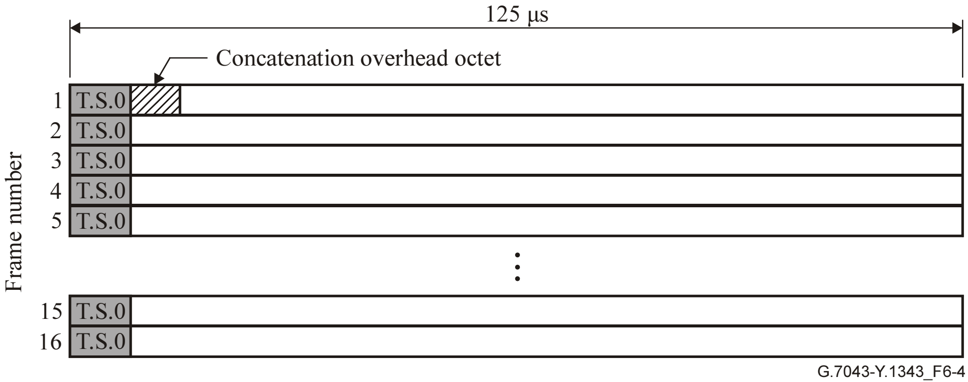

Figure 6-4/G.7043/Y.1343 – Concatenation overhead location for the *N* × 2048 kbit/s signal

6.2.2 Concatenation of *N* 2048 kbit/s signals

The concatenation overhead octet allows the virtual concatenation of *N* 2048 kbit/s signals to form a single channel referred to as a virtual concatenation group. The payload container bandwidth of the resulting VCG is *N* × [1984 – (64/16)] kbit/s = *N* × 1980 kbit/s. Client signals are mapped into the *N* 2048 kbit/s signal members of the VCG on an octet-wise, round robin basis. The round robin sequence follows the ascending order of the per-member sequence numbers that are communicated in each member's concatenation overhead octet. For example, if a data packet's octet 1 is mapped into the 2048 kbit/s signal with sequence number 0, the next packet octet is mapped into the 2048 kbit/s signal with sequence number 1, etc. Up to sixteen 2048 kbit/s signals can be virtually concatenated into a single VCG.

In general, the virtual concatenation and associated link capacity adjustment scheme functionality and definitions are the same as those specified for SDH virtual containers in ITU-T Rec. G.707/Y.1322. The areas in which they differ are specified in this Recommendation.

6.2.2.1 Concatenation overhead octet definition

The concatenation octet definitions for the 2048 kbit/s signal are the same as those specified in 6.1.2.1.

6.2.2.2 Differential delay detection

The differential delay compensation for the 2048 kbit/s signal is the same as specified in 6.1.2.2 except that the clock frequency is 2048 kbit/s. Note that the four MSBs of MFI2 are not used for differential delay compensation. The maximum differential delay that can be detected is ±(256)(16)(125µs)/2 = ±256 ms.

6.3 Interface at *N* × 34 368 kbit/s with virtual concatenation of a clear channel payload

6.3.1 Frame and multiframe format

The multiframe structure for the 24-frame multiframe as described in ITU-T Rec. G.832 shall be used with the addition of a concatenation overhead byte. Specifically, the first octet following the FA2 byte is used to carry the concatenation overhead for each 34 368 kbit/s signal, as illustrated in Figure 6-5. This octet is reserved for all values of *N* (*N* = 1…8).

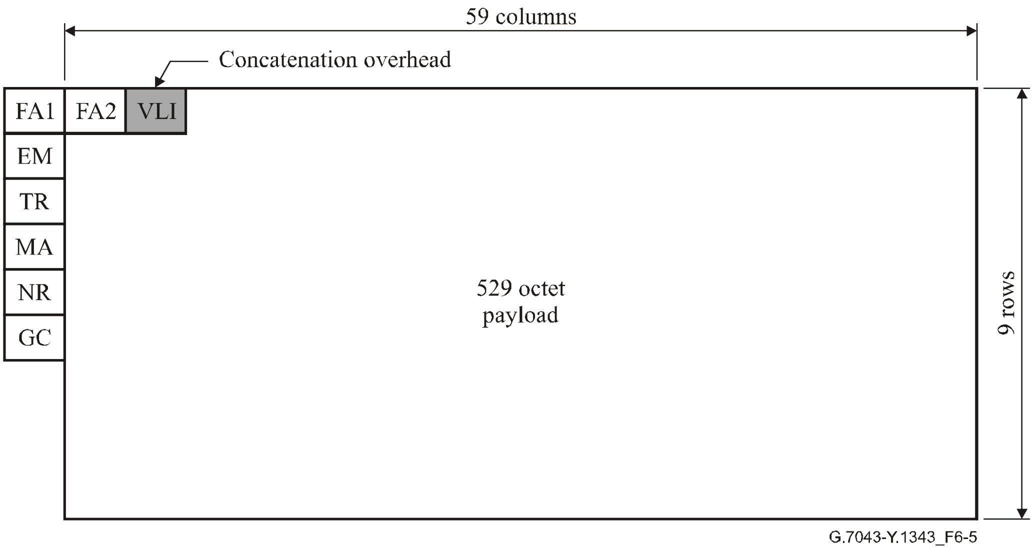

Figure 6-5/G.7043/Y.1343 – Concatenation overhead location for the *N* × 34 368 kbit/s signal

6.3.2 Concatenation of *N* 34 368 kbit/s signals

The concatenation overhead octet allows the virtual concatenation of *N* 34 368 kbit/s signals to form a single channel referred to as a virtual concatenation group. The payload container bandwidth of the resulting VCG is *N* × [(529/537) × 34 368] kbit/s ≈ *N* × 33 856 kbit/s. Client signals are mapped into the *N* 34 368 kbit/s signal members of the VCG on an octet-wise, round robin basis. The round robin sequence follows the ascending order of the per-member sequence numbers that are communicated in each member's concatenation overhead octet. For example, if data packet's octet 1 is mapped into the 34 368 kbit/s signal with sequence number 0, the next packet octet is mapped into the 34 368 kbit/s signal with sequence number 1, etc. Up to eight 34 368 kbit/s signals can be virtually concatenated into a single VCG.

In general, the virtual concatenation and associated link capacity adjustment scheme functionality and definitions are the same as those specified for SDH virtual containers in ITU-T Rec. G.707/Y.1322. The areas in which they differ are specified in this Recommendation.

6.3.2.1 Concatenation overhead octet definition

The concatenation overhead octet is time-multiplexed to carry the overhead required for virtual concatenation. This time multiplexing takes the form of a 16-nibble VLI that is transmitted one nibble per control octet. The control octet contains one nibble for the VLI and one nibble for the MFI1. The contents and format of the concatenation overhead octet and VLI are shown in Figure 6-6.

Concatenation overhead octet definition							
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
Control packet				MFI1			
MST (bits 1-4)				1	0	0	0
MST (bits 5-8)				1	0	0	1
0	0	0	RS-ACK	1	0	1	0
Reserved (0000)				1	0	1	1
Reserved (0000)				1	1	0	0
Reserved (0000)				1	1	0	1
Reserved (0000)				1	1	1	0
0	SQ bits 1-3			1	1	1	1
MFI2 MSBs (bits 1-4)				0	0	0	0
MFI2 LSBs (bits 5-8)				0	0	0	1
CTRL				0	0	1	0
0	0	0	GID	0	0	1	1
Reserved (0000)				0	1	0	0
Reserved (0000)				0	1	0	1
C_1	C_2	C_3	C_4	0	1	1	0
C_5	C_6	C_7	C_8	0	1	1	1

Figure 6-6/G.7043/Y.1343 – Virtual concatenation control packet format for *N* × 34 368 and *N* × 44 736 kbit/s signals

The definitions of the fields within the control packet are given in ITU-T Rec. G.7042/Y.1305.

MFI1 is the least significant four bits of the concatenation multiframe count and is incremented once per concatenation overhead octet with its LSB located in bit 8. MFI2 is the most significant eight bits of the 12-bit concatenation frame count.

The C_n bits are the CRC check over the control packet, with C_1 being the MSB of the CRC. CRC generator polynomial is $x^8 + x^2 + x + 1$, and the calculation method is specified in ITU-T Rec. G.7042/Y.1305.

The member status information is carried in each control packet as specified in Figure 6-7.

Frame number (MFI1)	VLI octet				
	Bit 1	Bit 2	Bit 3	Bit 4	
0	0	1	2	3	Member numbers
1	4	5	6	7	

Figure 6-7/G.7043/Y.1343 – Member status bit assignments for *N* × 34 368 and *N* × 44 736 kbit/s signals

6.3.2.2 Differential delay detection

All *N* 34 368 kbit/s member signals that constitute a VCG are aligned at their transmission from the VCG source with respect to their 34 368 kbit/s clock frequency, PDH signal frame and multiframe, MFI1 and MFI2. The VCG sink can determine the differential delay that the different members encountered in the network by comparing their respective MFI1 and MFI2 values, and performing the proper realignment. The maximum differential delay that can be detected is $\pm[(536)(8)(2^{12})]/2/34368000 = \pm 255$ ms.

6.4 Interface at *N* × 44 736 kbit/s with virtual concatenation of a clear channel payload

6.4.1 Multiframe format for *N* × 44 736 kbit/s

The multiframe structure for 44 736 kbit/s signal described in ITU-T Rec. G.704 shall be used. For the case of an *N* × 44 736 kbit/s signal, the first octet (two nibbles) following the first framing bit (X1) of the multiframe is used to carry the concatenation overhead in each constituent 44 736 kbit/s signal, as illustrated in Figure 6-8. This octet is reserved for all values of *N* (*N* = 1…8).

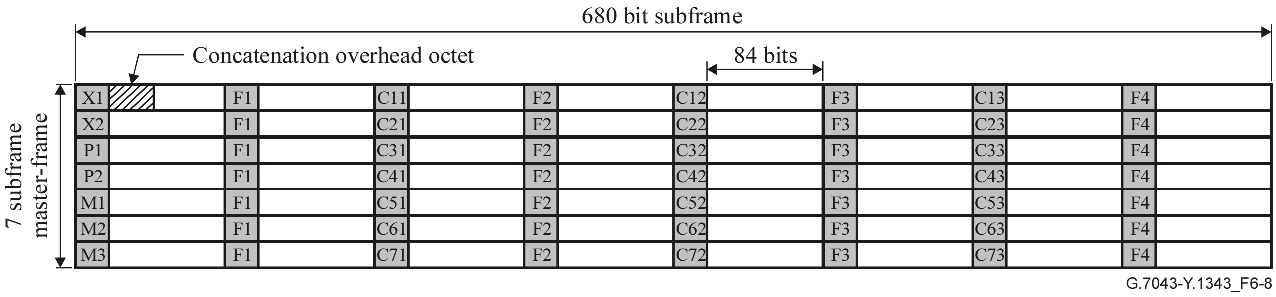

Figure 6-8/G.7043/Y.1343 – 44 736 kbit/s signal multiframe with reserved concatenation overhead octet for *N* × 44 736 kbit/s mappings

6.4.2 Concatenation of *N* 44 736 kbit/s signals

The concatenation overhead octet allows the virtual concatenation of *N* 44 736 kbit/s signals to form a single channel referred to as a virtual concatenation group. The payload container bandwidth of the resulting VCG is $N \times (44\,736)[(7)(680 - 8) - 8]/[(7)(680)]$ kbit/s ≈ *N* × 44 134 kbit/s. Client data signals are mapped into the *N* 44 736 kbit/s signal members of the VCG on a nibble-wise, round robin basis. The round robin sequence follows the ascending order of the per-member sequence numbers that are communicated in each member's concatenation overhead octet. For example, if the most significant nibble of GFP frame octet 1 is mapped into the 44 736 kbit/s signal with sequence number 0, the least significant nibble of GFP frame octet 1 is mapped into the 44 736 kbit/s signal with sequence number 1, the most significant nibble of GFP frame octet 2 is mapped into the 44 736 kbit/s signal with sequence number 2, etc. Up to eight 44 736 kbit/s signals can be virtually concatenated into a single VCG.

The virtual concatenation and associated link capacity adjustment scheme functionality and definitions are the same as those specified for SDH virtual containers in ITU-T Rec. G.707/Y.1322.

6.4.2.1 Concatenation overhead octet definition

The concatenation overhead octet is time-multiplexed to carry the overhead required for virtual concatenation. This time multiplexing takes the form of consecutive 16-octet control packets. The contents and format of the control packets are shown in Figure 6-6.

The definitions of the fields within the control packet are given in ITU-T Rec. G.7042/Y.1305. MFI1 is the least significant four bits of the concatenation multiframe count and is incremented once per concatenation overhead octet with its LSB located in bit 8. MFI2 is the most significant eight bits of the 12-bit concatenation frame count.

The C_n bits are the CRC check over the control packet, with C_1 being the MSB of the CRC. CRC generator polynomial is $x^8 + x^2 + x + 1$, and the calculation method is specified in ITU-T Rec. G.7042/Y.1305.

The member status information is carried in each control packet as specified in Figure 6-7.

6.4.2.2 Differential delay detection

All *N* 44 736 kbit/s member signals that constitute a VCG are aligned at their transmission from the VCG source with respect to their 44 736 kbit/s clock frequency, signal frame and multiframe, and their MFI1 and MFI2 frame count values. The VCG sink can determine the differential delay that the different members encountered in the network by comparing their respective MFI1 and MFI2 values, and performing the proper realignment. The maximum differential delay that can be detected is $\pm[(7)(680)(2^{12})]/2/44736000 = \pm217$ ms.

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