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SDH INTERCONNECT BETWEEN UK LICENSED OPERATORS

TECHNICAL RECOMMENDATION

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1 INTRODUCTION

1.1 History

March 1999	Issue 5	
July 2000	Issue 6 Draft A	Updated to include STM-64 and to align with the pending update to G.707.
8th September 2000	Issue 6 Draft B	Updated following comments from TIG
18th September 2000	Issue 6 Draft C	Updated following comments from the TIG meeting held on the 11th September 2000. This version was agreed to be sent for task group agreement.
29th September 2000	Issue 6	As agreed by correspondence

1.2 References

ITU-T Recommendations

Recommendation	Title (year published)
G.664	General Automatic Power Shutdown Procedures For Optical Transport Systems (1999)
G.691	Optical interfaces for single-channel SDH systems with Optical Amplifiers, and STM-64 systems (2000)
G.707	Network Node Interface for the synchronous digital hierarchy (SDH)(2000)
G.783	Characteristics of SDH Multiplexing Equipment Functional Blocks (2000)
G.784	SDH Management (1999)
G.803	Architectures of Transport Networks based on SDH (2000)
G.811	Timing requirements at the outputs of reference clocks and network nodes suitable for plesiochronous operation of international digital links. (1988)
G.823	The control of jitter and wander within digital networks that are base on the 2048kbit/s hierarchy.(2000)
G.825	The control of jitter and wander within digital networks which are based on the SDH. (2000)
G.841	Types and characteristics of SDH network protection architectures (1998)
G.957	Optical Interfaces for equipment and systems relating to the SDH.(1999)
G.958	Digital Line systems based on the SDH for use on optical fibre cables.(1994)

ETSI Standards

ETS 300 166	Physical and electrical characteristics of hierarchical digital interfaces for equipment using the 2048K bit/s based plesiochronous or synchronous digital hierarchies (1993)
ETS 300 417	Generic functional requirements for Synchronous Digital Hierarchy (SDH) transmission equipment. Part 1: Generic processes and performance (1991).

ETS 300 147	Transmission and Multiplexing (TM) - Synchronous Digital Hierarchy (SDH) Multiplexing Structure
ETS 300 462-3	Transmission and Multiplexing (TM) - Generic requirements for synchronisation networks; Part 3: The control of jitter and wander within synchronisation networks1998).

British Standards

BS EN 60825: Radiation Safety of Laser Products
Part 1: Equipment Classification Requirements and User Guide (1994).
Part 2: Safety of Optical Fibre Communication Systems (1995).

1.3 Definitions and Abbreviations

For terms & definitions refer to Recommendation G.707, section 3.0

There are a number of sections in this recommendation where use of particular bytes is considered to be for bilateral agreement between operators.

For the UK implementation see Annex 1 for additional terms and definitions.

ABBREVIATIONS

For the purposes of this Technical Recommendation the following abbreviations apply:

AIS	Alarm Indication Signal
ALS	Automatic Laser Shutdown
APS	Automatic Protection Switching
AU	Administrative Unit
AU-4	Administrative Unit, level 4
AU-n	Administrative Unit, level n
BIP	Bit Interleaved Parity
BIP-8	Bit Interleaved Parity, width 8
BIP-N	Bit Interleaved Parity, width N
BS	British Standard
DCC	Data Communications Channel
En	European Standard
ETS's	European Telecommunication Standards
ETSI	European Telecommunications Standards Institute
ITU-T	International Telecommunications Union - Telecommunications Standardisation Sector
MSOH	Multiplex Section Overhead
NICC	Network Interoperability Consultative Committee
Oftel	Office of Telecommunications
OLO	Other Licensed Operator
PDH	Plesiochronous Digital Hierarchy
PNO	Public Network Operators Group
POH	Path Overhead

POI	Point of Interconnect
PRC	Primary Reference Clock
RSOH	Regenerator Section Overhead
SDH	Synchronous Digital Hierarchy
SG13	Study Group 13 (Study group of ITU-T)
SOH	Section Overhead
STC	Sub Technical Committee (ETSI Standards Committee)
STM	Synchronous Transport Module
STM-1	Synchronous Transport Module, level 1
STM-16	Synchronous Transport Module, level 16
STM-4	Synchronous Transport Module, level 4
STM-64	Synchronous Transport Module, level 64
STM-256	Synchronous Transport Module, level 256
STM-N	Synchronous Transport Module, level N
TIG	Transport Interconnect Group
TM3	Transmission and Multiplexing Sub Committee 3.
TU	Tributary Unit
TU-1	Tributary Unit, level 1
TU-12	Tributary Unit, level 12
TU-2	Tributary Unit, level 2
UTC	Co-ordinated Universal Time
VC	Virtual Container
VC-12	Virtual Container, level 12
VC-3	Virtual Container, level 3
VC-4	Virtual Container, level 4
VC-n	Virtual Container, level n

1.4 Scope

This document addresses SDH interconnect between UK licensed operators at the STM-N level (where N=1,4,16,64 and 256) to support interconnection of VC-12, VC-3, VC-4 and VC-4-Xc, VC-4-Xv (for support of 2Mbit/s, 34Mbit/s, 45Mbit/s and 140Mbit/s ATM, IP and other client payloads). It specifies characteristics at the Point of Interconnect (POI) based on published versions of ITU-T Recommendations and ETSI standards as detailed in Section 1.3. This version has been updated to G.707.

In areas where the standards are non-explicit or still under development, specific options for the UK are identified that are consistent with available equipment practice. Where details of SDH-related interfaces are not covered in this recommendation, reference shall be made to ITU-T Recommendations and ETS's.

The long-term objective is to migrate to ETSI standards when the individual standards become sufficiently mature.

Revisions to this recommendation are likely to be required to reflect developments in the relevant standards.

This document assumes that the recommendations on the principles of SDH Interconnect which includes Topologies and Protection Mechanisms given in the Overview document Section 3, have been followed.

2 BASIC FRAME STRUCTURE OF STM-N at POI

2.1 Bit rates

The bit rate of the STM-N shall be according to Recommendation G.707.

2.2 Basic frame structure of STM-N

The basic frame structure of an STM-N signal shall be as in Section 6.2/G.707. The AU-4 option shall be used. The STM-N payload shall comprise a VC-4 transported by means of the association of an AU pointer to form one AU-4 according to section 8.1.1/G.707.

2.3 Scrambling of STM-N framed signal

The STM-N shall be scrambled in accordance with Section 6.5/G.707.

3 SECTION OVERHEAD (SOH)

Note: In sections 5, 6 and 7 of this recommendation the order of transmission and numbering conventions are as defined in Section 6/G.707.

All byte codings within this and following sections are given before scrambling.

3.1 Definition of RSOH bytes at POI

At the POI the RSOH bytes shall be as follows:

3.1.1 A1, A2 - Framing

The A1 and A2 bytes shall be as defined in Section 9.2.2.1 /G.707.

3.1.2 C1 - STM Identifier and Regenerator Section Trace: J0

The J0 byte shall be as defined in Section 9.2.2.2/G.707.

In earlier versions of Recommendation G.707, the content of bytes located at S(1, 7, 1) or [1, 6N+1] to S(1, 7, N) or [1, 7N] was defined as a unique identifier indicating the binary value of the multi-column, interleave depth co-ordinate, c. It may have been used to assist in frame alignment.
For interworking of equipment employing the Regenerator Section Trace function with old equipment implementing the STM identifier functionality, the former shall be able to transmit the pattern "0000 0001" in J0.

3.1.3 B1 - Bit Interleaved Parity-8 (BIP-8)

The coding of the B1 byte shall be as defined in Section 9.2.2.4/G.707.

This byte is intended for performance monitoring. Use of the information contained within this byte is for bilateral agreement between operators in line with the management principles in G.784.

3.1.4 E1 - Orderwire

The E1 byte is described in Section 9.2.2.5/G.707. Use of this byte is for bilateral agreement between operators.

3.1.5 F1 - User Channel

The F1 byte is described in Section 9.2.2.6/G.707. Use of this byte is for bilateral agreement between operators.

3.1.6 D1-D3 - RS Data Communication Channel (DCC_R)

The D1-D3 bytes are described in Section 9.2.2.7/G.707. The DCC function should be disabled and the bytes shall be ignored by the receiving equipment.

3.1.7 Unused bytes

Certain bytes in the RSOH are designated 'for national use' or 'for future international standardisation' in Recommendation G.707. Bytes reserved for 'national use' and residing in the first row of the RSOH (Figures 9.3 to 9.7/G.707) shall be set to '10101010' (as defined in Section 2.2.1/G.783). All other bytes in the RSOH designated as reserved for 'national use' (Figures 9.3 to 9.7/G.707) shall be ignored by the receiving equipment.

Bytes designated 'for future international standardisation' in Figures 9.3 to 9.7/G.707 shall be ignored by the receiving equipment.

3.2 Definition of MSOH at POI

At the POI the MSOH bytes shall be as follows:

3.2.1 B2 - Bit Interleaved Parity (BIP-N*24)

The coding of the B2 bytes shall be as defined in Section 9..2.2.8/G.707.

This byte is intended for performance monitoring and alarm indications. Use of the information contained within this byte is for bilateral agreement between operators in line with Recommendations G.783 and G.784.

3.2.2 E2 - Orderwire

The E2 byte is described in Section 9.2.2.5 /G.707. Use of this byte is optional under bilateral agreement between operators.

3.2.3 K1 and K2 (b1-b5) - Automatic Protection Switching (APS) Channel

These bytes are allocated for APS signalling for protection of the multiplex section. Use of K1 and bits 1 to 5 of K2 for APS according to G.841 shall be agreed between operators. If the function is not used the bytes shall be ignored by the receiving equipment.

3.2.4 K2 (b6-b8) - Multiplex Section Remote Defect Indication (MS-RDI)

The Multiplex Section Remote Defect Indication (MS-RDI) is used to return an indication to the transmit end that the received end has detected an incoming section defect or is receiving MS-AIS. MS-RDI is generated by inserting a “110” code positions 6, 7 and 8 of the K2 byte before scrambling. Use of this facility is for bi-lateral agreement between operators.

3.2.5 D4-D12 - MSOH Data Communication Channel

The D4-D12 bytes are described in Section 9.2.2.7 /G.707. The DCC function should be disabled and the bytes shall be ignored by the receiving equipment.

3.2.6 S1, Synchronization Status

3.2.6.1 Bits b5-b8

Transfer of synchronisation information shall be agreed between the operators and these bits set according to Table 9.2/G.707. As the default setting these bits shall be '1111' (Do not use for synchronisation purposes) in both directions. However, the transfer of synchronisation information may be exchanged between operators according to table 9.2/G707 by bi-lateral agreement.

The Synchronisation of public and private networks is becoming increasingly important as transmission rates increase. Operators are advised to apply the PNO-IG agreed National Network Timing Plan (NTTP) when planning SDH interconnect as cumulative characteristics can impact synchronisation.

3.2.6.2 M1, Multiplex Section Remote Error Indication (MS-REI)

Usage of this facility is for bi-lateral agreement and if supported should be used as per clause 9.2.2.12/G.707 with the following guidance.

G.707 comments that interworking of equipment that supports MS-REI and equipment that does not support MS-REI cannot be achieved automatically. This issue should be considered when interconnecting SDH equipment manufactured to different versions of the ITU-T Recommendations. Where two operators support MS-REI then it can be used with bi-lateral agreement. However, where one party does not support this facility the other party will have to disable it. The reason for this is that MS-REI was not used up to approximately three years ago and equipment that does not support this facility was generally set to the default number '000'. This could be seen as many errors if the facility is not disabled.

STM-64 interfaces of equipment designed prior to the (10/00) version of G.707 may support the single M1 REI only. STM-64 interfaces of new equipment has to be configurable to support the single byte M1 REI.

3.2.6.3 Media dependant bytes

The media dependant bytes are described in Section 9.2.2.13 / G.707. These 6N bytes, which are located at positions S (2,2,X) or [2,N+X], S (2,3,X) or [2,2N+X], S (2,5,X) or [2,4N+X], S (3,2,X) or [3,N+X], S (3,3,X) or [3,2N+X], S (3,5,X) or [3,4N+X] with X=1..N, are reserved for media dependant applications. For SDH radio these bytes are defined in ITU-R Recommendation F.750.

3.2.7 P1, Q1 - Forward Error Correction:

The Forward Error Correction bytes are described in Section 9.2.4 / G.707. For STM-16, STM-64 the P1 and Q1 bytes are reserved for an optional Forward Error Correction (FEC) function. Usage of Forward Error Correction is for bilateral agreement.

3.2.8 Unused bytes

Within the MSOH, bytes reserved for National use and future International Standardisation shall be ignored by the receiving equipment.

4 VC STRUCTURES AND PATH OVERHEADS (POH)

The logical interfaces between VC-12s, VC-3s, VC-4s, VC-4-Xc, VC-4-Xv and STM-N shall be based on the multiplexing structure given in ETS 300 147.

Editor's note: ETS 300 147 currently includes references to ITU-T Recommendations G.708 and G.709 - Updating of references by ETSI is expected.

4.1 Adaptation of VC-4 to STM-N

The logical relationship between a VC-4 and its parent STM-N is expressed in terms of a phase alignment of the VC-4 with its associated AU-4. The alignment shall be as described in Section 7.1/G.707.

4.2 Termination of VC-4 Path Overhead

4.2.1 J1 - Path Trace

The coding method of the J1 byte shall be as defined in section 9.3.1.1/G.707 using the 16 byte E.164 format. At the boundaries between the networks of different operators the content shall be mutulally agreed by the operators providing the transport. An example of such a content is given in clause 3/G.831.

4.2.2 B3 - Path BIP-8

The coding of the B3 byte shall be as defined in Section 9.3.1.2/G.707. This byte is intended for performance monitoring and use of the information contained within this byte is for bilateral agreement between operators in line with the principles in Recommendations G.783 and G.784.

4.2.3 C2 - Signal Label

The coding of the C2 byte shall be as defined in Section 9.3.1.3/G.707.

4.2.4 G1 - Path Status

The coding of the G1 byte shall be as defined in Section 9.3.1.4/G.707. Bits 6, 7 and 8 of this byte shall be ignored by the receiver. Use of this byte is for bilateral agreement between operators.

4.2.5 F2 - User Channel

The F2 byte, defined in 9.3.1.5/G.707, has been allocated for user communication purposes between path elements. Use of this byte is for bilateral agreement between operators.

4.2.6 H4 Byte

The H4 byte is a dual purpose byte. The two applications are given below:

4.2.6.1 - TU-2/TU-1 Multiframe Indicator

TU-2/TU-1 multiframe indication byte (H4) relates to the lowest level of the multiplexing structure and provides a 500μs (4-frame) multiframe identifying frames containing the TU-2/TU-1 pointers. Figures 8-9 of G.G07 shows the VC-2/VC-1 mapping in the multiframed TU-2/TU-1.

4.2.6.2 – VC-4/VC3 Position Sequence Indicator

The byte provides a multiframe and sequence indicator for virtual VC-3/4 concatenation (see section 11.2 of G.707) and a generalised position indicator for payloads. In the latter case the content is payload specific (e.g. H4 can be used as a multiframe indicator for VC-2/1 payload as defined in subclause 8.3.8 of G.707).

4.2.7 Automatic Protection Switching Channel (APS): K3 (b1-b4)

ETS 300 147 ed.3. table 4 makes reference to 9.3.1.7/G.707 which describes that these bits are allocated for APS signalling protection at the VC 4/3 path level. Use of these bits is for bilateral agreement between operators.

[Editors Note. At the time of writing, no formal protocol for using these bits has been defined in published standards, although standards contributions are being submitted to ETSI and the ITU-T.]

4.2.8 Z3 and Z4 - Spare

These bytes shall be ignored by the receiving equipment.

4.2.9 N1 - Network Operator Byte Monitoring - Application of:

The network operator byte: N1 shall be implemented as per clause Table 4 of ETS 300 147 ed.3. (9.3.1.8/G.707 Annex D Option 2). Use of this byte is for bilateral agreement between operators.

4.2.10 - Data link K3 (b7-b8):

Bits 7 and 8 of K3 are reserved for a higher order path data link. The applications and protocols are for further study.

4.2.11 Spare: K3 (b5-b6)

These bits are allocated in 9.3.1.10/G.707 for future use. They have no defined value and the receiver is required to ignore their content.

4.3 Adaptation of VC-3 to VC-4

The logical relationship between a VC-3 and the parent VC-4 is described in Section 7.2.1/G.707.

Numbering of lower order VCs within a higher order VC shall comply with ETS 300 417-1 Section 3.3.5.

4.4 Termination of VC-3 Path Overhead

VC-3 path overhead is the same as VC-4 path overhead given in 4.2 above.

4.5 Adaptation of VC-12 to VC-4

The logical relationship between a VC-12 and the parent VC-4 is described in Section 7.2/G.707.

Numbering of lower order VCs within a higher order VC shall comply with ETS 300 417-1 Section 3.3.5.

4.6 Termination of VC-12 Path Overhead

The VC-12 POH shall be as defined in Section 9.3.2/G.707.

4.6.1 V5 Byte

The coding of these bits shall be according to Section 9.3.2.1/G.707. The use of the information contained in Bits 1 and 2 is for bilateral agreement between the operators, but should be in line with the principles set out in Recommendations G.783 and G.784.

4.6.2 J2 Byte - Path trace identifier

At a date to be agreed between operators, the J2 byte shall be encoded as follows:
The coding method of the J2 byte shall be as defined in section 9.3.2.2/G.707 using the 16 byte E.164 format.

Note - The actual code allocation shall be agreed between operators with guidance from OFTEL.
Equipment developed prior to the adoption of the (03/93) version of G.707 may not support this functionality
[Editors note: The coding method of the J2 byte is now the same as the higher order path trace.]

4.6.3 N2 - Network Operator Byte Monitoring - Application of:

Use of the network operator byte: N2 shall be as described in ETS 300 147 ed.3 (9.3.2.3/G.707). Use of this byte is for bilateral agreement between operators.

4.6.4 Extended signal label: K4 (b1)

Use of the Extended Signal Label is described in Section 9.3.2.4 / G.707.

4.6.5 Low Order Virtual Concatenation: K4 (b2)

Use of the Lower Order Virtual Concatenation bit is described in Section 9.3.2.5 / G.707.

4.6.6 Automatic Protection Switching (APS) channel: K4 (b3-b4)

These bits are allocated for APS signalling for protection at the lower order path level. At the time of writing the usage of these bits is for further study within the ITU.

4.6.7 Reserved: K4 (b5-b7)

Remote Defect Indication (RDI) is not supported (Table 4 of ETS 300 147 ed. 3). These bits shall be set to “000” or “111” in the source direction and ignored in the sink direction.

4.6.8 Data Link: K4 (b8)

Bit 8 of K4 is reserved for a lower order path data link. The applications and protocols are for further study with the ITU..

5 ADAPTATION OF SIGNALS INTO VC-12, VC-3 and VC-4

5.1 VC11 into VC12 Case

VC11 should be mapped into VC12 according to ETSI Technical Standard (ETS) 300 147.

5.2 2 Mbit/s Case

5.2.1 Asynchronous Mapping

2 Mbit/s PDH signals shall be adapted to the VC-12 according to Section 10.1.4.1/G.707. The 2 Mbit/s asynchronous mapping shall be used (but see Section 5.4). The adaptation process shall be bit sequence independent such that all 2 Mbit/s bit patterns are transported transparently.

5.2.2 Floating Mode
The accommodation of tributary signals in VCs shall employ the floating TU mode described in G.707 where the reduced H4 coding sequence shown in Figure 8.14/G.707 shall be used.

5.2.3 Byte synchronous mapping of 2048 kbit/s
This mapping is not widely available at present, and its use is for further study.

5.3 34 Mbit/s Case

5.3.1 Asynchronous Mapping
34 Mbit/s PDH signals shall be adapted to the VC-3 according to Section 10.1.2.2/G.707.

5.3.2 Floating Mode
Refer to 5.2.2.

5.4 45 Mbit/s Case

5.4.1 Asynchronous Mapping
45 Mbit/s PDH signals shall be adapted to the VC-3 according to Section 10.1.2.1/G.707.

5.4.2 Floating Mode
Refer to 5.2.2.

5.5 140 Mbit/s Case

5.5.1 Asynchronous Mapping
140 Mbit/s PDH signals shall be adapted to the VC-4 according to Section 10.1.1.1/G.707.

5.6 ATM Case

5.6.1 Asynchronous Mapping
ATM cells shall be mapped into SDH according to Section 10.2/G.707. The transport of contiguous concatenated VC4s may not be possible in all networks and usage is for bi-lateral agreement.

5.6.2 Floating Mode
Refer to 5.2.2.

5.7 Mapping of HDLC framed signals
HDLC frame signals shall be mapped into SDH according to Section 10.3/G.707. Support of HDLC is for bilateral agreement.

5.8 Mapping of DQDB into VC-4
The mapping of Distributed Queue Dual Bus (DQDB) signals should be performed according to ETSI ETS 300 216. Support of DQDB is for bilateral agreement.

5.9 Asynchronous mapping for FDDI at 125 000 kbit/s into VC-4
FDDI signals shall be mapped into SDH according to Section 10.5/G.707. Support of FDDI is for bilateral agreement.

5.10 Mapping other payloads into SDH VC4

VC4 payload signals shall be scrambled at source for any mapping that is not specified in G.707 that allows emulation of the STM-N scrambler polynomial $1+x^6+x^7$ in more than 8 consecutive bytes of the VC-4 payload.

6 VC Concatenation

For the transport of payloads that do not fit efficiently into the standard set of virtual containers (VC-3/4/2/12/11) VC concatenation can be used. VC concatenation is defined for:

VC-3/4 - to provide transport for payloads requiring greater capacity than one Container-3/4;

VC-2 - to provide transport for payloads that require capacity greater than one Container-2, but lower than one Container-3/4.

VC-1n to provide transport for payloads that require capacity greater than one Container-1, but lower than one Container 2/3/4.

Two methods for concatenation are defined, contiguous and virtual concatenation. Both methods provide concatenated bandwidth of X times Container-N at the path termination. The difference is the transport between the path termination. Contiguous concatenation maintains the contiguous bandwidth through out the whole transport, while virtual concatenation breaks the contiguous bandwidth into individual VCs, transports the individual VCs and recombines these VCs to a contiguous bandwidth at the end point of the transmission. Virtual concatenation requires concatenation functionality only at the path termination equipment, while contiguous concatenation requires concatenation functionality at each network element.
It is possible to perform a conversion between the two types of concatenation. The conversion between virtual and contiguous VC-4 concatenation is defined in G.783. The conversion between virtual and contiguous VC-2 concatenation is for further study.

The four types offered by G.707 are:

6.1 Contiguous concatenation of X VC-4s (VC-4-Xc, X = 4, 16, 64, 256)
6.2 Virtual concatenation of X VC-3/4s (VC-3/4-Xv, X = 1 ... 256)
6.3 Contiguous concatenation of X VC-2s in a higher order VC-3 (VC-2-Xc, X = 1 ... 7)
6.4 Virtual concatenation of X VC-2/1s

USE of Concatenation is for bilateral agreement between operators.

7 PHYSICAL INTERFACE AT POI

This section includes requirements for both optical and electrical interfaces. The preferred method of interconnection is optical mid-span interconnection. However an In-Station Interconnect using an electrical interface is not precluded, and may be required in some cases.

7.1 Optical interface.

The POI shall be optical comprising one fibre for each direction of transmission. Requirements for single fibre working are not included in this document. Optical signal interfaces shall be at STM-N (where N= 1,4,16,64,256 SDH level) and shall conform to the requirements of

RecommendationsG.957 and G.691 as appropriate. The actual STM-1 interface used will be dependent on the application (Table 1/G.957),(G.691) and shall be agreed between the operators.

7.2 Electrical interface

The electrical signal interfaces shall be at STM-1 SDH level only and shall conform to the requirements of Recommendation ETS 300 166.

8 ALARMS AND PERFORMANCE MONITORING

Network Elements used for an interconnect should provide local and remote alarm and performance monitoring functions in accordance with ITU-T Recommendations G.783 and G.784.

9 SYNCHRONISATION

9.1 General

Recommendation G.803 and ETS 300 462-2 (Ed note: this has been through public enquiry and is now due to be published) describe a synchronisation distribution reference chain where timing references are traceable to a Primary Reference Clock (PRC), and it is recommended that operators follow these principles.

9.2 Timing references.

An operator can provide his own PRC meeting the requirements of G.811. This could take the form of a Caesium based system, or a system using a high stability oscillator with a radio navigation signal providing traceability to UTC (co-ordinated Universal Time). Under normal conditions (i.e. no faults), timing references at the POI should be traceable to a PRC.

Alternatively, provision of a traceable timing reference across a POI using traffic carrying connections is possible by means of bilateral agreement between operators. Because of potentially large phase movements encoded as pointer justifications, timing should not be carried by a 2 Mbit/s PDH signal embedded in an SDH signal. The effects of pointer events on embedded 34 and 140 Mbit/s although significantly less, may also cause synchronisation problems. To avoid the effects of all pointer events, timing should be carried at the STM-N rate on SDH interfaces using G.803 principles.

Note. NICC study group 29 has produced the National Network Timing Plan.

10 JITTER AND WANDER AT THE POINT OF INTERCONNECT

This section gives specific jitter and wander requirements relevant to the STM-N interface between operators. However it is important that the equipment SDH jitter and wander specification principles described in Recommendation G.783 and associated recommendations are also followed.

10.1 Jitter and Wander at the STM-N level

The jitter and wander of the STM-N signal at the POI shall not exceed the levels specified in Table 2 and Figure 2 of Recommendation G.825. This represents the minimum level of jitter and wander

that should be tolerated by the SDH equipment port. Measurements shall be made in accordance with the principles of Figure 1 /G.825.

[Editors note: There is a note against frequencies f2 and f3 in Table 2 of G.825 which says under study. A value of 1MHz has been suggested for f3 with f2 being derived from f3.]

Recent work within ETSI TM3 and ITU SG13 has recognised that jitter wander requirements for STM-N interfaces used for transporting synchronisation signals will require tighter jitter/wander limits than those for data interfaces. Where operators agree to transfer synchronisation signals then these requirements must be taken into account. Current requirements are contained in ETS 300 462-3.

10.2 Jitter and Wander of embedded PDH signals

The jitter and wander of embedded 2 Mbit/s signals within the STM-N is quantised into pointer movements (8 bit justifications) and bit justifications. Similarly for 34 Mbit/s and 140 Mbit/s the pointer movements are 8 bits and 24 bits respectively. Although the phase distortion caused by pointers is less at the higher rates (because the bit period is shorter) they can produce unacceptable performance if pointer justifications occur too frequently. The design objective is that these movements are sufficiently limited in the network such that the G.823 requirements are met at the sink port for the virtual container carrying the PDH rate. It is therefore difficult to specify requirements at the POI for embedded PDH signals, as this would require specification of pointer justification statistics. Because of their very nature, pointers occur randomly as the result of noise processes, temperature variations and transient effects in a network. This problem is being studied by the standards bodies but there are no recommendations at present. However it is important that each operator's SDH network should follow G.803 recommendations on network element timing (to limit pointer movements) and that network elements should follow G.783 in respect of pointer processor and mapping/demapping function design.

11 PROTECTION

The preferred protection mechanisms for SDH interconnects are described in the Overview Recommendation. This section details the specific technical features associated with protection.

Note. At the time of writing there is a proposed protocol for protecting interworking which is being developed through the standards community.

11.1 Protection Switching Time

VC Path Protection and Sub-Network Connection Protection shall operate as fast as possible. A value of 50 milli-seconds has been proposed as a target time. This value excludes the detection time necessary to initiate the protection switch and the hold-off time. A unidiretion single ended protection scheme is assumed.

12 Optical Safety

All optical interconnections should be designed, installed and operated in accordance with the safety requirements detailed in BS EN 60825.

The use of ‘Automatic Laser Shutdown’ (ALS) mechanisms is not specifically recommended in this document. However, operators should be aware that an ALS mechanism may be necessary to meet manufacturer’s recommendations and/or operator-specific safety standards.

The use of ALS is therefore for bi-lateral agreement. Where used, it is recommended that the mechanism should meet ITU-T recommendation G.958 Appendix 2, provided this meets the requirements for safety.

~ END ~