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NICC Document

UK Interconnect: Use of Signalling for Packet-Based PSTN/ISDN

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Contents

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Foreword

This NICC Document (ND) has been produced by NICC AP/TP Working Party

Introduction

This document provides information supplemental to that specified in ND1012 [2] for interconnect use of IP.The information is structured according to whether it concerns signalling applications, signalling transport or is general to both.

The information is intended for use by designers of signalling applications that require use of signalling transport protocols, as well as for use by network operators needing to engineer signalling transport networks and to configure signalling applications for UK national network interconnect.

This document will be revised as necessary and in accordance with the NICC workplan to include information appropriate to enhancements to the relevant signalling protocols.

1 Scope

The purpose of ND1119 is to give information about the signalling application and signalling transport protocols specified in ND1012 [2]. These signalling protocols are standardised for use across a UK national interconnect between Public Networks, in order to support packet-based PSTN/ISDN services.

This document was originally written to support the use of SCTP to carry BICC. The UK specification for BICC was completed, but it was agreed in NICC that this would not be published. Hence any references to BICC in this version of ND1119 **should** be disregarded.

2 References

For the particular version of a document applicable to this release see ND1610 [1].

2.1 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ND1610 “Multi-Service Interconnect of UK Next Generation Networks”

[2] ND1012 “Interconnect Stream Control Transmission Protocol (SCTP) and Adaptation Layers for UK Interconnect”

2.2 Informative references

[i.1] RFC 4346 “The TLS Protocol Version 1.1”

[i.2] RFC 4301 “Security Architecture for the Internet Protocol”

[i.3] RFC 3554 “On the use of Stream Control Transmission Protocol (SCTP) with IPsec”

[i.4] RFC 3436 “TLS over SCTP”

[i.5] ND1005 “C7 Interconnect Message Transfer Part (MTP)”

[i.6] ND1107 “UK Interconnect use of SCCP and MTP”

[i.7] RFC 2960 “Stream Control Transmission Protocol”

[i.8] RFC 3788 “Security Considerations for Signaling Transport (SIGTRAN) Protocols”

[i.9] RFC 3332 “Signalling System 7 (SS7) Message Transfer Part 3 (MTP3)-User Adaptation Layer (M3UA)”

[i.10] RFC 4165 “SS7 Message Transfer Part 2 (MTP2) - User Peer-to-Peer Adaptation Layer (M2PA)”

[i.11] ETSI Directives

[i.12] RFC 4168 “The Stream Control Transmission Protocol (SCTP) as a Transport for the Session Initiation Protocol (SIP)“

[i.13] ETSI TS 102 144 “Services and Protocols for Advanced Networks (SPAN); MTP/SCCP/SSCOP and SIGTRAN; SCTP [Endorsement of RFC 2960 and RFC 3309 , modified]”

[i.14] ND1613 “Management of NGN Interconnect Transport Service Layer”

[i.15] ND1610 “Multi-Service Interconnect of UK Next Generation Networks Purple Release”

[i.16] ND1610 “Multi-Service Interconnect of UK Next Generation Networks Green Release”

[i.17] ND1612 “Generic IP Connectivity for PSTN/ISDN Services between Next Generation Networks”

[i.18] ND1620 “NGN; Voice Line Control Service; Interconnect Architecture”

3 Definitions and Abbreviations

3.1 Definitions

The key words "**shall**", "**shall not**", "**must**", "**must not**", "**should**", "**should not**", "**may**", "**need not**", "**can**" and "**cannot**" in this document are to be interpreted as defined in the ETSI Directives [i.11].

3.2 Abbreviations

3GPP	3^{rd} Generation Partnership Project
A/V	Audio/Visual
ASP	Application Server Process
ATM	Asynchronous Transfer Mode
BICC	Bearer Independent Call Control
B-ISUP	Broadband - ISDN User Part
CP	Communications Provider
DNS	Domain Name Service
DSCP	Differentiated Service Code Point
DTMF	Dual Tone Multi-Frequency
ETSI	European Telecommunication Standards Institute
IETF	Internet Engineering Task Force
IP	Internet Protocol
ISC	Interconnect Standards Committee (replaced by NICC)
ISDN	Integrated Services Digital Network
IPSP	IP Server Process
ISUP	ISDN User Part of C7 signalling
ITU-T	International Telecommunication Union - Telecoms
IUP	Interconnect User Part
kbps	Kilobits per second
M2PA	MTP 2 Peer-to-peer Adaptation layer
M3UA	MTP 3 User Adaptation layer
MF4	Multi-Frequency signalling No. 4
ms	milliseconds
MSI	Multi-Service Interconnect
MTP L1	Message Transfer Part Level 1
MTP L2	Message Transfer Part Level 2
MTP L3	Message Transfer Part Level 3
NAT	Network Address Translation
NGN	Next Generation Network
NICC	Network Interoperability Consultative Committee
NNI	Network to Network Interface
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PNO	Public Network Operators (replaced by NICC)
PNO-ISC	Public Network Operators' – Interconnect Standards Committee (replaced by NICC)
PSTN	Public Switched Telephone Network
RFC	Request for Comments
RTCP	Real Time Control Protocol
RTD	Round Trip Delay
RTO	Retransmission TimeOut
RTP	Real Time Protocol
RTT	Round Trip Time
SBC	Session Border Controller
SCCP	Signalling Connection Control Part (of SS7)
SCTP	Stream Control Transmission Protocol
SDP	Session Description Protocol
SEP	Signalling End Point
SG or SGW	Signalling GateWay

SGP	Signalling Gateway Process
SIP	Session Initiation Protocol
SIP-I	Session Initiation Protocol with encapsulated ISUP
SMP	Significant Market Power
SPR	Signalling Point with Relay functionality
SS7	Signalling System number 7
SSCOP	Service Specific Connection Oriented Protocol
STP	Signalling Transfer Point
SUA	SCCP User Adaptation layer
TC	Transaction Capabilities
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TFC	TransFer Controlled (MTP Network Management message type)
TI-SCCP	Transport Independent SCCP
TLS	Transport Layer Security
TP	Transport Protocol
TSG	Technical Steering Group
UDP	User Datagram Protocol
UK	United Kingdom of Great Britain and Northern Ireland
UNI	User Network Interface
URI	Uniform Resource Indicator
VBD	Voice Band Data
VCI	Virtual Circuit Identity
VLC	Voice Line Control
WP	Working Party

Not all abbreviations will be used in this document.

4 GENERAL

This section gives general information about Signalling Networks for packet-based PSTN/ISDN services.

For historical reasons this section only containes SIGTRAN Network architectures. For SIP application architectures NICC has specified an interconnect architecture for IP-based networks interconnecting using IP-based signalling transport in its NGN Release documentation (see ND1610 [i.15] and [i.16]).

4.1 Guidelines on Interconnect Network Architectures

NOTE: The term 'packet-based' does not exclusively mean IP technologies, however this section covers only IP technologies.

In general there will be two types of network using IP technology:

- hybrid networks of TDM and IP, having evolved from TDM-only networks
- IP-only, being new entrants to the market

A pair of IP-only networks might wish to use an IP-based signalling transport interconnect to avoid the addition of any TDM technology, although if this isn't possible (for whatever reason), then there remains the last resort of implementing a SS7 TDM interconnect.

A pair of hybrid networks might wish to use an IP-based signalling transport interconnect to overcome, for example, bandwidth limitations or to avoid SS7 over TDM (conversion).

An interconnect between an otherwise IP-only and a hybrid network might use either TDM or IP-based signalling transport interconnects, depending on what is mutually possible. Or there might even be regulatory pressure on SMP hybrid networks to provide a signalling transport gateway as a service to IP-based start-ups.

The diagrams that follow show the logical topology of the signalling transport networks. The topology and construction of the underlying physical, IP or transmission networks are not described and are outside the scope of this document.

4.1.1 SIGTRAN Network architectures supported by UK Interconnect standards

The configurations supported by the current UK interconnect standards are:

- M3UA client-server model, exemplified in section 4.1.2

The NICC may study the following when the relevant IETF documents are stable and as required by NICC:

- M3UA peer-to-peer model, exemplified in section 4.1.3
- Standardisation of M2PA for UK national interconnects. See section 4.1.4
- Standardisation of M3UA extensions for SG to SG for UK national interconnects. See section 4.1.4

4.1.2 Quasi-associated (STP or SGW) signalling –STP one side

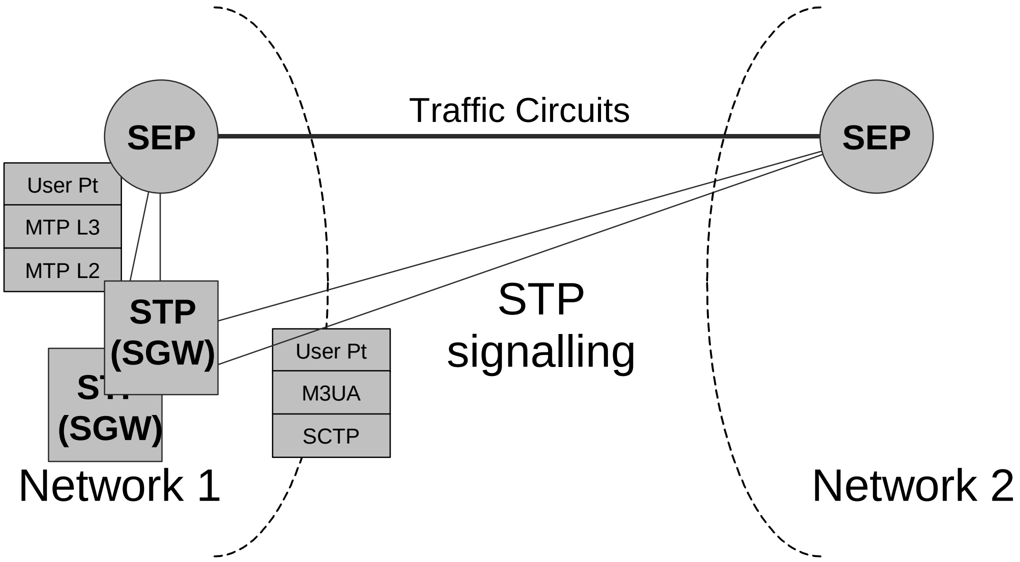

Figure 4-1 – Quasi-associated Signalling - STP one side

This asymmetrical network architecture arises if Network 1 provides a signalling gateway or some signalling gateways as a service for Network 2. The means of interconnect is the M3UA in client-server mode.

This configuration is supported by the current UK IP-based interconnect standards.

4.1.3 Associated signalling

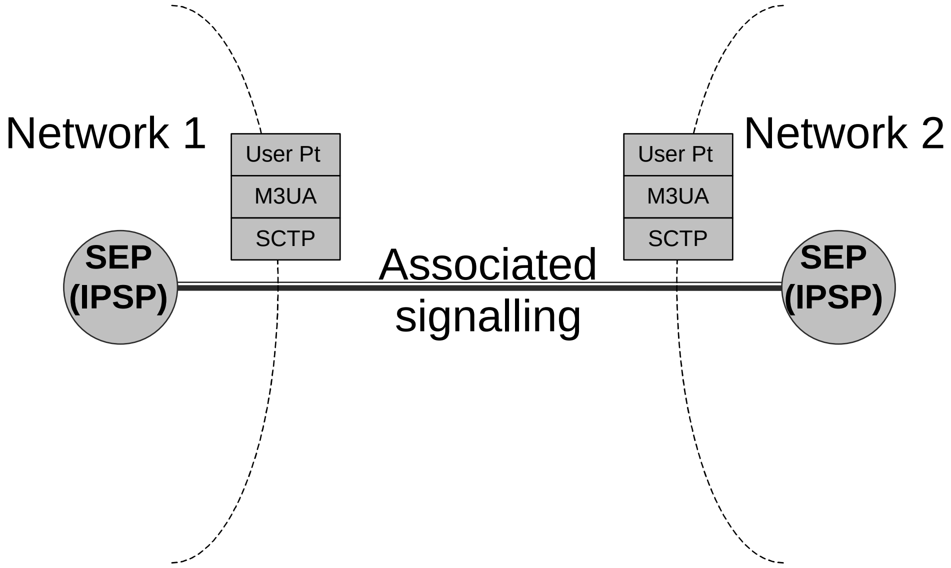

Figure 4-2 – Associated Signalling

This is the basic scenario, where the means of interconnect is the M3UA in peer-to-peer mode. The technology type of the interconnected networks could be TDM, with ISUP as the signalling application and IP as the signalling transport.

This configuration is NOT supported by the current UK IP-based interconnect standards, because the peer to peer model of RFC 3332 [i.9] requires clarification by the IETF or, if this is not forthcoming, by the NICC.

4.1.4 Quasi-associated (STP) signalling – STP each side

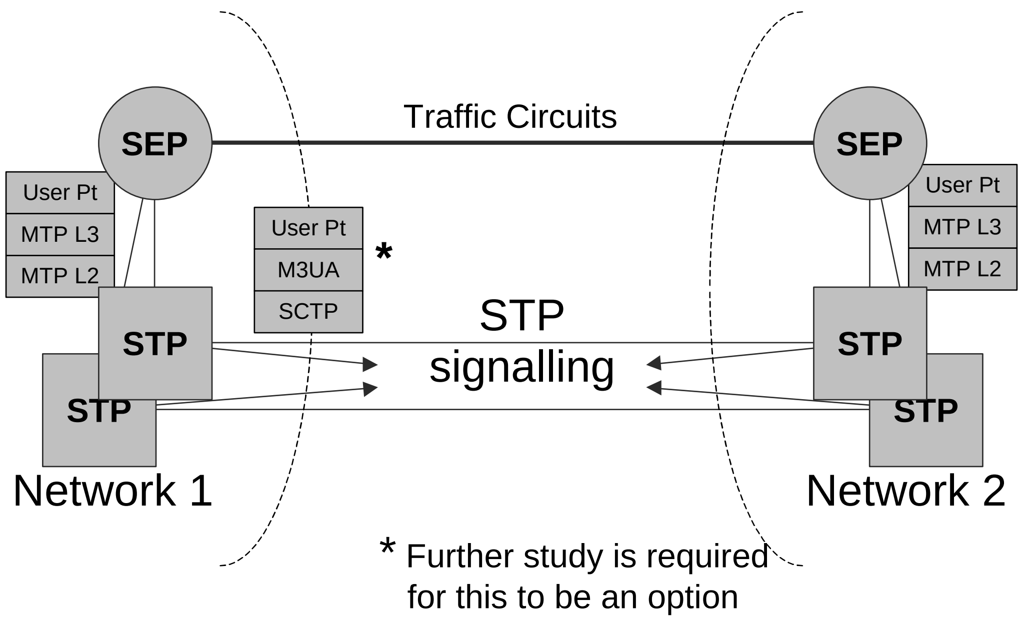

Figure 4-3 – Quasi-associated Signalling - STP each side

The means of interconnect in this scenario is M3UA in an extended peer-to-peer mode. The nodes that are shown as STPs could instead be SPR nodes, with SCCP as the signalling application, which would be a typical arrangement for interconnect between UK PLMNs.

This configuration is NOT supported by the current UK IP-based interconnect standards, because RFC 3332 [i.9] does not support SG to SG.

4.2 Guidelines on IP Security Choices

It is expected that security for the underlying IP network will be provided by some or all of the following techniques:

- Physical access control
- IPSec - see RFC 4301 [i.2]
- TLS (Transport Layer Security) - see RFC 4301 [i.2] and RFC 3436[i.4]

The standardisation of security measures is outside the scope of this document, however if TLS is chosen, then the effect on the SCTP data payload **should** be taken into account.

The potential problems of IPsec compared with TLS are that:

- Re-keying has the potential to cause interruption to service
- Management re-configuration requires potentially significant manpower.

These potential problems arise because each multi-homed SCTP association results in multiple security associations. For further information and proposed solutions, see RFC 3554 [i.3] and RFC 3788 [i.8].

The recommended default is currently outside the scope of this document, pending work in ETSI on security.

4.3 Guidelines on IP Address Assignment

Only selected combinations of IP addresses and Port identities **should** be allowed.

5 Signalling Application Protocols

This section gives configuration requirements of the SCTP for specific Signalling Application Protocols.

5.1 SCTP Transport for SIP

5.1.1 Ordered/Unordered delivery of data packets

Support for unordered delivery at the sending SCTP end-point **shall** be the default action. Where the application requires an ordered delivery service the application specification **can** overrule this requirement.

The receiving SCTP end-point **shall** support the reception of data packets marked for ordered and unordered delivery service.

5.1.2 SCTP streams

The number of streams to be supported at startup time by the association **shall** be the minimum requested (INIT) and offered (INIT ACK) by the two endpoints.

The number of outbound and inbound streams **shall** be same in both directions. The method of allocating calls to streams is implementation dependant.

A minimum of 16 outgoing and 16 incoming streams **shall** be supported.

5.1.3 SCTP stream 0

The receiving SCTP endpoint **shall** support the reception of data packets on stream 0.

There are no management specific messages allocated to stream 0, therefore, the CP **may** choose to use stream 0 for outbound data packets.

5.1.4 SCTP Payload Protocol Identifier for SIP

There is no standardised SCTP Payload Protocol Identifier for SIP registered with IANA. The value 0 **shall** be used.

NOTE: This is in agreement with RFC 4168 [i.12].

5.2 SCTP Transport for SIP-I

5.2.1 Ordered/Unordered delivery of data packets

Support for ordered delivery at the sending SCTP end-point **shall** be the default action.

The receiving SCTP end-point **shall** support the reception of data packets marked for ordered and unordered delivery service.

5.2.2 SCTP streams

The number of streams to be supported at startup time by the association **shall** be the minimum requested (INIT) and offered (INIT ACK) by the two endpoints.

The number of outbound and inbound streams **shall** be same in both directions. The method of allocating calls to streams is implementation dependant.

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5.2.3 SCTP stream 0

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There are no management specific messages allocated to stream 0, therefore, the CP **may** choose to use stream 0 for outbound data packets.

5.2.4 SCTP Payload Protocol Identifier for SIP-I

There is no standardised SCTP Payload Protocol Identifier for SIP registered with IANA. The value 0 **shall** be used.

NOTE: This is in agreement with RFC 4168 [i.12].

6 Signalling Transport Protocols

This section gives information about Signalling Transport Protocols for packet-based PSTN/ISDN services.

6.1 Protocol Architectures

The following options are considered to be appropriate for UK interconnects for packet-based PSTN/ISDN. Of course, other choices may be used by bi-lateral agreement.

For historical reasons this section only containes SIGTRAN/MTP protocol architectures. For SIP protocol architectures NICC has specified an interconnect architecture for IP-based networks interconnecting using IP-based signalling transport in its NGN Release documentation (see ND1610 [i.15] and [i.16]).

6.1.1 Bearer-related Protocol Architectures

Bearer-related MTP User Part			
MTP3	MTP3b	M3UA	MTP3
	SSCOP		M2PA
MTP2	AAL5	SCTP	SCTP
MTP1	ATM	IP	IP
Option A	Option B	Option C	Option D

Figure 6-1 – Bearer-related Protocol Architectures

Option A, using the MTP3, MTP2, MTP1 stack will be maintained as a signalling transport option. It is suitable as a last resort for implementing an interconnect (e.g. for low signalling load) and it is supported by ND1005 [i.5] and ND1107 [i.6].

Option B includes MTP3b in order to cater for more complex networks. SSCOP itself does not support alternative routing, and this was felt to be a significant limitation. This option is no longer being actively considered for UK interconnects for packet-based PSTN/ISDN.

Option C is supported by ND1012 [2]. Currently M3UA is more appropriate to a protocol architecture shown in sections 4.1.2 or 4.1.3, whilst M2PA is more appropriate to the protocol architecture shown in section 4.1.4, because M3UA is currently unable to support STP traffic. That is to say, M3UA is currently not specified for use between SGWs. In principle, M3UA supports SEP to SEP (peer to peer) as well as SEP to SGW (client server), but it is not always clear how to interpret some of the M3UA requirements in the SEP to SEP case. The standardisation of option C was given higher priority than option D, due to the relative maturity of the IETF documents, and is therefore the default signalling network architecture for UK interconnects for packet-based PSTN/ISDN.

Option D is not yet supported for UK Interconnects. Although it is the simplest method of using IP to carry signalling and the IETF document (RFC 4165 [i.10]) is simple in concept, this option is an answer to a specific problem (e.g. wideband links), rather than a general answer to interconnect.

NOTE: The option of SCTP without MTP3 was excluded, because it is only appropriate in a fully IP environment, where interworking with TDM networks is not required.

6.1.2 Non-bearer-related Protocol Architectures

TC			
SCCP			
MTP3	MTP3b	M3UA	MTP3
	SSCOP		M2PA
MTP2	AAL5	SCTP	SCTP
MTP1	ATM	IP	IP
Option A	Option B	Option C	Option D

Figure 6-2 – Non-bearer-related Protocol Architectures

The information in section 6.1.1 is equally applicable to these options.

TI-SCCP and SUA are not required, provided MTP3 or MTP3b functionality is available, but they may be considered in future. SUA is not currently identified as a UK interconnect requirement.

6.2 SCTP Timers and Parameters information and guidelines on choosing values

The default timer and parameter values in RFC 2960 [i.7] are not appropriate in a PSTN replacement environment, so the following values are recommended for UK interconnect as defined in ND1612 [i.17] and ND1620 [i.18].

For optimal performance appropriate values **should** be agreed by interconnecting parties; if such agreement can not be reached then the default values described below **shall** be used.

NOTE: For other applications different default values may be appropriate.

6.2.1 RTO.Initial

This is the value to use for RTO until an RTT measurement has been made.

The value **shall** be 100 milliseconds.

6.2.2 RTO.Min

This is the minimum value that RTO **may** take.

The value of RTO.Min **should** be in the range 40 to 100 milliseconds inclusive.

The default value **shall** be 40 milliseconds.

6.2.3 RTO.Max

This is the maximum value that RTO **may** take.

The value **shall** be 200 milliseconds.

6.2.4 RTO.Alpha

This is a parameter that contributes to the calculation of the value to be used for RTO.

The value **shall** be 1/8.

6.2.5 RTO.Beta

This is a parameter that contributes to the calculation of the value to be used for RTO.

The value **shall** be 1/4.

6.2.6 Valid.Cookie.Life

This is the time allowed completely to setup an association. The value of this parameter has no direct effect on the grade of service of the signalling network.

The value **shall** be 60 seconds.

6.2.7 Association.Max.Retrans

This is the maximum number of retransmission attempts for a given association, which may comprise multiple paths.

The value of ‘Association.Max.Retrans’ **should** be in the range 6 to 10 inclusive. Its value **should** be greater than 'Path.Max.Retrans' (see 6.2.8).

The default value **shall** be 10 attempts per association.

6.2.8 Path.Max.Retrans

This is the maximum number of retransmission attempts on a single path. It is effectively the maximum number of accumulated RTO delays experienced by a single message.

The value of ‘Path.Max.Retrans’ **should** be in the range 3 to 8 inclusive.

The default value **shall** be 8 attempts per destination address.

6.2.9 Max.Init.Retransmits

This is the maximum number of attempts at initialising an association. The value of this parameter has no direct effect on the grade of service of the signalling network.

The value **shall** be 8 attempts.

6.2.10 HB.interval

This timer values governs the 'Heartbeat' procedure, which gives protection against latent faults. It is functionally equivalent to the MTP signalling link test procedure, which has a periodicity of 3 to 6 seconds.

The value **shall** be 3 seconds.

6.2.11 SACK period

This is the maximum delay before generating an acknowledgement after receipt of a packet containing a DATA chunk.

The value **shall** be 0 milliseconds (i.e. no artificial delay is to be added).

6.2.12 SACK frequency

This defines how often a SACK is generated for every n packets received containing one or more DATA chunks within the SACK period.

The value **shall** be 1 (i.e. every packet containing any data chunks is to be acknowledged individually).

6.2.13 MTU Size

This is the maximum size of each packet in any transmission, including the IP header and payload, specified in octets. It is the value to be used for the Path MTU referred to in RFC 2960 [i.7].

The value of the Path MTU **shall** be no larger than 1438 octets.

NOTE: The value above ensures that should the packet later be encapsulated using IPsec using the encryption and authentication options specified in ND1613 [i.14], then the resultant packet size would be less than or equal to 1500 octets and would therefore not require IP fragmentation when carried over Ethernet.

6.2.14 Consequences of choosing either IPv4 or IPv6 address types

The 'INIT' and 'INIT ACK' chunk sizes are large enough to accommodate multiple IP addresses, however they do have a finite size, so if the number of IP addresses configured is large, then it is important to check that they do not exceed the chunk size. IPv6 addresses, being larger than IPv4 addresses, will reach the limit sooner.

6.3 Guidelines for choosing the number of SCTP paths to a given destination

The chosen number of IP addresses for a given association **should** be a number that is supported by the implementations at each end of that association.

A node **should** make use of multiple IP addresses if known for multi-homing. Whether this is done within the SCTP or is initiated by the SCTP's user is implementation dependent.

ETSI TS 102 144 [i.13] mandates two or more SCTP paths. For the UK the choice of single or dual-homed associations is dependant upon the resilience requirements and the product being supported e.g. PSTN/ISDN IP Interconnect or VLC.

6.4 Guidelines for M3UA

6.4.1 Use of M3UA 'Error' message type

A permitted option is to provide the supported version in the 'diagnostic information' parameter of the Error message.

6.4.2 Nodal congestion control

There is a greater risk of nodal overload with IP-based signalling transport, because the available bandwidth between a pair of nodes is no longer constrained to 64kbit/s. Therefore the importance of effective nodal congestion controls is even greater than for SS7 signalling transport. The following clauses give guidance on the signalling protocol options by which a node might notify other nodes that it is (at risk of) being overloaded by the presented signalling load.

For the network configuration shown in 4.1.2, the important elements are:

- The SGP and ASP are aware of their local nodal load, such an implementation-dependent means can either make them send SCON messages or cause a reduction in the credit window of their underlying SCTP association;
- The ASP informs the User Parts using the MTP-STATUS_Indication, if either it receives SCON messages or an implementation-dependent mechanism indicates excessive occupancy of the underlying SCTP association;
- The User Part has an effective method of reducing its outgoing signalling traffic
  (this requirement is the same as for SS7 signalling transport);
- The SGP either sends TFC messages concerning the AS's own pointcode or causes a reduction of the rate at which its underlying MTP Level 2 acknowledges incoming MSUs, if either it receives SCON messages or an implementation-dependent mechanism indicates excessive occupancy of the underlying SCTP association.

6.4.3 M3UA message distribution failure at the Signalling Gateway

The behaviour if no active ASP is available is a nodal function, but the layer management **should** be informed if the received messages are discarded. The duration of buffering, if used, **should** be minimised because it may cause excessive signalling delay.

6.4.4 M3UA load-balancing across associations

Assuming that:

- all associations have an equal end-to-end bandwidth and latency for all paths;
- equal processing capacity is provided across all ASPs;

then M3UA **should** use an algorithm that produces an even distribution for transmitting message across associations.

Any variance from the above assumptions needs to be negotiated.

6.4.5 Guidelines for choosing the number of M3UA streams

If delivery in sequence is NOT required (equivalent to SCCP protocol class 0), then only 1 stream need be used in addition to stream 0, without incurring 'head of line' blocking. (Stream 0 **should not** be used for data transfer.)

History

Document history		
Issue 1	July 2006	Approved for issue.
1.2.1	November 2008	Format changed to latest NICC Template styling. Added SIP and SIP-I specific SCTP parameters. Updated Generic SCTP parameters. SIP-I Ordered delivery mandated. Changes to 6.2, 6.2.2, 6.2.7 and 6.2.8 to incorporate ranges. Editorial change to 6.4.3.