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UK Interconnect use of SCCP & MTP

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PNO-ISC INFORMATION DOCUMENT NUMBER 007

UK INTERCONNECT USE OF SCCP & MTP

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0.2 Normative Information

All enquiries about distribution reproduction, changes and clarifications should be addressed in the first instance to the Chairman of the NICC/PNO-IG/ISC at the address on the title page.

0.3 Contents

0.4 History

Revision	**Date of Issue**	**Updated By**	**Description**
Issue 3	August 2000	Mike Luntz, Vodafone	Approved by PNO-IG
Issue 3.1	October 2001	Tom Hayden, Vodafone	Inclusion of SSNs specific to GSM network interconnection

0.5 Issue Control

SECTION	ISSUE	DATE
All	Issue 3.1	October 2001

0.6 References

/1/ PD 6625 PNO-ISC/SER/001 Issue 1, Draft A UK Completion of Calls to Busy Subscriber (CCBS) Supplementary Service. Combined Service Description and Functional Description

/2/ PD 6626 PNO-ISC/SER/003 Issue 1, Geographic Number Portability

/3/ PD 6638 PNO-ISC/SPEC/003 Issue 2, C7 INTERCONNECT SIGNALLING CONNECTION CONTROL PART (SCCP)

/4/ PD 6650 PNO-ISC/SPEC/004 Issue 1, C7 INTERCONNECT TRANSACTION CAPABILITIES

/5/ PD 6639 PNO-ISC/SPEC/005 Issue 3, C7 INTERCONNECT MESSAGE TRANSFER PART

/6/ PD 6647 PNO-ISC/INFO/001 Issue 1, Draft A POINT CODES - MANAGEMENT AND ALLOCATION BETWEEN UK PTOS

/7/ ETS 300 134: December 1992 Transaction Capabilities (TC) signalling requirements in and between networks, for non circuit related services which use the CCITT Signalling System No.7, for inter-network dialogues

/8/ ETS 300 356-18: February 1995 Integrated Services Digital Network (ISDN); Signalling System No.7; ISDN User Part (ISUP) version 2 for the international interface; Part 18: Completion of Calls to Busy Subscriber (CCBS) supplementary service

/9/ ITU-T Q.713 (07/96) SCCP Formats and Codes

/10/ ITU-T Q.714 (07/96) SCCP Procedures

/11/ ITU-T Q.715 (07/96) SCCP User Guide

/12/ Geographic Number Portability End to End Process Manual Issue 7a http://www.oftel.gov.uk/isp/netint.htm

/13/ ITU-T Q.711 (07/96) SCCP Functional Description

/14/ PNO-ISC/SER/008 Issue 1, Mobile Number Portability

/15/ ITU-T Implementors' Guide (9/97) for Q.705 (1993)

/16/ ITU-T Implementors' Guide (3/99) for Q.703 (1996)

/17/ ITU-T Implementors' Guide (12/99) for Q.704 (1996)

/18/ PNO-ISC/SER/007 Issue 1, Non Geographic Number Portability

/19/ ETS 300 599: January 1998 Digital Cellular Telecommunications System (Phase 2) Mobile Application Part (MAP) Specification (GSM 09.02 ver 4.17.1)

/20/ ITU-T Introduction to CCITT Signalling System No. 7 Q.700 (03/93)

/21/ PD 6646 PNO-ISC/SPEC/001 Issue 1, Use of SS7 Point codes for network interconnect in the UK

/22/ ITU-T Q.703 (07/96) Signalling Link

/23/ ITU-T Q.704 (07/96) Signalling network functions and messages

/24/ ITU-T Q.751.1 (10/95) Network Element Management Information Model For The Message Transfer Part (MTP)

/25/ PD 6623 PNO-ISC/SPEC/007 Issue 2.3 ISDN User Part (ISUP)

/26/ ETS 300 008 V1.3.1, December 1999 Message Transfer Part (MTP) to support international interconnection

/27/ ITU-T Q.705 (03/93) Signalling System No 7 – Signalling Network Structure

/28/ ITU-T Q752 (06/97) Monitoring and Measurement for Signalling System No 7 Networks

0.7 Glossary Of Terms

0.7.1 Abbreviations

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
BICC	Bearer Independent Call Control
BSSAP	Base Station Subsystem Application Part
C7	CCITT Signalling System Number 7
CC	Country Code
CCBS	Completion of Calls to Busy Subscriber (Service)
CLI	Calling Line Identification
CPN	Called Party Number
CR	Circuit Related
DPC	Destination Point Code
DUP	Data User Part (of C7)
ETS	ETSI Telecommunications Standard
ETSI	European Telecommunications Standards Institute
GCP	Gateway Control Protocol
GGSN	Gateway GPRS Support Node
GN	Generic Number
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GT	Global Title
GTAI	Global Title Address Information
GTI	Global Title Indicator
INAP	Intelligent Network Application Protocol (of C7)
ISC	Interconnect Standards Committee
ISDN	Integrated Services Digital Network
ISUP	Integrated Services User Part (of C7)
ITCC	International Telecommunications Charge Card (Service)
ITU	International Telecommunications Union
ITU-T	ITU Telecommunications Standardisation Sector
LSSU	Link Status Signal Unit
MNP	Mobile Number Portability
MPOI	MTP Points Of Interconnect
MSU	Message Signal Unit
MTP	Message Transfer Part (of C7)
NCR	Non Circuit Related
NDC	National Dialling Code
NICC	Network Interoperability Consultative Committee
NNG	National Number Group
NSN	National Significant Number
NTP	Network Termination Point
O&M(BSS)	Operations and Maintenance (Base Station Subsystem)
OMAP	Operations, Maintenance and Administration Part (of C7)

OSS	Operator Service Subsystem
PC	Point Code
PCI	Point Code Indicator
PCR	Preventive Cyclic Retransmission
PNO	Public Network Operators
PPOI	Physical Point Of Interconnect
PTO	Public Telecommunications Operator(s)
RI	Routing Indicator
RTB	Retransmission Buffer
SCCP	Signalling Connection Control Part (of C7)
SDL	Specification and Description Language
SEP	Signalling End Point
SGSN	Serving GPRS Support Node
SIB	Status Indication “Busy”
SP	Signalling Point
SPOI	SCCP Point Of Interconnect
SSN	Subsystem Number
SSNI	Subsystem Number Indicator
STP	Signalling Transfer Point
TB	Transmission Buffer
TC	Transaction Capabilities (of C7) (was TCAP)
TCAP	TC Application Part (of C7) (now just TC)
TUP	Telephony User Part (of C7)
UDT	Unitdata (message)
UDTS	Unitdata service (message)
UK	United Kingdom of Great Britain and Northern Ireland
UPU	User Part Unavailable (message)
XUDT	Extended UnitDaTa (message)
XUDTS	Extended UnitDaTa Service (message)

0.7.2 Terminology

The following definitions apply;

Called Party - The SCCP user to which the SCCP message is directed.

Calling Party - The SCCP user initiating the SCCP message.

UK interconnect network - that part of the UK network where point codes are allocated from the common interconnect range defined by ISC /6/.

Global Title - an element of SCCP called and calling party addresses having its inclusion and content signalled by the coding of the global title indicator.

Incoming Network - The network to which a C7 message is passed from a point of interconnection between two networks.

Originating Network - The network in which the Calling Party resides.

Outgoing Network - The network from which a C7 message is passed to a point of interconnection between two networks.

Terminating Network - The network in which the Called Party resides.

White Book - The ITU-T(03/93 or later) Recommendations.

0.8 Scope

The information provided in this document covers provision and use of the interconnect SCCP specified in /3/; this being a subset of the latest edition SCCP recommendations which satisfies the SCCP requirements of the CCBS service specified in /1/. The subset is in essence for the connectionless service class of SCCP using Global Title Indicator GTI=4. The subset has no requirement for segmenting and re-assembly, or subsystem status management procedures associated with point code plus subsystem number addressing.

There are known difficulties in future enhancement of the SCCP specified in /3/ to provide a more complete White Book capability. Such development will have to take account of:

- continuing international requirements for Blue Book compatibility
- the need for the hop counter to be set at a value suitable for all applications
- the inability of applications using SCCP to know what network capabilities are available towards destinations.

These are subject to possible future studies within the PNO-ISC (MTP/SCCP WP).

This document also provides information relating to the MTP specified in /5/ and covers the impacts and issues regarding the interconnect of MTP networks.

1 Introduction

This document provides specific information supplemental to that specified in /3/ for interconnect use of SCCP signalling between public networks operated in the UK. Included is a section describing the architectural options for provisioning such interconnect,

This document also contains supplemental information to that specified in /5/ for the interconnect use of MTP. It provides guidance for specific parameter settings and the use of MTP over interconnect for any ‘user part’.

The information is intended for use by designers of applications which require use of SCCP or MTP as well as by network operators needing to engineer SCCP or MTP networks and configure those applications for network interconnect.

The information provided states the definitive requirements relating to those services which are standardised in the UK for national interconnect and dependent upon the application of MTP and SCCP for their operation. In particular the SCCP address codes standardised for use in the UK are listed. The International and UK network operator addressing assignments are also included in order to minimise the possibility of conflict when the capability of the UK national interconnect is extended.

Definitive requirements are specified for the interconnect use of SCCP as needed for the UK CCBS service to perform and function as intended in /1/. Advisory information is documented for other aspects of SCCP use made known to the ISC.

This document will be revised when necessary and in accordance with the NICC/PNO-ISC workplan to include information appropriate to enhancements to SCCP & MTP and additional services having a requirement to use MTP and SCCP.

2 Requirements On Applications Making Use Of SCCP

This section identifies and gives information on the parameters to be provided to SCCP and options to be set by the application for correct operation of the underlying SCCP layer.

Use of SCCP service and management primitives is described in line with their use in /13/ where this may be helpful to aiding the understanding. This document has no requirement for implementation of such primitives.

2.1 SCCP Return Message on Error Procedure

The SCCP connectionless class of service specified in /3/ provides the application using SCCP with the ability to transfer signalling messages via the signalling network without setup of a permanent signalling connection. Under certain conditions of network congestion, and unavailability of subsystems supporting the application and/or signalling points, SCCP connectionless messages could be discarded instead of being delivered. SCCP provides a return on error procedure as a means for the application to be informed about messages that SCCP cannot route to the end destination. If the application using SCCP wishes to use the SCCP Return message on error procedure, the Return Option parameter must be provided to SCCP. If the Return Option parameter is not provided to SCCP by the application then no error information will be provided by SCCP to the application.

When routing on Global Title, the return message on error procedure is the only way for the application using SCCP to be informed of messages encountering routing problems, and is a valuable means of receiving information quickly about routing problems in the network.

Applications shall always provide the Return Option parameter to SCCP. Wherever possible, applications shall take appropriate action on the Reason for Return parameter provided from SCCP.

Possible actions are given in Table 2.1.

TABLE 2.1 – **Action taken by Application upon receipt of return reason**

no translation for this specific address	stop requests and report problem
subsystem congestion	reduce requests and log problem
subsystem failure	pause requests and report problem
unequipped user	stop requests and report problem
network congestion	reduce requests and log problem
network failure	pause requests and report problem

Whilst SCCP is designed always to route correctly, it should be understood that the sent UDTS messages may themselves be mis-routed or discarded. Applications shall have internal mechanisms that ensure control is not lost in the event of failure to receive responses to messages sent.

2.2 SCCP Calling and Called Addresses Structure

The SCCP interconnect signalling specification /3/ states that the called and calling party address parameters are required but leaves open the selection of type of address information to be provided. An application requiring SCCP must provide sufficient information to enable the correct construction of SCCP message called and calling party addresses. The constituent parts of these addresses are identified in the following sub section. The formats to be used and values to be assigned are specified in sections 4 and 5.

2.2.1 Address Indicator (Octet)

The address indicator octet specified in /9/ indicates the type of address information contained in the address field. The following parameters require encoding:
- signalling point code indicator
- subsystem number indicator
- global title indicator
- routing indicator.

2.2.2 Global Title Contents

The specification /3/ restricts the Global Title Indicator to a value of four (GTI=4). According to specification /9/ this format means that global title fields must be populated with:
- translation type

- numbering plan
- encoding scheme
- nature of address indicator
- global title address information.

2.2.3 Routing Indicator

Bit 7 of the address indicator octet is the Routing Indicator.

A "0" in bit 7 indicates that routing should be based on the Global Title in the address.

A "1" in bit 7 indicates that routing should be based on the destination point code in the MTP routing label and the subsystem number information in the called party address.

Routing in the UK interconnect SCCP network shall be based on Global Title.

2.3 Management of Address Information by the Transaction Capability Sub-Layer

Based on /7/ ETS 300 134 § 3.5

Although TC does not convey address information in any of its message parameters, the Transaction sub-layer must provide any necessary address information to the SCCP in every N-UNITDATA request primitive (e.g. global title and sub-system number with a "Global Title routing required" indication).

The procedures are intended to be analogous with those relating to Transaction IDs:

i) The calling address information received in the first N-UNITDATA indication primitive in each direction of a transaction, shall be used as called address in all subsequent messages to the peer within that transaction.

ii) Each SCCP application is responsible for providing its own address in the calling address information of every N-UNITDATA request primitive. This shall not change during the life of the transaction and shall be in a form which can be used by the SCCP to return messages, e.g. from the distant node.

iii) Once the transaction is established, the address information provided to SCCP shall remain constant for the life of the transaction.

Because the calling party address in a response will not necessarily be the same as the called party address in the original TC-BEGIN message, it is the TCAP transaction IDENTITY and not SCCP address information that is used by TC for identifying related messages.

2.4 Protocol Class

The protocol class has to be set by the application. The classes allowed by /3/ are

0	basic connectionless
1	sequenced connectionless

2.5 Sequence Information

Based on /10/ Q.714 1.1.2.2

If the sequenced connectionless protocol class 1 is to be used, the application must indicate this to SCCP by use of the sequence control parameter. SCCP will then encode the Signalling Link Selection field of the MTP routing label identically for all signalling messages of the sequence.

2.6 Quality of Service

These are parameters used for connection oriented procedures and are not covered by /3/.

2.7 Stream Identity

These are parameters used for connection oriented procedures and are not covered by /3/.

2.8 SCCP User Management

Because routing in the UK SCCP network is based on Global Titles, management, which is based on PC+SSN addressing, is not required. Exceptionally, where applications reside in the UK interconnect network and point codes are known to both parties, routing may be based on subsystem numbers by mutual agreement. In this case the following requirements may apply.

2.8.1 N-STATE Primitive

SCCP requires the application using SCCP to react to the N-STATE Indication primitive, taking into account the service characteristics and the status of its peer application using SCCP.

2.8.2 N-PCSTATE Primitive

SCCP expects the application using SCCP to react to the N-PCSTATE Indication primitive, taking into account the service characteristics and the status of the affected SP or SCCP.

2.8.3 N-COORD Primitive

If the application using SCCP requires use of the co-ordinated state change feature of SCCP, then SCCP requires the application using SCCP to respond to the N-COORD Indication primitive, taking into account its workload.

3 Requirements On SCCP Networks

This section gives guidelines for network operators and designers in order to avoid and correct the following known potential problems that may otherwise occur.

3.1 Use of the Return Option

The following sub-sections describe how to avoid known potential problems.

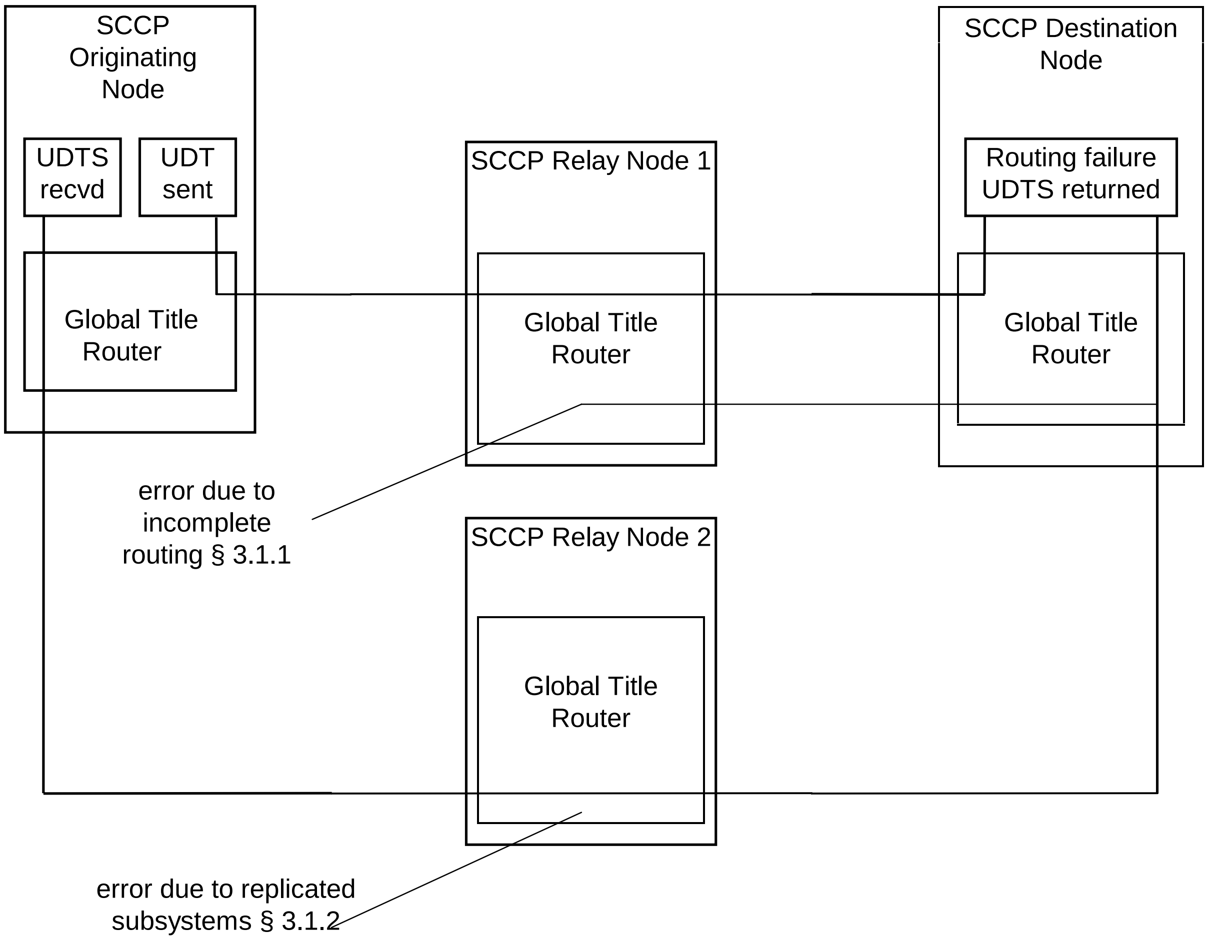


FIGURE 3.1 – **Errors Due to Routing Failures**

3.1.1 Incomplete Routing

Based on /11/ Q.715 §8.3.1.1

Every node on an outward route must know a valid route on which to return the message. All nodes on the outward route must be configured to be able to perform global title translation of the Global Title Address Information of returned messages formed from the calling party address of the outward message.

3.1.2 Replicated Subsystems

Based on /11/ Q.715 §8.3.1.2

The calling party address of UDT messages, and the called party address of UDTS messages, must unambiguously identify the node where the UDT message originating subsystem is located.
The final GT translation of the called party address in a UDTS message must result in the UDTS message being routed to the node hosting the UDT message originating subsystem, and must therefore be subjected neither to backup routing nor loadsharing.

3.1.3 Changes to Calling and Called Party Addresses.

In order to help minimise possible problems with the return message on error procedure described in 2.1 above, neither the calling nor called party addresses shall be changed as they pass through the UK network, including and up to end nodes, except as described in /2/, /14/ and /18/ for number portability.

3.1.4 Scope of Calling Party Address

Based on /11/ Q.715 §8.3.1.3

The calling party address of the subsystem originating the message must be valid in every network through which the message passes.

3.1.5 Calling Party Addresses in UDTS Messages.

Based on /11/ Q.715 §8.3.1.4

When the routing indicator in messages received at end nodes has been set to RI = 'route on SSN', the called party address will then include the SSN of the destination application and possibly the DPC of the end-node. Potentially, these address parameters could then form the calling party address in a returned UDTS message. However, if DPCs and perhaps national specific SSNs were derived from the final GT translation, these may be valid only in the destination network, and therefore should not be used for the calling party address in a returned UDTS message.
Problems of this nature are minimised in the UK network by not permitting changes to the calling and called party addresses (see 3.1.3).

3.1.6 Conversion of Called Party Address

Based on /11/ Q.715 §8.3.1.5

The calling party address sent back in a UDTS message may contain any intermediate result of translation of the called party address in the UDT message, and have no apparent relation to it. It cannot therefore be used as a reliable indication for such purposes as accounting, measurements, or traffic management activity.
If screening of calling party address is applied to UDTS messages, many messages could be blocked because their calling party address is not valid. Also, many messages might be rejected or discarded, since the calling party address was originally the called party address in a UDT that could not be routed. Problems of this nature are minimised in the UK network by not permitting changes to the calling and called party addresses (see 3.1.3). Care should be taken that the screening of calling party address does not impair the normal operation of the UK SCCP network.
To achieve a meaningful calling party address, the international component of the Global Title Address Information shall be included and retained for UK interconnect.

3.1.7 Syntax Checks

Based on /11/ Q.715 §8.3.1.7

Syntax checks in a relay node are permitted to be less stringent than in end-nodes. Only the 'necessary' routing data are required to be checked (See /10/ Q.714 §4.3). If the return option is now applied, the danger exists that a message is returned that is corrupted, but is 'repaired' through the reformatting of the UDTS message, although containing complete nonsense. It would be advisable to perform a more complete syntax check of the received UDT message before using its information to format the UDTS message. In addition, called party addresses that are not reliably decodable should be treated as 'syntax errors' (as it is now described in /10/ Q.714, § 3.10). The appropriate action is to discard them (i.e. not to subject them to the return procedure), otherwise complete nonsense may be returned in the message, especially in the calling party address.

3.2 Corrective Action for Message Returned on Error Reasons

At present there are no actions specified for SCCP to take other than to pass on the Reason for Return parameter to the application. The consequences of errors are anticipated to be at a level where the normal operation of the SCCP network is unimpaired. However, it should be a requirement of interconnect agreements that SCCP errors be recorded and action taken to find and rectify their cause.

3.3 Checking for Ported Numbers in Own Node or Network

Before an SCCP message is sent from a node in an Outgoing Network to an Incoming Network, the Outgoing Network should first check whether the called party has been ported to the sending node in the Outgoing Network. If such a check shows that porting has occurred then the Outgoing Network shall not send the message to the

Incoming network. The donor network from which the address has been ported shall not rely on such checks being made and shall route all SCCP messages to their correct destination.

3.4 Checking for Circular Routing of Messages to Ported Numbers

Number portability increases the possibility that messages could be routed into a loop. This is because subsystem routing would not be performed at a donor exchange (now an intermediate point (where routing is on Global title), not an end node as was the case prior to porting). An operator could be alerted to loops by monitoring for excessive frequency of messages relayed to individual addresses.

3.5 Management of SCCP

Subsystem status management of SCCP itself is optionally allowed by /3/ and permits the status of the SCCP management at a node to be determined. In particular, the subsystem status test procedure of /10/ Q.714 § 5.3.4.2.b may be used to verify the status of the remote SCCP, thereby ensuring that messages are only sent to nodes where a SCCP is able to process them.

4 Requirements Of Specific Services Using SCCP

Service aspects which specifically influence the UK interconnect use of SCCP are derived from a requirement to support the UK CCBS service consistent with international interconnect and the UK number portability supplementary service.

4.1 UK Interconnect

In order to maximise compatibility with international interconnect requirements, the UK interconnect is based on and consistent with the requirements of /9/ and has adopted the following addressing principles.

4.1.1 Sub System Number and Point Code

Information from /9/ Q.713 Annex B.2
A SSN address element shall always be present in the SCCP called party address, but its value shall be coded "0" if the SSN of the SCCP user entity was not known or not nationally standardised. A PC may be present in the SCCP called party address, but is not evaluated.

4.1.2 E.164 Address Format

UK originated SCCP messages that use an E.164 address shall use the full international E.164 calling party address across the UK interconnect (i.e. the international portion of the E.164 number shall be retained).
Notes:

SCCP messages with truncated international E.164 addresses received from international interconnect may be passed across the UK Interconnect.

An application may need to modify the form of address that it used for circuit related signalling (e.g. remove a leading zero [0], remove any service prefix or indirect access digits, and add the country code [44]) before passing it to SCCP as the Called Party Address.

4.2 SCCP Support for Geographic, Non Geographic and Personal Number Portability.

The service description is in /2/.

4.2.1 Donor Relay of SCCP Messages

When a service has been specified for UK interconnect and is supported by the donor node, the donor network is required to relay the SCCP messages for that service.
There is no requirement for the donor network to relay SCCP messages for services which have not been specified for UK interconnect or for services that the donor node does not support.

4.2.2 Format of Address Indicator and Address

When the message has been addressed to a ported number, the UK format of § 4.2.2.1 shall apply to the called party address of SCCP UDT messages from the donor network.
The calling and called party addresses of any UDTS message shall be an exact swap of those received in the corresponding UDT message.

4.2.2.1 UK Specific Address Indicator and Address

Based on /9/ Q.713 Annex B.4.1.1

8	7	6	5	4	3	2	1	
0	RI = 0	GTI = 4				SSNI = 1	PCI = 0	octet 1
SSN = see note								octet 2
Translation type = see note								octet 3
Numbering plan = 1 (E.164)				Encoding scheme = 1 or 2				octet 4
0	Nature of address indicator : See 6.1.4.4							octet 5
Prefix digit 2 = X				Prefix digit 1 = 5				octet 6
Prefix digit 4 = X				Prefix digit 3 = X				octet 7
Prefix digit 6 = X				Prefix digit 5 = X				octet 8
Called address digit 2				Called address digit 1 = 0				octet 9
•				•				•
Called address digit 10 (if present)				Called address digit 9 (if present)				octet 13
If needed, filler = 0				Called address digit 11 (if present)				octet 14

FIGURE 4.1 –**UK Specific Address Global Title**

Notes:
- the intention is for the portability function to work using any E.164 number
- prefix digits take the form 5XXXXX where XXXXX identifies the new host exchange or operator, and are administered by Oftel.
- the called address digits include the leading zero
- the total number of address digits could exceed the E.164 number length
- for CCBS the SSN=11 and the Translation type=17
- see also /12/

4.3 SCCP Support for CCBS Supplementary Service.

The service description is in /1/

4.3.1 E.164 Service Centre Address

Based on /8/ ETS 300 356-18 § 9.7.2

The exchange which initiates a dialogue using the Global Title routing option, shall give its E.164 service centre address as the GT in the SCCP calling party address field. This precludes that number information sensitive to privacy regulations (e.g. Calling Line Identification (CLI)) is used for routing on the interface.
The E.164 service centre address shall be:
for networks using numbers without geographical significance (e.g. mobile)
i) an international number from the range allocated to the operator of the C7 node that originated the TC transaction
and, for networks using numbers having geographical significance (e.g. fixed)
ii) an international number from the NNG at the node where the CCBS application which originated the transaction resides.
The E.164 service centre address shall not be allocated to an NTP.
The use of alternative forms of calling party address such as exchange identity or generic global address is for further study.

4.3.2 CCBS CPN to Ported Numbers

When routed via the donor exchange the SCCP Called Party Address will be changed by the donor exchange or network to include the prefix digits,. The CCBS CPN, the Calling Party Address and the originating end transaction identity will be received at the new host exchange unchanged.
Note: How such a change of address is achieved is outside the scope of this document.

4.3.3 Transaction Capabilities (TC) Resources

Based on /8/ ETS 300 356-18 § 6.2 & 6.3

In order to operate the CCBS supplementary service, both the originating network and destination networks shall have Transaction Capabilities (TC) resources in the end nodes and as specified in the UK specification /4/.

4.3.4 Format of Address Indicator and Address

The format of § 4.3.4.1 shall apply to the calling and called party addresses of SCCP UDT messages with the following exception. When the message has been addressed to a ported number, the UK format of § 4.2.2.1 shall apply to the called party address of SCCP UDT messages from the donor network.
The calling and called party addresses of any UDTS message shall be a swap of those received in the corresponding UDT message.

4.3.4.1 Format of Address Indicator and Address for ISDN Supplementary Service - CCBS.

Based on /9/ Q.713 Annex B.4.1.1

8	7	6	5	4	3	2	1	
0	RI = 0	GTI = 4				SSNI = 1	PCI = 0	octet 1
SSN = 11 (ISDN Supplementary Service)								octet 2
Translation type = 17 (CCBS translation table)								octet 3
Numbering plan = 1 (E.164)				Encoding scheme = 1 or 2				octet 4
0	Nature of address indicator = 4 (International)							octet 5
Country code digit 2 (if present)				Country code digit 1				octet 6
National significant number (NSN) digit 1				Country code digit 3 (if present)				•
NSN digit 3				NSN digit 2				•
•				•				octet 10
•				•				octet 11
NSN digit 11 (if present)				NSN digit 10 (if present)				octet 12
If needed, filler = 0				NSN digit 12 (if present)				octet 13

FIGURE 4.2 – **Global Title Address for CCBS for ISDN Supplementary Service**

Note: This is the generic format for ISDN supplementary services of which only CCBS is required for UK interconnect.

4.4 SCCP Support for Mobile Number Portability (MNP)

The service description is in /14/.

The standard method by which the UK industry manages and operates services for mobile subscriptions with ported numbers is based on the provision of Signalling Relay Functionality in donor networks.

4.4.1 Signal Relay Function Addressing

The signal relay function uses a re-routing code to address a routing enquiry, or other signal addressed to a ported number, to the recipient network.

4.4.2 Format of Address Indicator and Address

The MNP format of § 4.4.2.1 shall apply to the called party address of SCCP messages from the signal relay function in the donor network.
All further SCCP addresses associated with the service conform to Section 4 of /19/.
The calling and called party addresses of any UDTS message from the recipient network shall be a swap of those received in the corresponding UDT message.

4.4.2.1 MNP Called Party Address Indicator and Address

Based on /9/ Q.713 Annex B.4.1.1

8	7	6	5	4	3	2	1	
0	RI = 0	GTI = 4				SSNI = 1	PCI = 0	octet 1
SSN = 6 (HLR)								octet 2
Translation type = 0 (Unknown)								octet 3
Numbering plan = 1 (E.164)				Encoding scheme = 1 (or 0 if even)				octet 4
0	Nature of address indicator = 4 (International)							octet 5
Country code digit 2 = 4				Country code digit 1 = 4				octet 6
Re-routing code digit 2 = 9				Re-routing code digit 1 = 7				octet 7
Re-routing code digit 4 = X				Re-routing code digit 3 = 9				octet 8
Ported Number NNG digit 2 = b				Ported Number NNG digit 1 = a				octet 9
Ported Subscriber Number digit 1 =1				Ported Number NNG digit 3 = c				octet 10
•				•				•
Filler = 0				Ported Subscriber Number digit 6 =6				octet 13

FIGURE 4.3 – **Global Title Address for MNP**

Notes:
- the MNP re-routing codes take the form 799X where X defines the recipient network.
  X = 1 Cellnet
  X = 2 One2One
  X = 3 Orange
  X = 4 Vodafone
- the digit values shown are those of an example mobile subscriber directory number 07abc123456 or 0abc123456

4.5 ETSI INAP

Awaiting outcome of study. Generic Numbering Plan (see 6.1.4.2) may be suitable for calling party address.

5 Clarifications Of Specific MTP And SCCP Clauses

This section shall contain clarifications of specific ITU or ETSI clauses. These clarifications shall be included as necessary when identified. Work on the UK MTP and SCCP specs has currently not identified any clarifications.

6 Summary Of SCCP & MTP Parameter Assignments

This section lists the setting of options and encoding of parameters required from applications to help ensure the SCCP and MTP are able to support the services identified, for use over UK interconnect.

Also included are existing and proposed assignments made known to the ISC. They are included so that an informed choice can be made in selecting future assignments from reserved values.

6.1 SCCP Parameters

6.1.1 SCCP Return Option

Applications shall always provide the Return Option parameter to SCCP and, when the calling address of the returned message is known, make use of the return message on error procedure (refer to 2.1 which gives recommended application actions).

When a UNITDATA SERVICE message is sent, it shall contain the Called Party Address of the undelivered UNITDATA message in its Calling Party Address Parameter. This shall apply whatever node originates the UNITDATA SERVICE message.

6.1.2 Routing Indicator

Bit 7 of the address indicator octet shall be set to “0” in the SCCP interconnect network as routing is to be based on the global title in the address.

Bit 7 of the address indicator may only be set to “1” in the destination network. This indicates that routing should be based on the subsystem number information in the called party address. In this case any signalling point code in the called party address shall be ignored, the DPC in the MTP routing label shall be used for routing purposes.

6.1.3 Subsystem Number (SSN)

SSNs have to be included in all SCCP messages that cross UK network boundaries. The SSNs to be used across the UK SCCP network are recorded **in bold** in Table 6.1.

Based on /9/ Q.713 § 3.4.2.2 and ISC member input

TABLE 6.1 – **Subsystem Number Allocation**

Decimal Value	Bits 8 7 6 5 4 3 2 1	Meaning	Assignment
0	**0 0 0 0 0 0 0 0**	**SSN not known/not used**	**ITU-T**
1	**0 0 0 0 0 0 0 1**	**SCCP management**	**ITU-T**
2	0 0 0 0 0 0 1 0	reserved for ITU-T-T allocation	ITU-T
3	0 0 0 0 0 0 1 1	ISDN user part	ITU-T
4	0 0 0 0 0 1 0 0	OMAP	ITU-T
5	0 0 0 0 0 1 0 1	MAP (mobile application part)	ITU-T
6	**0 0 0 0 0 1 1 0**	**HLR (home location register)**	**ITU-T**
7	**0 0 0 0 0 1 1 1**	**VLR (visitor location register)**	**ITU-T**
8	**0 0 0 0 1 0 0 0**	**MSC (mobile switching centre)**	**ITU-T**
9	0 0 0 0 1 0 0 1	EIC (equipment identifier centre)	ITU-T
10	0 0 0 0 1 0 1 0	AUC (authentication centre)	ITU-T
11	**0 0 0 0 1 0 1 1**	**ISDN supplementary services**	ITU-T
12	0 0 0 0 1 1 0 0	INAP	ETSI
13	0 0 0 0 1 1 0 1	broadband ISDN edge-to-edge	ITU-T
14	0 0 0 0 1 1 1 0	TC test responder	ITU-T
15	0 0 0 0 1 1 1 1		
	to	Reserved for international use	ITU-T
31	0 0 0 1 1 1 1 1		
32	0 0 1 0 0 0 0 0		
	to	Reserved for ETSI allocation network	
146	1 0 0 1 0 0 1 0		
147	1 0 0 1 0 0 1 1	GSM (CAP)	ETSI GSM 03.03
148	**1 0 0 1 0 1 0 0**	**GSM (SCF)**	**ETSI GSM 03.03**
149	1 0 0 1 0 1 0 1	SGSN (serving GPRS support node)	ETSI GSM 03.03
150	1 0 0 1 0 1 1 0	GGSN (gateway GPRS support node)	ETSI 03.03
151	1 0 0 1 0 1 1 1		
	to	Reserved for UK inter-network use	ISC
214	1 1 0 1 0 1 1 0		
215	1 1 0 1 0 1 1 1		
		In use	BT
229	1 1 1 0 0 1 0 1		
230	1 1 1 0 0 1 1 0	Range 215 to 252 is reserved	
	to	for intra-network use (Note 1)	UK PTOs
244	1 1 1 1 0 1 0 0		
245	1 1 1 1 0 1 0 1	In use	Orange
246	1 1 1 1 0 1 1 0	In use	Orange
247	1 1 1 1 0 1 1 1		
	to	In use	Orange/Vodafone
250	1 1 1 1 1 0 1 0		
251	1 1 1 1 1 0 1 1	In use	Orange
252	1 1 1 1 1 1 0 0	In use	Orange
253	1 1 1 1 1 1 0 1	O&M(BSS)	ETSI GSM 08.06
254	1 1 1 1 1 1 1 0	BSSAP	ETSI GSM 08.06
255	1 1 1 1 1 1 1 1	Reserved for expansion	ITU-T

Network specific subsystem numbers should be assigned in descending order starting with "11111110".

Note 1: Code points identified in the range for intra network use is for information only and these values may be reused in other networks than those identified here.

6.1.4 Global Title Format for Indicator 0100 (GTI=4)

6.1.4.1 Translation Type

The translation types to be used across the UK SCCP network are recorded **in bold** in Table 6.2.

Based on /9/ Q.713 § 3.4.2.3.4 and ISC member input.

TABLE 6.2 – **Translation Type Allocation**

Decimal value	Encoding Bits 8 7 6 5 4 3 2 1	Meaning	Assignment
0	**0 0 0 0 0 0 0 0**	**Unknown** (Note 1)	**ITU-T**
1	0 0 0 0 0 0 0 1	ITCC Service	ITU-T
2	0 0 0 0 0 0 1 0	"Generic" Numbering Plan	ITU-T
3	0 0 0 0 0 0 1 1	Broad-Band Edge-to-Edge	ITU-T
4	0 0 0 0 0 1 0 0		
To		Reserved for international services	ITU-T
16	0 0 0 1 0 0 0 0		
17	**0 0 0 1 0 0 0 1**	**ISDN Supplementary Services**	**ITU-T**
18	0 0 0 1 0 0 1 0		
To	to	Reserved for international services	ITU-T
63	0 0 1 1 1 1 1 1		
64	0 1 0 0 0 0 0 0		
To	to	Spare	
127	0 1 1 1 1 1 1 1		
128	1 0 0 0 0 0 0 0	Mobile number portability “call related” message	ETSI GSM 03.66
129	1 0 0 0 0 0 0 1		
To	to	Reserved for UK inter-network	ETSI
150	1 0 0 1 0 1 1 0	services	reserved values
151	1 0 0 1 0 1 1 1		
To	to	Reserved for inter-network services	UK ISC
214	1 1 0 1 0 1 1 0		
215	1 1 0 1 0 1 1 1		
To	to	Reserved for intra-network services	UK ISC
253	1 1 1 1 1 1 0 1		
254	1 1 1 1 1 1 1 0	In use	Vodafone
255	1 1 1 1 1 1 1 1	Reserved for expansion.	ITU-T

Notes

1 This value of Translation type is currently required by UK interconnect for Mobile Number Portability.

6.1.4.2 Numbering Plan

The numbering plan allocations to be used across the UK SCCP network are recorded **in bold** in Table 6.3.

Based on /9/ Q.713 § 3.4.2.3.3 and ISC member input

TABLE 6.3 – **Number Plan Allocation**

Decimal value	**Encoding Bits** 4 3 2 1	**Meaning**	**Assignment**
0	0 0 0 0	unknown	ITU-T
1	**0 0 0 1**	**ISDN/telephony numbering plan (Recommendations E.163 and E.164)**	**ITU-T**
2	0 0 1 0	generic numbering plan	ITU-T
3	0 0 1 1	data numbering plan (Recommendation X.121)	ITU-T
4	0 1 0 0	telex numbering plan (Recommendation F.69)	ITU-T
5	0 1 0 1	maritime mobile numbering plan (Recommendations E.210, 211)	ITU-T
6	0 1 1 0	land mobile numbering plan (Recommendation E.212)	ITU-T
7	0 1 1 1	ISDN/mobile numbering plan (Recommendation E.214)	ITU-T
8	1 0 0 0	spare	
9	1 0 0 1	spare	
10	1 0 1 0	in use	BT
11	1 0 1 1	in use	BT
12	1 1 0 0	spare	
13	1 1 0 1	spare	
14	1 1 1 0	private network or network-specific numbering plan	ITU-T Proposed
15	1 1 1 1	reserved.	ITU-T

6.1.4.3 Encoding Scheme

The encoding scheme allocations to be used across the UK SCCP network are recorded **in bold** in Table 6.4.

Based on /9/ Q.713 § 3.4.2.3.2.

TABLE 6.4 – **Encoding Scheme Allocation**

Decimal value	**Encoding Bits** **4 3 2 1**	**Meaning**	**Assignment**
0	0 0 0 0	unknown	ITU-T
1	**0 0 0 1**	**BCD, odd number of digits**	**ITU-T**
2	**0 0 1 0**	**BCD, even number of digits**	**ITU-T**
3	0 0 1 1	national specific	ITU-T
4	0 1 0 0	⎫	
	to	⎬ spare	
14	1 1 1 0	⎭	
15	1 1 1 1	reserved.	ITU-T

6.1.4.4 Nature of Address Indicator

The NAI allocations to be used across the UK SCCP network are recorded **in bold** in Table 6.5.

Based on /9/ Q.713 § 3.4.2.3.1

TABLE 6.5 – **Nature of Address Allocation**

Decimal value	**Encoding Bits** **7 6 5 4 3 2 1**	**Meaning**	**Assignment**
0	0 0 0 0 0 0 0	Unknown	ITU-T
1	0 0 0 0 0 0 1	Subscriber Number	ITU-T
2	0 0 0 0 0 1 0	Reserved for national use	ITU-T
3	0 0 0 0 0 1 1	National Significant Number	ITU-T
4	**0 0 0 0 1 0 0**	**International Number**	**ITU-T**
5	0 0 0 0 1 0 1	⎫	
		⎬ spare	
111	1 1 0 1 1 1 1	⎭	
112	1 1 1 0 0 0 0	⎫	
		⎬ Reserved for ETSI allocation	ETSI
120	1 1 1 1 0 0 0	⎭	
121	1 1 1 1 0 0 1	⎫	
125	1 1 1 1 1 0 1	⎬ Reserved for national network use	ETSI
126	**1 1 1 1 1 1 0**	⎭ **UK Specific Address**	**UK (provisional)**
127	1 1 1 1 1 1 1	reserved	ITU-T

Note: code values 112 to 126 inclusive are “national network specific” - ITU-T.

6.2 MTP Parameters

6.2.1 Allocation of Service Indicator Codes

Reference Implementors' guide (12/99) for recommendation Q.704, 14.2.1

The allocation of service indicator codes for Interconnect use shall be as given against NI=10 in Table 6.6. SI codes for the international network are given for information only and should not be assumed exhaustive:

TABLE 6.6 – **Service Indicator Code Allocation**

NET IND DC	SERVICE IND DCBA	ALLOCATION
00	0000	Signalling network management messages
	0001	Signalling network testing and maintenance messages
	0010	Reserved
	0011	SCCP
International	0100	Telephone User Part
Signalling Network	0101	ISDN User Part
(for information	0110	Data User Part (call and circuit-related messages)
only)	0111	Data User Part (facility registration and cancellation messages)
	1000	MTP Tester
	1001	Broadband ISDN User Part
	1010	Satellite ISDN User Part
	1011	Signal Processing Network Equipment User Part
	1100	Reserved for AAL type 2 Signalling Transport Converter
	1101	Bearer Independent Call Control (BICC, Q.1901)
	1110	Reserved For Gateway Control Protocol (GCP, H.248)
	1111	Reserved for extension
10	0000	Sig Network Management
	0001	Sig Testing and Maintenance
National	0011	UK Signalling Connection Control Part
Signalling Network	0100	Interconnect User Part
(for Interconnect use)	0101	UK ISDN User Part
	1000	MTP Testing User Part
	1110	OSS User Part

6.2.2 Service Indicators for UPU Messages

Reference Implementors' guide (12/99) for recommendation Q.704, 15.17.4

For UPU messages an implementation shall be expected to terminate and recognise SI values of both NI=00 and 01. These are given in Table 6.7. SI codes for the international network should not be assumed exhaustive:

TABLE 6.7 – **Service Indicator Code in UPU Allocation**

NET IND DC	SERVICE IND DCBA	ALLOCATION
00	0000	Reserved
	0001	Reserved
	0010	Reserved
	0011	SCCP
International	0100	TUP
Signalling Network	0101	ISUP
(for information	0110	DUP
only)	0111	Reserved
	1000	MTP Tester
	1001	Broadband ISDN User Part
	1010	Satellite ISDN User Part
	1011	Signal Processing Network Equipment User Part
	1100	Reserved for AAL type 2 Signalling Transport Converter
	1101	Bearer Independent Call Control (BICC, Q.1901)
	1110	Reserved For Gateway Control Protocol (GCP, H.248)
	1111	Reserved
10	0000	Sig Network Management
	0001	Sig Testing and Maintenance
National	0011	UK Signalling Connection Control Part
Signalling Network	0100	Interconnect User Part
(for Interconnect use)	0101	UK ISDN User Part
	1000	MTP Testing User Part
	1110	OSS User Part

7 Guide To MTP Network Interconnection

This section contains guidance relating to the impacts and issues regarding the interconnect of MTP networks.

It clarifies known areas of complexity or where difficulties have been experienced previously.

7.1 MTP Use of Signalling Transfer Points (Quasi Associated Signalling)

The ITU definition of Signalling Transfer Points is used i.e. processing at the MTP level only using point codes, not the SCCP relay function.

Associated Signalling – the messages relating to a particular signalling relation between 2 adjacent points are conveyed over a link set directly interconnecting those signalling points. This is also known as Direct signalling.

Quasi Associated Signalling - the messages relating to a particular signalling relation between 2 adjacent points are conveyed over 2 or more link sets in tandem passing through one or more signalling points other than those that are the origin or destination of the messages. At a given point in time the path through the network that is taken by a message is pre-determined and fixed. This is also known as STP signalling.

Non Associated Signalling – similar to Quasi Associated but the path of the message is not pre-determined or fixed. SS 7 DOES NOT SUPPORT THIS MODE OF SIGNALLING.

Circuit Related Signalling – these are messages concerning the control of a specific speech or data circuit (e.g. IAM) and they contain a Circuit Identification Code as a reference to a particular circuit.

Non Circuit Related Signalling – these messages do not relate to a specific circuit e.g. an IN number translation request or a MAP location update.

7.1.1 Associated Signalling

This is the most common form of signalling currently used for UK Interconnect. Wherever 2 signalling end points are Inter-connected with speech circuits a number of signalling links are provided between the 2 signalling end points. This mode simplifies the processes required to support Interconnect as the calculation of the number of signalling links required (for circuit related signalling) is straightforward, being based on the number of speech circuits between the 2 points.

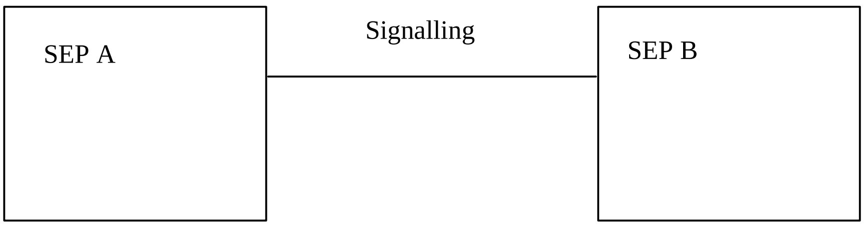


FIGURE 7.1 – **Associated Signalling**

7.1.2 Quasi Associated Signalling

In this form of signalling a 3rd (or several – see 7.1.3) signalling point(s) is introduced between the signalling end points. All signalling between the 2 end points passes through this Signalling Transfer Point(s). The STP could be a stand alone STP with no user part functions or it could be an Integrated STP that also has User Part functions i.e. it is also a signalling end point.

The advantage of using this form of signalling is that, dependent on the level of signalling traffic and number of signalling relationships required, it allows a reduction in the total number of signalling links compared with a network using an architecture based on associated signalling. Where many-to-one or many-to-many signalling relationships are necessary an STP based architecture may offer a significant reduction in signalling link numbers. This is of particular advantage where signalling link costs are high e.g. where long distances are involved such as in the USA.

The main disadvantage of using this mode of signalling is that it results in a signalling network being provided that requires more complex planning and management processes to be implemented.

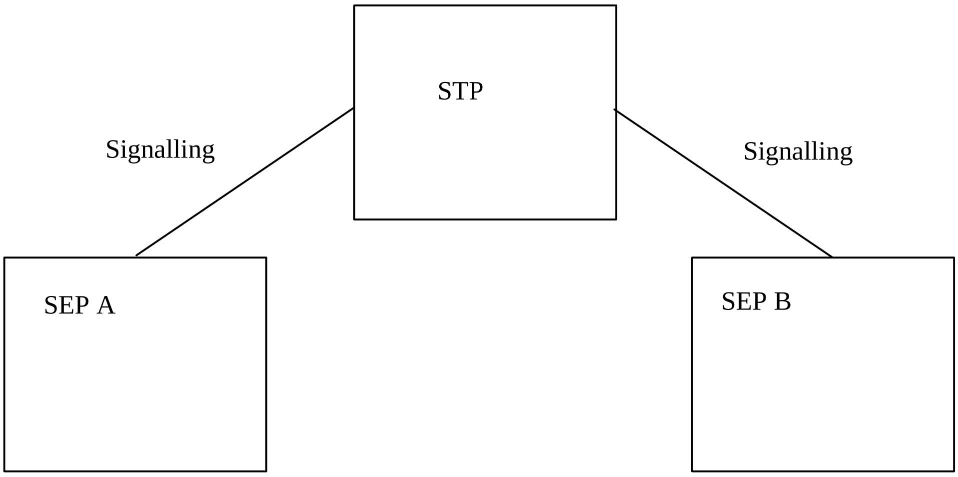


FIGURE 7.2 – **Quasi Associated Signalling**

7.1.3 STP Network Architectures

The "classic" STP network architecture taken from /27/ are mated pairs. Here a pair of STPs act as mutual backup for each other, with a signalling end point being connected to each STP mate. In this architecture the signalling from an SEP is often "loadshared" between its 2 STPs. Note that this loadsharing is not supported by the UK MTP Interconnect Specification /5/, therefore in the UK interconnect signalling routes will be used in priority order. Under failure conditions the load from 1 STP is transferred to its mate. Mated pairs of STPs are then connected to each other to form a signalling network to provide signalling routes between signalling end points.

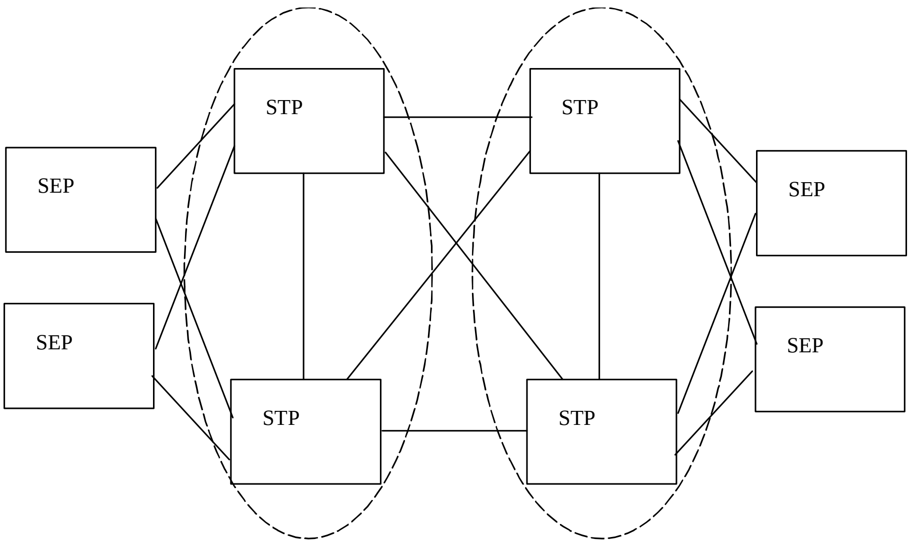


FIGURE 7.3 – **Mated Pairs**

Alternatively STPs can be provided in a non-mated configuration. In this mode an SEP is connected to at least 2 STPs but on failure of an STP its load is distributed between several other STPs determined by which STPs are used by which SEPs.

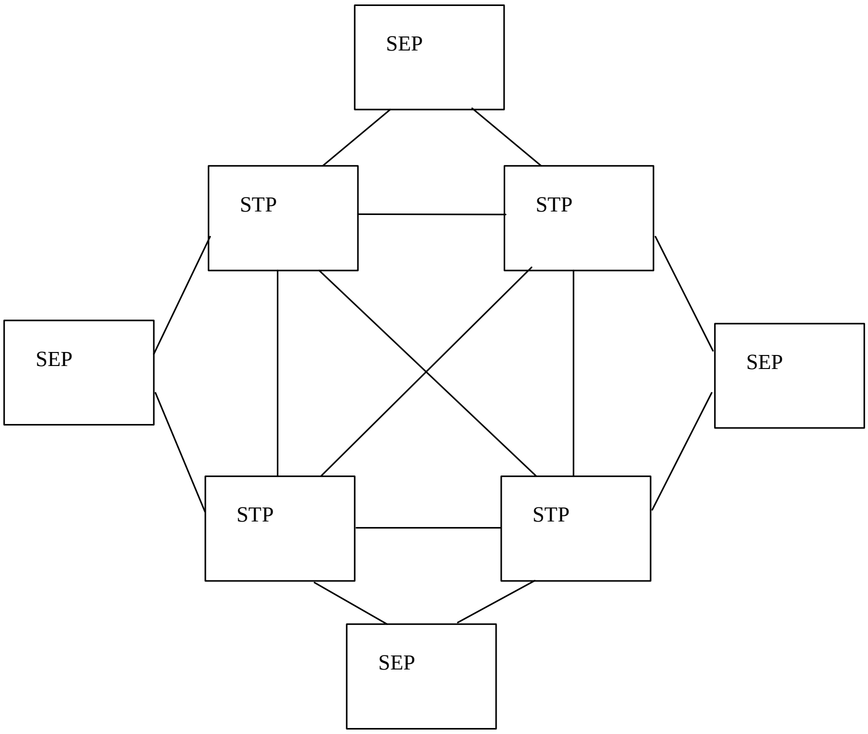


FIGURE 7.4 – **Non Mated Pair STPs**

7.1.4 Factors to be Taken Into Account When Using STPs

When designing a network using STPs many factors must be taken into account in order to provide the necessary performance and resilience. These include

a) Potential for Unidirectional Signalling

In an STP based network it is possible to have a signalling route from A to B without having a signalling route from B to A. This situation must be avoided or the user parts will be unable to function. This problem could occur in either normal or failure situations and care must be taken to ensure that this does not occur. The avoidance of non-symmetrical routes i.e. A to B via C but B to A via D can help to avoid the problem.

Interconnect signalling routes in the UK will be used in priority order, the number of routing choices being dependent on implementations and network configuration. It must be ensured that there is the same number of routing choices in each direction and asymmetrical routing should be avoided.

The diagram below shows that if symmetrical routes are not used then with a link set failure A cannot signal to B but B can signal to A

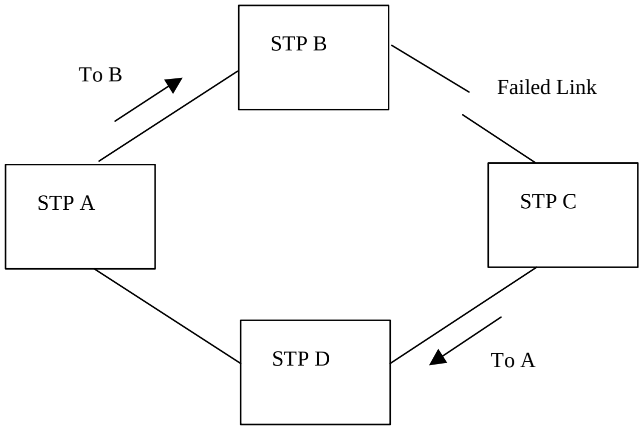


FIGURE 7.5 – **Example of Unidirectional Signalling**

b) Potential for Circular Routing

Circular routing is a situation in which messages for a signalling point can, under network failures (in a mesh network), be passed from and between signalling transfer points (STPs) in a closed loop, never terminating. In an extreme case it may even result in a message being returned to its origin for onward routing towards the destination it can never reach. The result of this will be the rapid overload of that particular part of the network formed by the loop.

Although Transfer Prohibited procedures in recommendation Q.704 13.2 prevent the formation of a closed loop between two nodes in a network, it will not provide this safeguard between three or more points, as illustrated below. This serious problem can be reduced by

i. keeping to a minimum the number of STPs in a signalling route

ii. avoiding the use of signalling points acting as STPs for each other to the same destination where possible.

iii. avoiding the use of links between a mated pair of STPs

In earlier ITU recommendations it was recommended that when sending a preventative TFP this message should be repeated. This recommendation was removed from later recommendations. If ii. above cannot be implemented then the repeating of this TFP is recommended. If a single TFP was lost then a circular route could occur, the repeated TFP reduces the probability of this happening.

Ref /20/ section 3.15 states that a means of avoiding circular routing shall be agreed by interconnecting operators. One set of circumstances in which circular routing can occur is explained below, there could be other circumstances which also result in circular routes.

Example of Circular Routing

To illustrate the formation of circular routing the basic mesh network is considered, see figure 7.6 below, with particular reference to the intermediate nodes Z, Y, D, and E. For many networks, the STPs will be integral to the SPs. In addition the following assumptions have been made:-

- Only routing actions are considered. Level 2 and changeover actions etc. work satisfactorily.
- Only the loss of routes is considered for simplicity (return to service could cause further problems).
- One re-routing action is completed before another starts; where messages overlap, complications may ensue.
- Load sharing across link sets is not used. Although load sharing does not change the results of circular routing it is simpler not to consider it in this illustration.

Considering Figure 7.6, the primary routes from Z, E, and Y, to D are direct.

Z's secondary route to D is via Y,

Y's secondary route to D is via E,

E's secondary route to D is via Z. (These routes are marked with arrows).

If the routes Z->D, E->D and Y->D fail, in any order, then circular routing will occur.

For example; if Z->D fails initially (1);

Z re-routes via Y and sends Y a Transfer Prohibited, Z->D.

Y receives transfer prohibited Z->D and marks any route it may have to D via Z as unavailable.

No re-routing is performed at Y.

Should Y->D now fail(2);

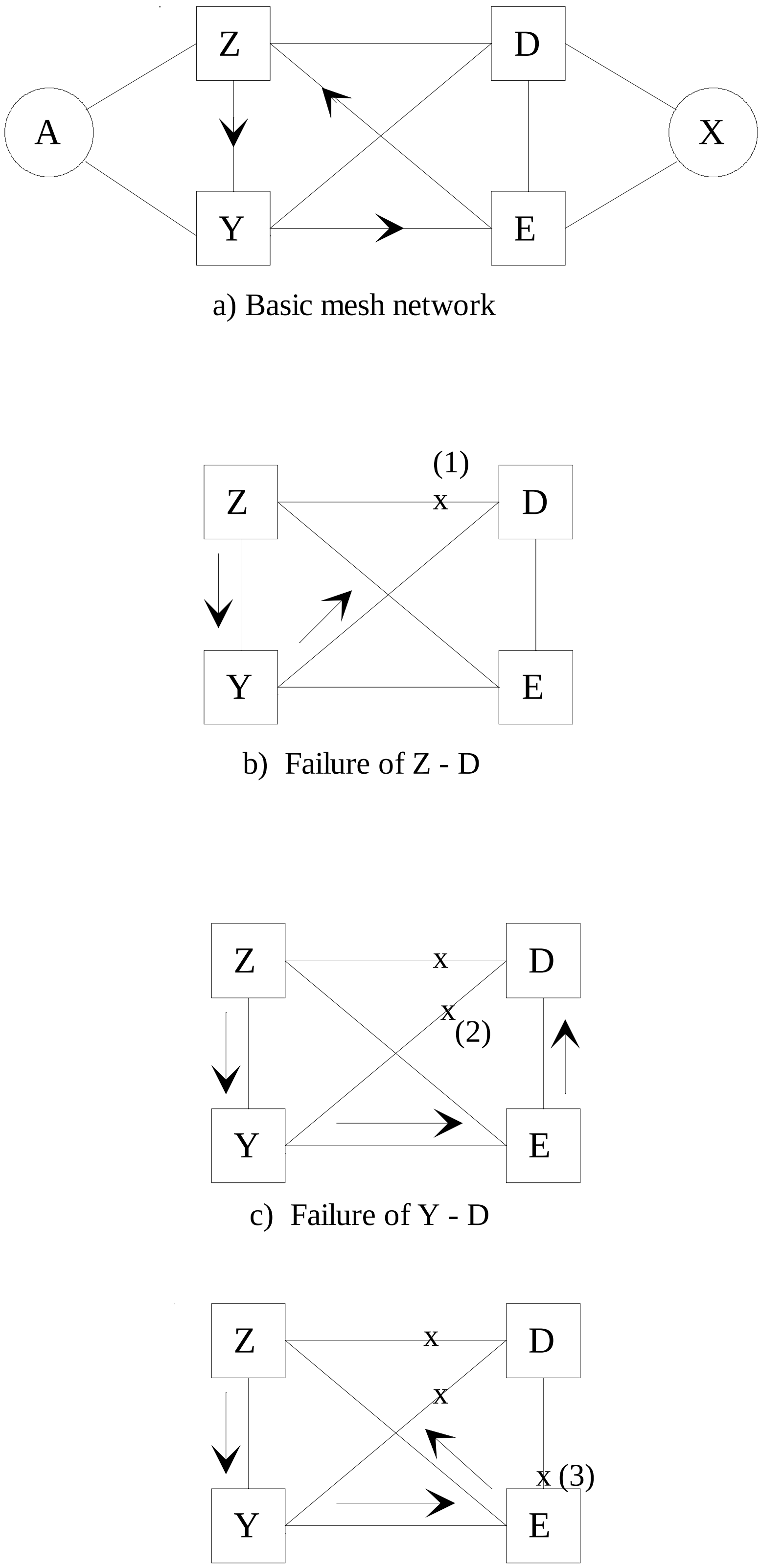
Y re-routes via E, and sends transfer prohibited Y->D to E.

E marks any route to D via Y as unavailable but does not re-route since the route that is currently used (E->D) is still available.

This network is now so primed that should E->D fail (3); circular routing will result, i.e. any message from either Z, Y or E, destined for D, will circulate within the loop Y->E->Z->Y.

An extension of this mechanism will be secondary looping i.e. the message is not returned to the origin but to the first STP. This is illustrated in Figure 7.7 where a message from A destined for D is 'trapped' in the circular routing loop Y->E->Z->Y.

It has been shown that in a ITU-T SS No 7 mesh network, in which more than two routes have to fail to create a destination inaccessible, circular routing can occur.



a) Basic mesh network

b) Failure of Z - D

c) Failure of Y - D

d) Failure of E - D producing circular routing

FIGURE 7.6 – **Example of Circular Routing Establishment**

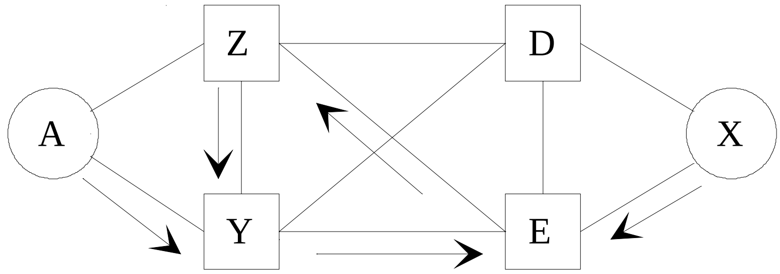


FIGURE 7.7 – **Secondary Circular Routing**

c) Dimensioning of signalling links to avoid congestion

Calculations must be performed to work out the number of signalling links required between signalling points in an STP network. This number is dependent on the number of traffic circuits being supported by the signalling links, the call sequences, message lengths and spread of call holding times. The number of signalling links needed for a given link occupancy can then be established, there may also be a dependency on system architecture. For non-circuit related signalling the message sequences, lengths, peak and average signalling rates are required.

The dimensioning must be established for both normal and failure conditions (see 7.1.2 above and the Congestion Procedures section.) This necessitates identifying the number of signalling relationships supported by a given link set and the number of traffic circuits supported by these signalling relationships. Except in very small signalling networks some form of planning tool may be required.

A consequence of an STP based network is the concentration of signalling traffic leading to higher link loadings and increased possibility of congestion.

d) Dimensioning of STPs to avoid signalling network overload

The total load on each STP must be calculated in order to avoid loss of signalling due to overload. With integrated STP/SEPs excessive STP signalling could also result in loss of user part traffic. This calculation will also be dependent on STP system architecture.

e) Cost of STPs

The cost of using STPs must be taken into account and compared with the cost of using associated signalling. These costs must include the STP system costs and associated planning and operational costs.

f) MTP Restart.

Many countries which use STP based networks have found it necessary to introduce the MTP “White Book” restart procedures in order for the STPs to recover correctly from failures. See section 7.3 for further details.

g) Number Of signalling route choices

Ref /5/ does not support load sharing between link sets – hence in the UK interconnect signalling routes will be used in priority order. In order to protect against the failure of an STP at least 2 routes, each through a different STP, should be available to each SEP. There should be the same number of routes in each direction, this number must be agreed between the interconnecting operators.

h) Interconnect Point Codes

Every node in the interconnect network, both SEPs and STPs, requires a unique point code as described in /21/.

7.1.5 Different Network Architectures.

Some networks in the UK use STPs for signalling and others do not. With 2 networks that use STPs it is likely that interconnection between the STPs in each network is the logical architecture. When connecting a non-STP network to an STP based network the interconnection is more complicated.

7.1.6 Circuit Related and Non-Circuit Related Signalling

The use or otherwise of STPs for interconnect will be influenced by the type of signalling being supported. For circuit related signalling the 2 SEPs will be connected with speech circuits so the transmission overhead of using associated signalling is small.

With non-circuit related signalling the signalling relations are more complex – this is described in more detail in section 8.

7.1.7 Recommendations

In general one network cannot make assumptions about the architecture of the networks to which it is interconnected. Each operator is able to use the most appropriate MTP network architecture for their network and hence a particular MTP Interconnect architecture cannot be specified that is suitable for use between all networks

The most suitable architecture for of MTP level interconnect is dependent on the architecture of the networks involved and must therefore be agreed bilaterally, following the guide lines in this document.

If an STP Interconnect Architecture is used then careful planning and management is required in order to avoid the problems outlined in this section.

The procedures for planning and operating an STP based MTP network interconnect architecture are more complex for interconnected networks than for intra network signalling.

If an STP Interconnect Architecture is used this results in a UK signalling network being implemented. An architecture using only associated signalling does not result in such a signalling network . It must be ensured that problems do not spread through this UK signalling network and affect all interconnected networks.

7.2 MTP Congestion Handling

7.2.1 Introduction to Congestion Procedures

Refer to section 11 of reference /23/.

Congestion procedures for the complete ITU Signalling System No.7 are based on a number of principles and assumptions. These include: -

a) That function A can know that function B is entering congestion, e.g. by examination of the interface (buffer) between the two.

   In particular for MTP this applies to the following function A to B combinations: -

   i) Level 3 outgoing to level 2 outgoing
   ii) Level 2 incoming to level 3 incoming
   iii) Level 3 incoming to level 4 (User part) incoming

b) That function A can detect that it is itself entering congestion.

c) When a function is aware that the subsequent function is congested it should take the appropriate flow control action and continue to process its own inputs normally, although the normal process may be modified by appropriate congestion level indicators. Should it be unable to pass the output to the following function, e.g. its output buffer is full, the output should be discarded.

d) When a function is aware that it is itself congested, it should take the appropriate flow control action and continue to process its own inputs as best it can. It may be that the processing of an input is modified by the function being in congestion e.g. non priority inputs may be discarded.

Peer to peer communication (MTP level 2 to level 2 and level 3 to level 3) is adequately covered by references /22/ and /23/.

7.2.2 How Signalling Link Congestion Occurs and the Impacts

Signalling link congestion occurs when its effective capacity is exceeded. The capacity of any signalling link depends on the lower of the sending or receiving capacity and this might be much lower than the data rate (64 kbit/s) of the bearer path. The effective capacity can be reduced by a hardware problem, such as a higher than usual bit error rate. Note that the layer management embedded within the MTP Level 2 can only see that the effective capacity is exceeded. It cannot easily tell whether the cause is a reduction in the effective capacity or that the level of signalling traffic presented to the signalling link is in excess of what was planned.

If the congestion is a transient effect, that is, it lasts for only a matter of tens of milliseconds, then there is no external impact, because the MTP Level 2 signalling protocols are designed to handle this. However if the effect is persistent or periodic, then it might cause failure of the signalling link. This in turn could cause an overflow of the problem onto other signalling links, eventually resulting in complete loss of service between any two signalling nodes.

For this reason it is important that the mechanisms provided by the signalling protocols of the MTP Level 3 and the MTP Users are used in a way that is effective in minimising signalling congestion and limiting the consequences. For further details see reference /25/ and ‘SCCP reaction to MTP congestion’ (SCCP).

7.2.3 Levels of Congestion

The international signalling network makes use of only one level of congestion, that is a signalling link is either congested or it is not. Reference /5/ makes use of three levels of congestion, thus providing an indication of the severity of the congestion problem. Note that the description of the congestion status of signalling links in reference /23/ includes discard thresholds as well as onset and abatement thresholds, however discard thresholds are not relevant to UK interconnects.

7.2.4 Parameters that Control Congestion

Although reference /23/ describes two methods of measuring the severity of signalling link congestion, a common method is to measure the occupancy of the MTP Level 2 outgoing buffer (TB and RTB). In some implementations, these thresholds are fixed, but other implementations offer the ability to change the settings using the system’s management interface. See reference /24/, particularly the informal description of the signalling link’s attributes in Appendix B, which reads as follows:

> “Transmission (and possibly re-transmission) buffer thresholds exist for the determination of onset of congestion. Multiple thresholds might be defined, to allow different levels of response. A timer, or thresholds, might be used to determine the abatement of congestion. If the method of multiple congestion levels with message priorities is used, then message discard thresholds are also defined. All these thresholds might be human-machine up dateable. Any quantitative limits (and checks that the abatement threshold is sufficiently lower then the corresponding onset threshold to avoid oscillation) would need to be enforced.”

7.2.5 How to Determine the Values

In order that congestion control is effective, it is recommended that the congestion threshold settings are compatible at each end of a signalling link and that the links within a link set should have similar capacity. Even if the implementation at one end of a signalling link has a high-capacity outgoing buffer (TB and RTB), the thresholds might have to be set to relatively low occupancy levels in order to give a better match with a remote implementation, if that has a low-capacity incoming buffer. For example, if implementation A can store 1000 MSUs ready for transmission, but implementation B can accept only 10 MSUs before LSSU SIB is triggered. If A and B are interconnected, then the outgoing congestion thresholds for implementation A should be set in such a way that outgoing congestion is detected with 10 or fewer MSUs in the RTB. If this is not done, then the outgoing buffer at side A will accumulate a lot of MSUs waiting to be sent, therefore there will be a long delay before the MTP Users at side A are informed of the problem of congestion. If the signalling link should fail at this time, then there is the potential for large message loss or the messages will be very much delayed by the time that they are retrieved and re-transmitted. The judgement in reference /23/ is that messages delayed by more than 1 second are ‘old’.

7.2.6 Link Set Capacity

Note that the capacity of a link set is determined by the capacity of the lowest capacity signalling link.

7.2.7 ITU-T Implementors Guide

The ITU-T has issued an Implementers’ Guide (03/99) to reference /22/. This can be found on the home page for Study Group 11 on the ITU’s website. One of the important aspects included in the guide is a correction to the SDL diagram for Basic Transmission Control, whereby reception of LSSU SIB is ignored if the Retransmission Buffer is empty.

7.2.8 Nodal Congestion

Nodal congestion occurs when the effective capacity of the whole node or a major part of the node is exceeded. This could be due to either STP or SEP signalling traffic or a combination of both, if the node is an integrated STP and SEP. In this event reference /23/ allows the use of self-referential TFC as an implementation option.

This means that subject to mutual agreement between the operators concerned, a Transfer Controlled message may be sent from either a signalling end point or a signalling transfer point to indicate congestion of the node itself. In the case of an SEP, the Transfer Controlled message destination field shall contain the point code of the end point. In the case of a STP, the TFC destination field should not contain the point code of the node itself, but one or more of the remote destinations, because the User parts will not have any signalling relations with an STP node. An integrated STP can use either of these methods or both.

7.2.9 SCCP Reaction to MTP Congestion

The SCCP reaction to MTP congestion is a nodal function and is implementation dependent. The procedures of section 2.6.3 of reference /10/ cannot be used, because the importance parameter currently cannot be used and is for further study. However an internal scheme to reduce SCCP traffic towards the affected destination is allowed, because reference /3/ allows the message return procedure to use the reason for return of ‘network congestion’. Such a scheme is recommended and it would have to discard messages at random, unless it used either nodal data or an implicit method to judge the importance of messages. See reference /11/ for guidelines about assigning importance values to application messages, for example.

7.2.10 Fault Handling During Signalling Link Congestion

The fault handling behaviour of signalling points in the event of signalling link congestion is not standardised, nor is it standardised in the event of periodic signalling link test failure. In order to minimise cascade failures of signalling links and hence link sets and route sets, it is recommended that implementations do not put signalling links out of service due to persistent congestion or frequent changes in congestion/abatement or periodic signalling link test failure while congested. This is based on the assumption that signalling link congestion is most likely to be because the level of signalling traffic presented to the signalling link is in excess of what was planned. Note that this recommendation does not overrule signalling failure due to excessive delay to acknowledgement by MTP Level 2 (T7/Q.703 or T6/Q.703), which is standardised.

Note that MTP procedures (reference /23/) do not support re-routing of signalling traffic in the event of signalling network congestion.

7.3 MTP Restart Procedures

7.3.1 Network Options

The MTP Q.704 Red Book allowed a network one of two options when a Signalling Transfer Point (STP) restarted:

1) all routes through the restarted STP are available, hence message traffic is restarted immediately the STP becomes available, with the Transfer Prohibited response mechanism used to correct dynamic data. Or
2) all routes through the STP should be tested using the signalling route set test procedure for each destination that could be accessed through the STP, for each newly available link set. This was defined in section 12.4.2 b) of the Red Book Q.704.

Some UK network operators adopted option 2.

The Q.704 Blue Book signalling point restart procedures were defined to limit the number of messages when a node restarted, Red Book option 1 was adopted with exceptions being signalled during the restart procedure. A restarting STP would broadcast Traffic Restart Allowed (TRA) messages when it could accept STP messages, but, if the STP also had end point capability (i.e. it had MTP users), end-point messages could be sent to it as soon as its connected signalling links became available.

The Blue Book restart procedures did not cater properly for a restarting node providing SCCP Relay and other User Part transit facilities − resumption of such message traffic should wait until its associated MTP signalling routes are available, essentially the same condition as for the STP function.

Thus, reference [5] states that Blue Book signalling point restart procedures shall not be used for UK interconnect.

7.3.2 Q.704 07/96 MTP Restart Procedures

The 07/96 procedures are identical to those published in the 03/93 edition of Q.704.

These procedures rectify the Blue Book problems. In addition, they allow connectivity to be established quickly by aligning links from different link sets in parallel, with the first link of each link set undergoing emergency alignment.

Network implementation dependent decisions on the number of links and link sets that have become available, and on the sufficiency of received routing data, are made by a restarting STP in order to decide when its dynamic data is trustworthy.

In addition, the 07/96 procedures were written to enable interworking with nodes to earlier Recommendations, with the proviso that, if unidirectional message traffic during restart were a problem, other nodes should be updated to include the 07/96 MTP restart procedures.

7.3.3 UK Interconnect Use of MTP Restart

If the MTP restart procedures are provided at a node for the UK interconnect, they should be based on the 07/96 Q.704 section 9 procedures. They should be such as to allow the network to be upgraded gracefully, and hence additionally should allow for the Red Book section 12.4.2 b) national option to be performed on a link set basis.

7.3.4 Interworking Red Book and 07/96 Restart Procedures

The Q.704 section 9 informal explanatory SDL is included here, modified for the UK, and extended for 07/96 nodes interworking with Red Book adjacent nodes. This SDL includes additional compatibility aspects in the 07/96 nodes to make interworking easier, marked with { and }. Red Book nodes are assumed to use the Q.704 Red Book §12.4.2 b) route set test option.

Figures 7.8 through 7.12 contain an MTP User test, as proposed to ITU-T Study Group 11, being performed at the end of MTP restart. This could consist of any User Part message requiring a response being sent to the adjacent node. Each node is assumed to test independently, although a test from just one end using a three message interchange would actively synchronise each end. Such a test allows User Part data to be synchronised with MTP data before User Part traffic is restarted.

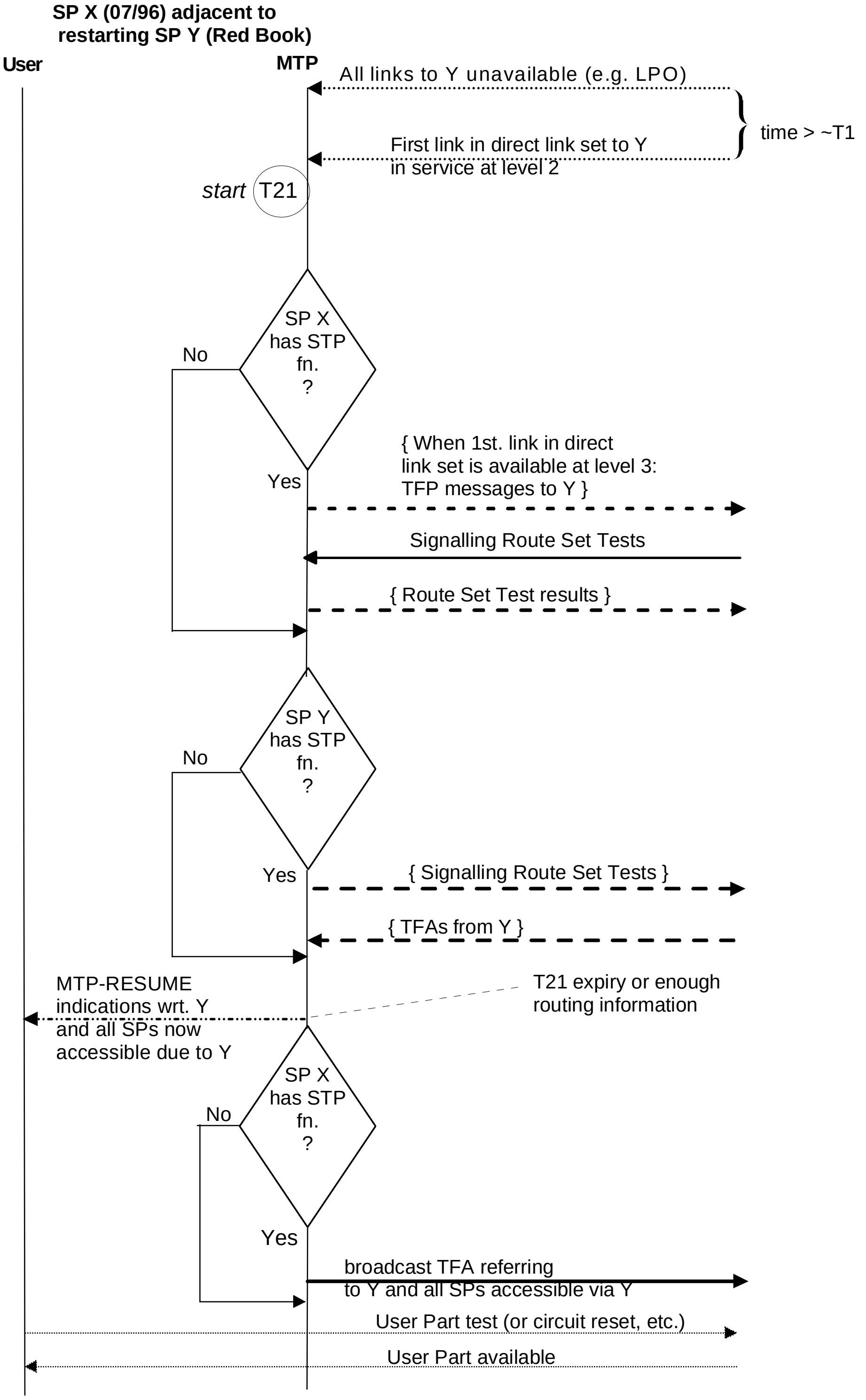


FIGURE 7.8 - **SP X (07/96) adjacent to restarting SP Y (Red Book)**

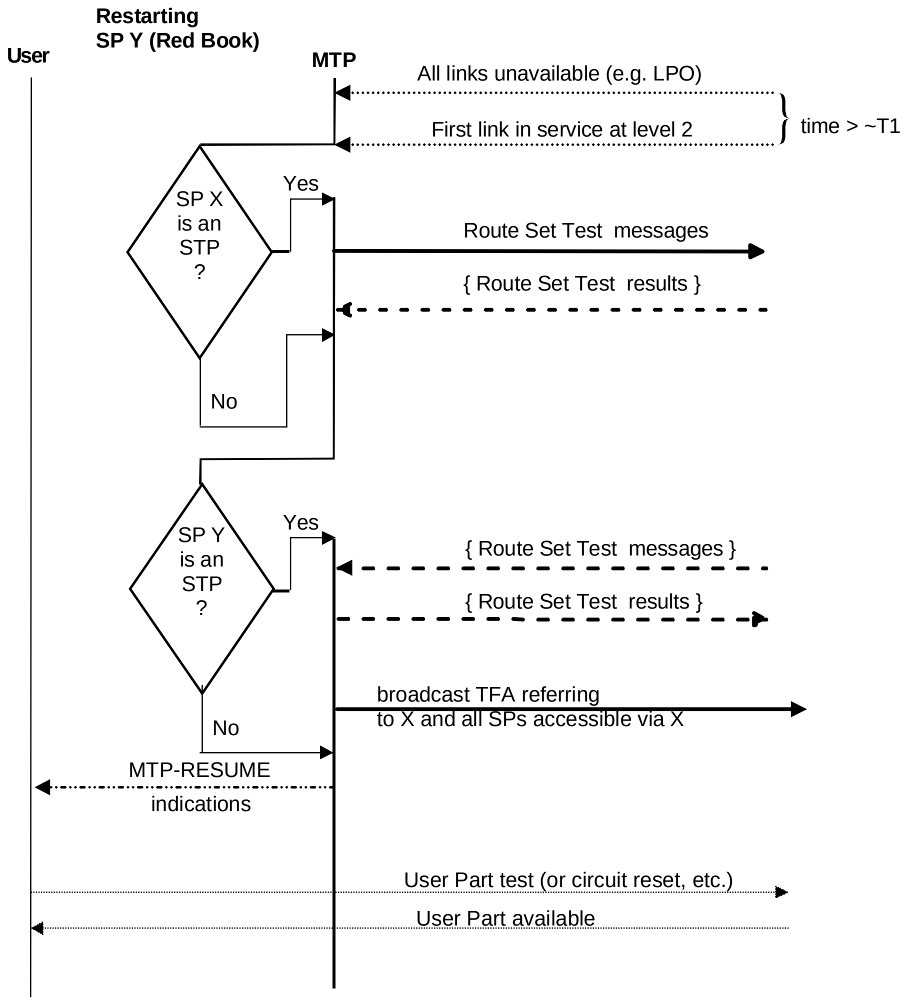


FIGURE 7.9 - **Restarting SP Y (Red Book)**

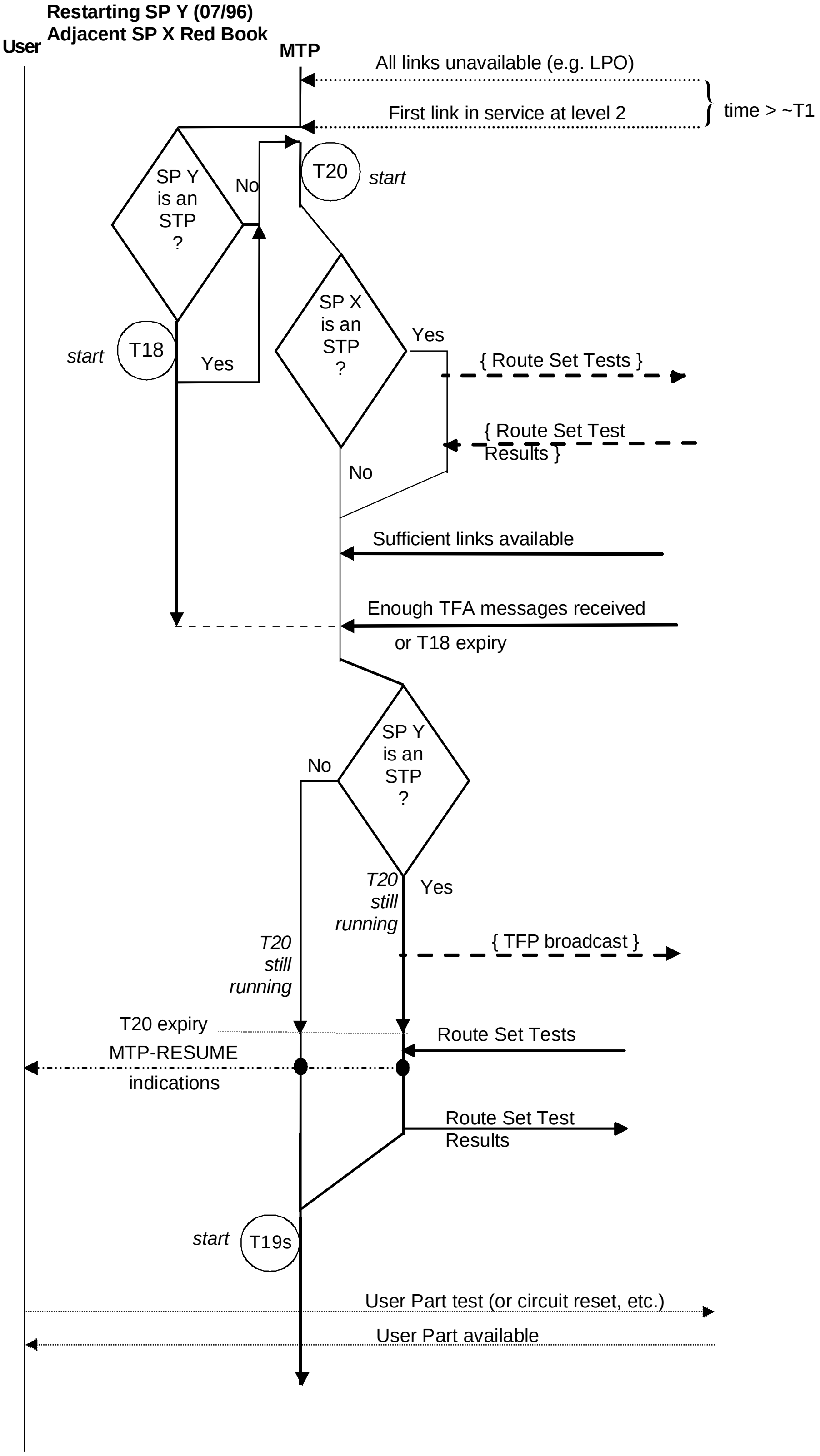


FIGURE 7.10 - **Restarting SP Y (07/96), adjacent SP X Red Book**

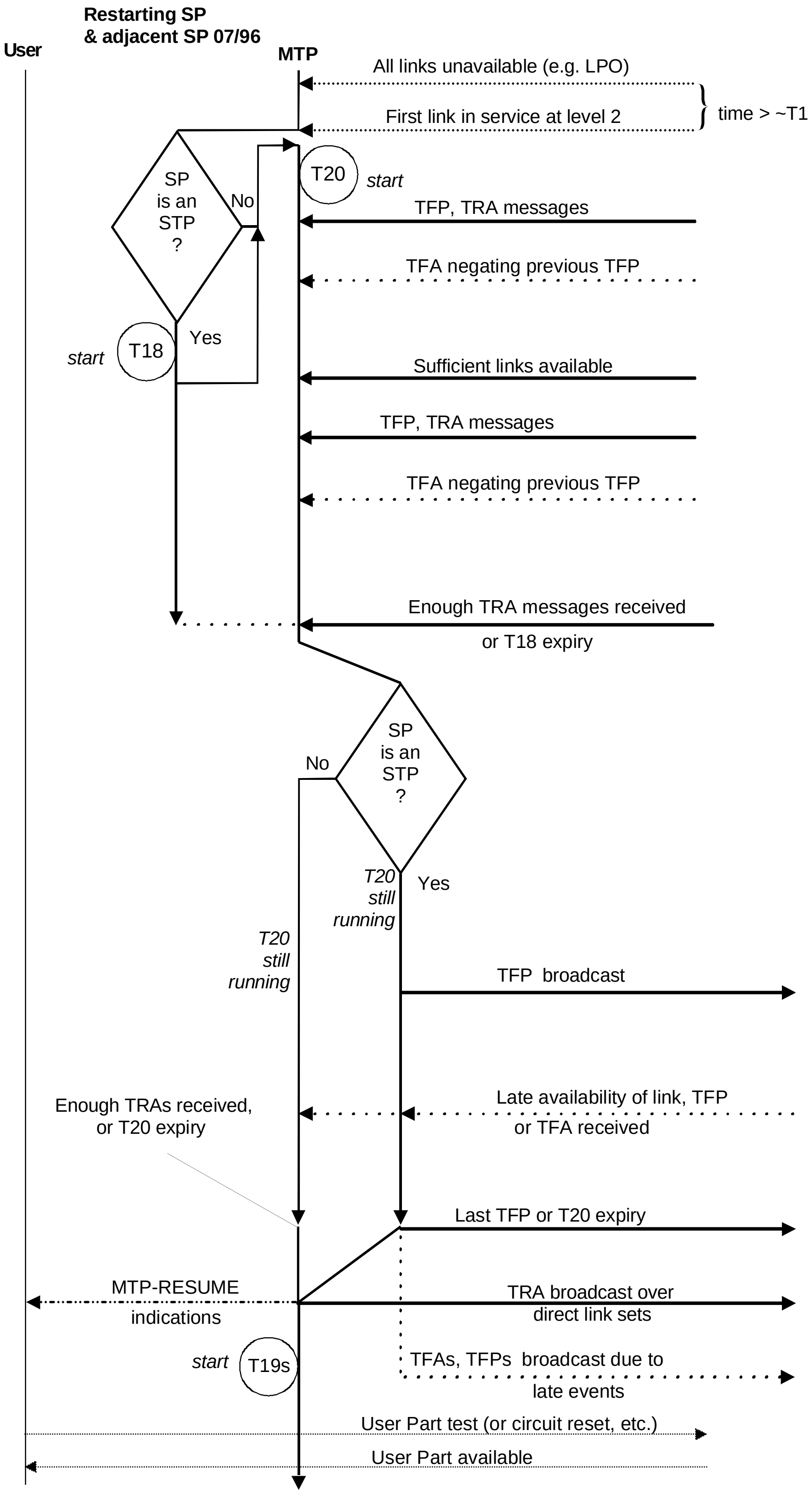


FIGURE 7.11 - **Restarting SP & adjacent SP 07/96**

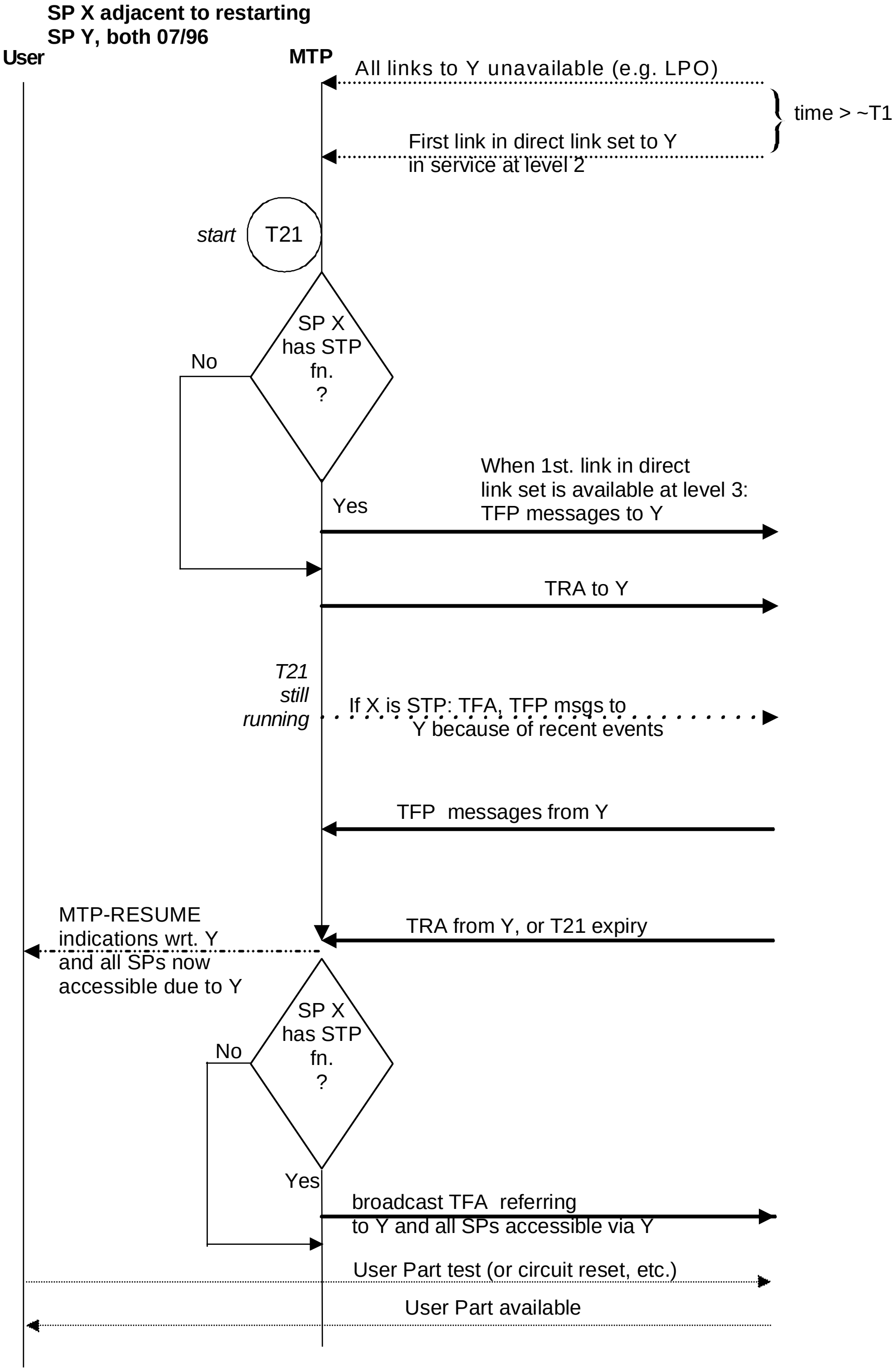


FIGURE 7.12 - **SP X adjacent to restarting SP Y, both 07/96**

7.3.4.1 Signalling End Points (SEPs) Only Involved

7.3.4.1.1 Restarting Node is Red Book, Adjacent Node(s) 07/96 (Figure 7.8)

If the adjacent nodes have no knowledge of their surrounding nodes' capabilities (such discernment is anyway not prescribed in the 07/96 Q.704), they would each start a timer T21 (~1 minute) when their first link to the restarting node goes in service at MTP level 2 (i.e. the link aligns successfully). When its first link passes the signalling link test (and hence goes into service at MTP level 3), a node would also send a TRA (Traffic Restart Allowed) message to the restarting node. The restarting node would probably discard this TRA message.

The adjacent node then waits to receive a TRA message from the restarting node. This will not be received, and T21 will expire, at which point the adjacent node will resume normal message traffic to the restarted node.

The Red Book node will restart end point traffic to its adjacent nodes as soon as it is able (soon after the links have aligned and passed their signalling link test). But message traffic received by the adjacent node from the restarting node will be discarded until T21 expires. **There is therefore unidirectional signalling from the Red Book node, and calls from the Red Book node cannot be started successfully until T21 expires.**

If the adjacent node can discern that the restarting node is Red Book, it will not send a TRA message to it, and not expect to receive one. It might still be advisable for it to wait for a short time after the signalling link has aligned and passed its link test, but not the T21 time, before restarting end point traffic. Alternatively, any procedure to ensure bi-directional User Part signalling could be used (e.g. the User Part test defined for use in User Part Availability Control, or reset circuit, etc.) Each end, including the Red Book node, would have to perform the test separately if bi-directional traffic is required, or possibly a three message sequence could be used in one test which would ensure synchronism.

7.3.4.1.2 Restarting Node is 07/96, Adjacent Node(s) Red Book (Figure 7.10)

Restart begins when the first link in a link set goes into service at MTP level 2. The restarting node tests this first link, starts a timer T20 during which it expects to receive TRA messages, and aligns and tests further links in its link sets. When "sufficient" links and link sets are available, and "sufficient" TRA messages have been received (see §7.3.5), the signalling point stops T20 and broadcasts TRA messages over all direct link sets to all accessible adjacent nodes. During T20, the restarting node discards any traffic messages received.

The Red Book node will restart message traffic soon after the first link aligns and passes the signalling link test. **Hence there will be unidirectional signalling from the Red Book node until T20 expires.**

If however the restarting node understands that it will not receive a TRA message from the Red Book node, the "sufficient" TRA messages received test will not apply to it. It would therefore be possible to reduce the time during which unidirectional message traffic could occur, depending upon the relative numbers of Red Book and 07/96 adjacent nodes.

7.3.4.2 STP Involvement in Restart

7.3.4.2.1 Red Book STP (with Red Book Q.704 §12.4.2 b)) Restarts, Adjacent Nodes are 07/96

See figure 7.8. When the first link in a link set from an adjacent node goes into service at MTP level 2, restart begins.

The adjacent nodes start timer T21, if they do not discern that the node is Red Book, and the nodes among them with the STP function also send out TFP and possibly TFA messages to the Red Book node, once their first direct link to it goes into service at MTP level 3. The TFAs are sent if signalling points declared unavailable earlier during the restart procedure become available during it. Each adjacent node also sends a TRA message (after any TFP and TFA messages). The adjacent nodes then expect to receive a TRA message from the Red Book STP, possibly preceded by TFP and some TFA messages.

If an adjacent node does not receive the TRA message, T21 expires and the node assumes the STP is available for routing.

The Red Book node's endpoint function (if it has one) could restart message traffic to adjacent nodes immediately, but this would be discarded by 07/96 adjacent nodes during T21. All messages received from the Red Book STP during its presumed restart (other than link test, TFP and TFA messages) would be discarded, including any route set test messages it might itself send to build its dynamic routing data.

Message traffic from the Red Book node using its adjacent node as an STP could not be started until T21 expired, since there would have been no response to the Red Book node's route set test messages.

If the adjacent nodes do discern that the restarting STP is Red Book with Red Book Q.704 section 12.4.2 b) capability, they need not start T21, and would not send TFPs followed by a TRA to it. They should respond to the Red Book node's route set test messages, if they have the STP function, with TFA if the tested route is available through them. In addition, they should perform route set tests themselves, immediately their direct link set to the Red Book node becomes available at MTP level 3. Thus there need be no significant unidirectional traffic period.

7.3.4.2.2 07/96 STP Restarts, Adjacent Node(s) Red Book with §12.4.2 b) (Figure 7.10)

The STP starts the overall restart timer T20, and timer T18 whose length is implementation dependent, when the first link in any link set aligns and proves successfully. During T18 the STP expects to receive any TFPs and TFAs from each adjacent STP, followed by a TRA from each adjacent signalling point. The STP decides when it has had sufficient TRA messages, and when the number of links and link sets now in service at MTP level 3 are sufficient to carry its message traffic. This decision is dependent upon the network and the number and types of nodes surrounding the STP. T18 is then stopped. The STP then broadcasts any necessary TFPs, including preventive TFPs, followed by a TRA message to each adjacent directly accessible point. T20 is then stopped.

The Red Book nodes with §12.4.2 b) capability would start route set tests to the STP when their direct link sets became available. The STP would ignore such messages until its T20 were stopped. The Red Book nodes would ignore TRA messages from the STP.

Thus no STP traffic would be sent until the 07/96 STP had restarted, either from the STP or to it. Hence there need be no unidirectional STP traffic.

If the 07/96 STP knew that an adjacent node were Red Book with §12.4.2 b) capability, it would not expect TRA messages from it, and would not send them to it. It might still send out TFP messages after T18, but T18 might be shortened, depending upon the relative numbers of Red Book and 07/96 nodes around it. Figure 7.10 shows that the restarting node might usefully perform signalling route set tests to an adjacent red Book STP, during timer T18. This would enable its routing tables to be updated at the same stage in its restart as if the adjacent STP were an 07/96 version.

7.3.5 Timer Values and Parameter Settings

Timers T18, T20 and T19 are used at a node whose MTP restarts. T18 is used only for STP MTP restart, and is to guard link and link set activation and for receipt of dynamic routing information. T20 is the overall restart guard timer at an end point and at an STP. T19 is to avoid oscillation of restarts.

Timers T21 and T19 are pertinent for a node adjacent to one whose MTP restarts. T21 is the overall guard timer at the adjacent node.

The timer values are dependent on the volume of dynamic routing information to exchange in the form of single TFP and TFA messages, suggested values are:

T18	Timer[1] within a signalling transfer point whose MTP restarts for supervising link and link set activation as well as the receipt of routing information. The value is implementation and network dependent. Criteria to choose T18 are given in section 9.2 of Q.704 (07/96). U.K value 45 to 57 seconds. This should be long enough at a restarting STP to receive enough dynamic routing information from its surrounding STPs.
T19	Supervision timer during MTP restart to avoid possible ping-pong of TFP and TRA messages. UK value 67 to 69 seconds. This timer should not be shortened.
T20	Overall MTP restart timer at the signalling point whose MTP restarts. UK value 59 to 61 seconds. This must be longer than T18.
T21	Overall MTP restart timer at a signalling point adjacent to one whose MTP restarts. U.K value 63 to 65 seconds. This should be longer than the largest of its adjacent signalling points' T20 values.

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[1] The values of the MTP restart timers (T18 to T21) defined above are for use during normal operation. It might be advantageous for the network operator to define an alternative value for each timer, for use in potential network failures. Such an emergency might be recognised by an abnormally large number of outages, and it would be at the discretion of the operator to use the emergency set of timer values within the network.

Note that the value of timers T20 and T21 might be shortened for 07/96 nodes in networks with significant proportions of nodes to earlier specifications. However, the effect of this needs to be considered carefully with respect to the network configuration and the tasks that are performed during restart. Enough time needs to be given to the restarting node to build its dynamic routing data in the MTP, and to synchronise this with its MTP Users. Enough time needs to be given to STPs adjacent to the restarting node to send routing data to it. The requirement to minimise the time during which unidirectional signalling might occur must be weighed with the need to ensure that the routing data (of both the MTP and MTP Users) in the restarting node is stable.

The parameters that need to be set for a restarting node are dependent upon the network, in particular the number and type of adjacent nodes. The parameters are :

for the number of activated links and link sets deemed sufficient to carry the message traffic, and

for the number of adjacent STPs deemed to be sufficient that respond with dynamic routing information (indicated by the number of TRA messages received). Note that an 07/96 SEP adjacent to a restarting node also sends a TRA message when it can accept end point traffic.

7.4 MTP Policing

Reference Q.704, §2, §3 and §15

It is recommended that interconnecting nodes have a message policing function to prevent non-agreed messages being sent to/from the interface. Requirements for any such MTP policing function will be documented by the Network Operator concerned.

Refer also to /15/, ITU-T Implementers Guide (9/97) for Q.705 (1993) which removed the OLS/DPC screening option.

7.5 Signalling Network Management Correlation

Reference Q.704, §3

In order to facilitate correlation of associated signalling network management indications from the same point code, it is recommended that the Level 3 function waits for a nominal period (in the order of 150ms from the first indication received at level 3 management) before initiating changeover or re-routing etc.

8 Guide To SCCP Network Interconnection

This section examines the architectural options for SCCP Non Circuit Related (NCR) signalling interconnect between networks in the UK. The various options are explained with advantages and disadvantages given for each. Guidelines are provided on what should be taken into account in deciding which option is most suitable for a particular network interconnect.

Although the initial need for interconnect is to support ISDN CCBS this guide also considers other uses of SCCP interconnect. In addition the carrying of transit NCR signalling is covered. It is expected in the future that support to some form of INAP interconnect will be required and this is also taken into account. The SCCP protocols to be used are defined in PNO-ISC SPEC 003 with the addressing and routing to be used detailed in this document.

8.1 Background Information

Several important factors have to be taken into account when studying the options for NCR signalling interconnect.

1. SCCP messages are much longer than IUP and ISUP messages, typically the latters' average message lengths is less than 20 and 35 octets respectively whilst the average SCCP message is over 100 octets. These long messages consume more processing power, significantly increase signalling link occupancy and delay short (e.g. IUP) messages.

2. SCCP message levels are not constrained in the way IUP & ISUP message level is constrained by the number of speech circuits available. There is therefore no straightforward way of limiting the amount of SCCP messages which are generated.

3. SCCP enables signalling messages to cross network boundaries - this is one of its main purposes. The initial origination and final destination points of SCCP messages do not have to be, and in some cases may never be, the points of interconnection between networks. See figure 7.8.

4. The complexity of SCCP routing data can be significantly increased if the "wrong" addressing scheme and/or interconnect options are used.

5. Some form of screening (also known as policing) of NCR messages will be required in order to protect network integrity and resilience.
6. Some form of accounting for NCR messages will be required.
7. Sufficient capacity and resilience with acceptable message delays and cost is required.
8. Existing IUP and future ISUP interconnect must not be adversely affected by SCCP interconnect - UK network integrity is paramount.

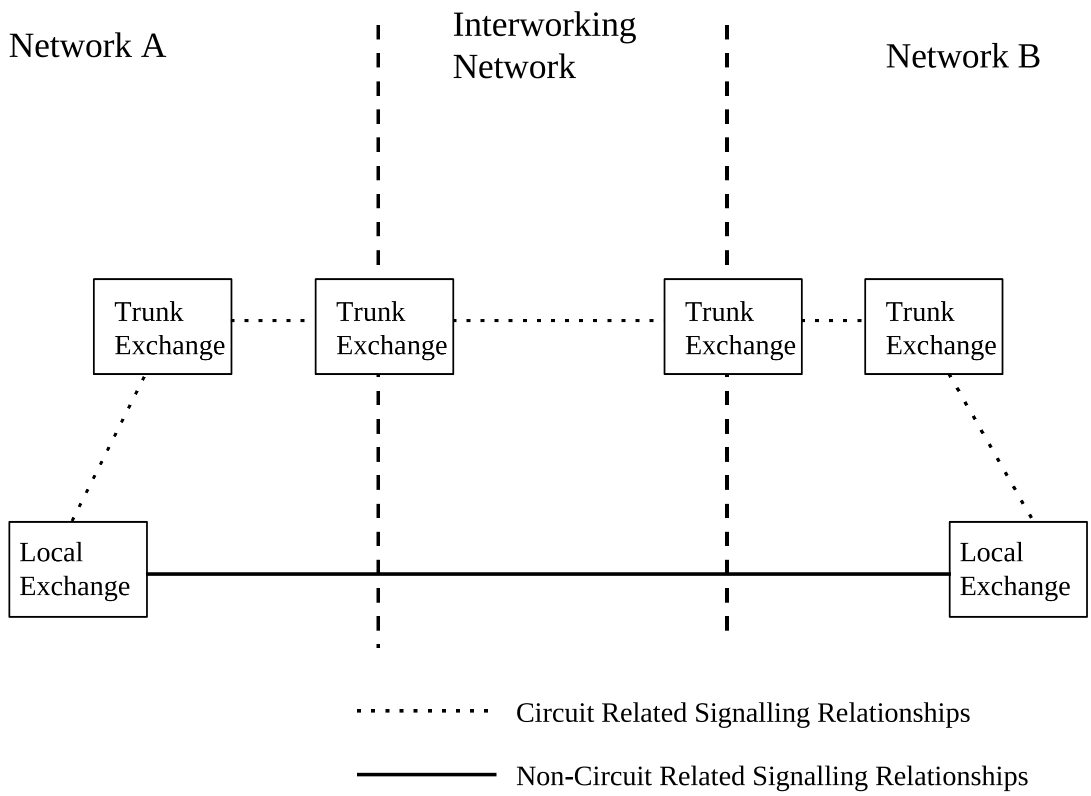

Figure 8.1 - **Example Signalling Relationships For ISDN CCBS (NOT** physical realisation)

8.2 Options Available

Options for the NCR interconnect are available at SCCP level, MTP level and physical level.

- The SCCP level interconnect is the logical NCR interconnect i.e. the boundary or gateway points between networks at which the last/first processing of the message at SCCP level takes place in the network. This is the SCCP Point Of Interconnect (SPOI).
- The MTP level interconnect is the signalling network interconnect i.e. the boundary or gateway points between networks at which the last/first processing of the message at MTP level takes place in the network . These MTP Points Of Interconnect (MPOI) may or may not be the same as the SPOIs.
- For the purposes of this document the physical level interconnect is assumed to be the point at which a 64k timeslot carrying SS No.7 signalling in a 2M PCM system is terminated. This Physical Point Of Interconnect (PPOI) may be the same as the MPOI, if not some form of digital cross-connect will route the signalling on to the MPOI.

These 3 points of interconnect could be located at 1, 2 or 3 places. There are options for each POI which are examined in detail below.

8.2.1 Options At SCCP Level

At the SCCP level the options are basically to have SCCP relations at many points of interconnect e.g. between any exchanges which have IUP interconnect, or to limit the number of points of interconnect. These limited SCCP points of interconnect could be dedicated SCCP nodes or nodes supporting IUP interconnect. The SCCP points of interconnect must be allocated point codes from the interworking range.

Discussions that have taken place within the MTP/SCCP working party of PNO-ISC indicate that the number of points of interconnect at the SCCP level should be kept to a minimum. This is driven particularly by points 5, 6 and 8 in section 8.1 above.

Advantages and disadvantages of the 2 SCCP options are shown in Table 8.1.

Table 8.1 – **Interconnect Options at SCCP Level**

INTER-CONNECT	**ADVANTAGES**	**DISADVANTAGES**
ANYWHERE	1. MTP interconnect may already exist. 2. Capacity required may possibly be distributed around more points. 3. Very efficient if end points for SCCP are the same as the end points for IUP.	1. The Policing, Screening and Accounting required at many points is complex to manage and uses up processing power at every point. 2. Unconstrained SCCP load at interconnect points may cause overloads and affect existing interconnect services. 3. Cost of SCCP processing and possibly extra links at every point of interconnect. 4. Greater management overhead e.g routing data at more places. 5. May introduce additional delays. Depending on NCR architecture of the network the POI may be several “hops” from the final destination.
LIMITED	1. The Policing, Screening and Accounting required at fewer points is easier. 2. Limited number of points to protect from SCCP overload. 3. Less management overhead e.g. fewer data tables. 4. Should minimise delays - depends on NCR architecture of the network	1. MTP interconnect may not currently exist. 2. Large capacity needed at SCCP POI.

8.2.2 Options at MTP Level

At the MTP level the options are to have either direct signalling links between the SCCP interconnect points or to use Signalling Transfer Points. Direct signalling links could be for SCCP traffic only. If the STP function is to be used then it may be possible to use existing IUP points of interconnect - this would depend for example on whether they support the STP function and have sufficient capacity available. The MTP points of interconnect must be allocated point codes from the interworking range.

It must be recognised that STP working is not currently in general use in the interworking network and significant work would be required in order to assess any problems which its use might incur.

Table 8.2 – **Interconnect Options at MTP Level**

INTER-CONNECT	ADVANTAGES	DISADVANTAGES
DIRECT	1. More robust network than using STPs 2. Minimises delays for SCCP messages and avoids SCCP traffic affecting other traffic. 3. Complicated STP policing not required	1. MTP interconnect may not currently exist 2. Larger number of signalling links required at SCCP interconnect point
STP	1. May be able to use existing MTP interconnects 2. Smaller number of signalling links required at SCCP interconnect point	1. Policing, Screening, Accounting at many points is complex. 2. Unconstrained SCCP load at interconnect points may cause overloads and affect existing interconnect services 3. Cost of STP processing at every point of interconnect 4. STP will introduce additional delays. Messages from other networks would have bigger delays than own network messages. 5. Additional links required from the STP to the SCCP POI.

8.2.3 Options At The Physical Level

At the physical level the options are either to provide new 2M systems to the MTP point of interconnect or to use timeslots in 2M systems to existing MTP points of interconnect. In the case where the existing MTP point of interconnect is not the same as the MTP point of interconnect required for NCR there would have to be some form of digital cross connect.

Table 8.3 – **Interconnect Options at the Physical Layer**

INTER-CONNECT	ADVANTAGES	DISADVANTAGES
NEW 2M	1. More robust. 2. Minimises delays 3. Easy to plan	1. Additional 2M systems needed 2. Inefficient in 2M use
EXISTING TS	1. Existing 2M to existing MTP POI 2. Possibly more efficient use of 2M systems	1. Less robust 2. Reduces timeslots available for speech 3. More difficult to plan 4. May need extra 2M systems from existing MTP POI to those needed for NCR interconnect.

8.3 Assessment Of Options

8.3.1 SCCP Points Of Interconnect

From an SCCP point of view the option of proving SPOIs anywhere does not offer significant advantages over limiting the number of SPOIs. Appropriate MTP interconnect may already exist but the capacity of this may have to be increased. SCCP processing capacity may have to be increased at many SPOIs and additional link capacity may be required to send messages on from these. A performance advantage would be gained if the SPOI was also the destination of the message, in a large network this is unlikely.

Keeping the SPOIs to a minimum reduces the costs of initial set up and subsequent management of the associated data. Constraining the number of SPOIs will help to ensure network resilience.

8.3.2 MTP Points Of Interconnect

Using direct MTP routes to the SPOI i.e. the SPOI and MPOI are the same, provides a more reliable and simple to plan and manage interconnect. Using these links just for SCCP traffic limits the affect on other traffic. Additional signalling links will be required over and above those needed for existing IUP interconnect. However it should be noted that these extra links may be needed anyway to cope with the additional signalling capacity required to support SCCP.

Using STPs has implications for existing link loadings and STP processing capacity. In addition signalling link capacity will be needed from the MPOI to the SPOI. The total cost of signalling links plus processing capacity may be more than the cost of direct signalling links.

8.3.3 Physical Points Of Interconnect

Use of existing 2M systems and cross connects appears to be more cost effective than providing new systems. The penalty is more complex planning and data management and lower reliability. Where large numbers of signalling links are involved then additional 2M systems may be more cost effective.

9 Considerations In Choosing An SCCP Architecture Option

In deciding between the various options many areas have to be taken into account. These are described in more detail below.

9.1 Network Integrity

Due to

- the significantly greater length of NCR messages compared with CR messages
- the fact that there is no constraint on the amount of NCR messages which can be generated
- the increased addressing capability of NCR signalling

there is more concern over network integrity with NCR interconnect than with CR interconnect. These concerns must be taken into account in discussing particular network interconnects and will include:-

1. agreement to the amount and mix of message traffic to be supported
2. agreement to the addressing information which is valid

Network operators may wish to implement screening functions in order to preserve the integrity of their network.

9.2 Reliability of Interconnect

The NCR interconnect between networks should offer sufficient reliability to meet the requirements of the services to be supported by the interconnect. Signalling link sets should contain at least 2 signalling links which are physically separated in order to minimise the probability of simultaneous failure of all links. If an STP is used there should be an alternative STP in case of unavailability of the 1st choice STP. For example if on failure of a telephony/ISDN route an alternative route is available then the NCR interconnect should allow for NCR signalling to support services on this alternative route. Depending on the NCR interconnect architecture chosen failures of NCR signalling may or may not be independent of failures in the telephony/ISDN routes.

9.3 Capacity and Performance Requirements

In order to establish the capacity required for the NCR interconnect information is needed on the

1. message sequences and service types to be supported
2. the lengths of messages in the supported sequences
3. the frequency of each message sequence (including peaks and averages)
4. which signalling points in the networks require interconnection

This information can then be used in the following areas.

9.3.1 Signalling Link Capacity

The required signalling link capacity will take into account the link occupancy which should be used (peak and average) and will be influenced by whether the NCR signalling is to be carried

- on the same links as CR signalling
- on separate links to the CR signalling

In the 1st case the traffic patterns for the CR signalling are required. The relative importance and value of the CR and NCR signalling must take into account current and future trends in traffic. Since NCR messages are significantly longer than CR messages and their rate of generation is not restricted by availability of speech circuits the NCR traffic could swamp the CR signalling.

If sharing of signalling links with CR signalling requires the provision of additional link capacity then it may be preferable and less complex to provide separate NCR and CR links.

If separate NCR and CR links are used then they should terminate at the most appropriate nodes (identified by different point codes) e.g. the interconnected exchanges for CR and signalling nodes for NCR.

9.3.2 Processor Capacity

Factors similar to those for link capacity can be taken into account to establish the processing capacity required for NCR signalling at the interconnect points. Processor capacity issue may dictate that current CR interconnect points are not suitable as NCR interconnect points. The overheads of SCCP GT translation and any screening which is carried out must be taken into account.

9.3.3 Signalling Delays

The signalling delays must be appropriate for the services being supported - information on delays is contained in Q.709 and various E.series recommendations. For example the delay encountered by a GSM Short Message Service message is not as critical as that encountered by a call setup message.

9.4 Capital costs

9.4.1 Signalling Links

Although it is desirable to minimise capital costs, in the longer term a higher initial capital cost may enable smaller current account costs to be achieved and give an overall cost reduction.

9.4.2 Processor Capacity

Although it is desirable to minimise capital costs, in the longer term a higher initial capital cost may enable smaller current account costs to be achieved and give an overall cost reduction.

9.4.3 Transmission Capacity

Although it is desirable to minimise capital costs, in the longer term a higher initial capital cost may enable smaller current account costs to be achieved and give an overall cost reduction.

9.4.4 Routing Data Capacity

The choice of addressing schemes has a large impact on the amount of SCCP routing data required, large amounts of data result in high operational costs. For example the use of E.164 addresses for CCBS will require each network to support up to 10 000 global title translation entries in order to identify the 1 to 2 000 exchanges in the UK; this is without taking into account support of the 5xxxxx codes used for number portability.

9.5 Current Account Costs

9.5.1 Signalling Link Capacity Management

Appropriate processes are needed to monitor link capacity usage and compare this with what is expected, keeping the interconnect less complex will help to minimise the cost of this. Measurements which may be helpful in this area are given in /28/.

9.5.2 Processor Capacity Management

Appropriate processes are needed to monitor processor capacity usage, keeping the interconnect less complex will help to minimise the cost of this. Measurements which may be helpful in this area are given in /28/.

9.5.3 Transmission Capacity Management

Procedures should take into account capacity required for signalling and ensure that the required physical separation between links in a link set is maintained.

9.5.4 Routing Data Management

It may be appropriate for some operators to use other operators to transit NCR signalling to other networks and thus reduce the amount of data they have to provide and manage. Transit networks would need the ability to charge for this service, measurements which may be helpful in this area are given in /28/.

9.6 Recommendation

It is not possible to recommend one particular option to cover all interconnects. The most appropriate option for a particular network is dependent on many different factors but the main influences are the size of the networks and their architecture together with the type and volume of NCR traffic to be carried.

- Medium to large networks may have an architecture which includes elements dedicated to carrying SS No.7 signalling thus giving a distinct signalling network. For such networks the option of inter-connecting Non-Circuit Related signalling into their signalling networks at a limited number of points offers many advantages for both interconnect parties.

- Small to medium networks may not have a distinct signalling network and the option of inter-connecting Non-Circuit Related signalling at all (or most) points in these networks has benefits.

The choice of options is therefore dependent on the networks involved. The options to be used should be determined by the interconnecting network operators who should be free to use the optimum number of points of interconnect for their network. The information in this document can be used to help this choice of options.

10 Interworking Issues

10.1 Interworking Issues Between UK and ETSI MTP

The following interworking issues apply between reference /5/ and reference /26/:

10.1.1 Preventive Cyclic Retransmission

Reference /5/ excludes PCR, whereas reference /23/ does not. Interworking is not possible between the basic error correction method and PCR, but this is not a problem because there is no current requirement for satellite signalling bearers between UK national operators.

10.1.2 MTP Restart

Reference /5/ allows either the Red Book national option of §12.4.2.b) of CCITT Q.704 or the standard procedure of reference /23/, whereas reference /26/ allows only the latter. Further information about the interworking aspects of this procedure is given in section 7.3.

10.2 SCCP Interworking Issues

The Red Book and Blue Book connectionless SCCP message types (UDT and UDTS) made no provision for optional parameters and so could not be extended to cater for the requirements of segmentation of application data. The ITU-T was obliged to specify two new message types (XUDT and XUDTS) with optional parameters. In addition to the optional segmentation parameters, the XUDT and XUDTS may also carry a hop counter or a message importance parameter or both.

These message types will not be recognised by relay nodes or terminating nodes implemented according to the SCCP Red Book or Blue Book version, hence an interworking problem will arise if segmentation, hop counter or message importance parameters need to be used. Given that a co-ordinated upgrade of every UK signalling network cannot be expected, then any solution would have to be based on nodal data that records the capabilities of remote SCCP nodes. This is in order that XUDT, XUDTS and their parameters may be prevented from reaching SCCP nodes that will not process them correctly.

However no compelling service requirement has currently been identified for segmentation, hop counter or message importance parameters to be used.

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