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Introduction:

This document contains **TS 29.202 v. 2.0.0** that have been agreed by **TSG CN WG4**, and are forwarded to TSG CN Plenary meeting #11 for approval.

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Technical Specification

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document defines the possible protocol architectures for transport of SS7 signalling protocols in Core Network.

2 References

The following documents contain provisions, which through reference in this text constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

2.1 Normative References

[1] 3GPP TR 21.905: "3G Vocabulary"

[2] ITU-T Recommendation Q.701: "Functional description of the message transfer part (MTP) of signalling system No. 7"

[3] ITU-T Recommendation Q.702: "Signalling data link"

[4] ITU-T Recommendation Q.703: "Signalling link"

[5] ITU-T Recommendation Q.704: "Signalling network functions and messages"

[6] ITU-T Recommendation Q.705: "Signalling network structure"

[7] ITU-T Recommendation Q.706: "Message transfer part signalling performance"

[8] RFC 2960: "Stream Control Transmission Protocol"

[9] ITU-T Recommendation G.804: "ATM cell mapping into Plesiochronous Digital Hierarchy (PDH)"

[10] ITU-T Recommendation I.112: "Vocabulary of terms for ISDNs"

[11] ITU-T Recommendation I.361: "B-ISDN ATM layer specification"

[12] ITU-T Recommendation I.363.5: "B-ISDN ATM Adaptation Layer specification: Type 5 AAL"

[13] ITU-T Recommendation Q.2110: "B-ISDN ATM adaptation layer - Service specific connection oriented protocol (SSCOP)"

[14] ITU-T Recommendation Q.2140: "B-ISDN ATM adaptation layer - Service specific coordination function for signalling at the network node interface (SSCF at NNI)"

[15] ITU-T Recommendation Q.2210: "Message transfer part level 3 functions and messages using the services of ITU-T Recommendation Q.2140"

2.2 Informative References

[16] RFC 2719: "Framework Architecture for Signalling Transport"

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAL5	ATM Adaptation Layer type 5
ATM	Asynchronous Transfer Mode
IP	Internet Protocol
MTP	Message Transfer Part
MTP1	Message Transfer Part layer 1
MTP2	Message Transfer Part layer 2
MTP3	Message Transfer Part layer 3
M3UA	MTP3-User Adaptation
PDH	Plesiochronous Digital Hierarchy
SSCF	Service Specific Coordination Function
SSCOP	Service Specific Connection Oriented Protocol
SCCP	Signalling Connection Control Part
SCTP	Stream Control Transmission Protocol
SDH	Synchronous Digital Hierarchy

TCAP Transaction Capabilities Application Part

4 Introduction

The Core Network enables the transport of SS7 signalling protocols between two entities by means of different underlying networks (e.g. MTP-based, IP-based or ATM-based).

The transport of SS7 signalling protocol messages of any protocol layer that is identified by the MTP level 3 layer, in SS7 terms, as a user part (MTP3-user) shall be accomplished in accordance with the protocol architecture defined in the following sub-clauses. The list of these protocol layers includes, but is not limited to, Signalling Connection Control Part (SCCP).

The transport of protocols which can be identified as SCCP-users, like for example TCAP, and in turn the transport of TCAP-users like MAP and CAP, shall also be accomplished in accordance with the defined protocol architectures, since their protocol messages are transferred as SCCP payload.

5 Protocol Architectures

5.1 Protocol architecture in the case of MTP-based SS7 signalling transport network

The transport of an MTP3-user signalling messages shall be accomplished in accordance with the relevant ITU-T Recommendations [2], [3], [4], [5], [6], [7].

The protocol architecture applicable in the case of MTP-based SS7 signalling transport network is shown in Figure 5.1/1

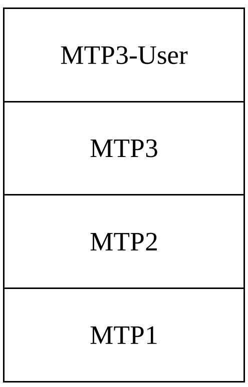

Figure 5.1/1: Protocol architecture in the case of MTP-based SS7 signalling transport network

5.2 Protocol architecture in the case of IP-based SS7 signalling transport network

The transport of an MTP3-user signalling messages shall be accomplished in accordance with the architecture defined by the "Framework Architecture for Signalling Transport" [16], by "Stream Control Transmission Protocol"[8] and by the IETF document available in Annex A

The protocol architecture applicable in the case of IP-based SS7 signalling transport network is shown in Figure 5.2/1

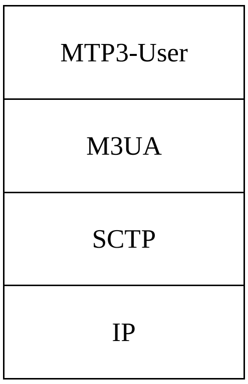

Figure 5.2/1: Protocol architecture in the case of IP-based SS7 signalling transport network

5.3 Protocol architecture in the case of ATM-based SS7 signalling transport network

The transport of an MTP3-user signalling messages shall be accomplished in accordance with the relevant ITU-T Recommendations [9], [10], [11], [12], [13], [14], [15]

The protocol architectures applicable in the case of ATM-based SS7 signalling transport network are shown in Figure 5.3/1

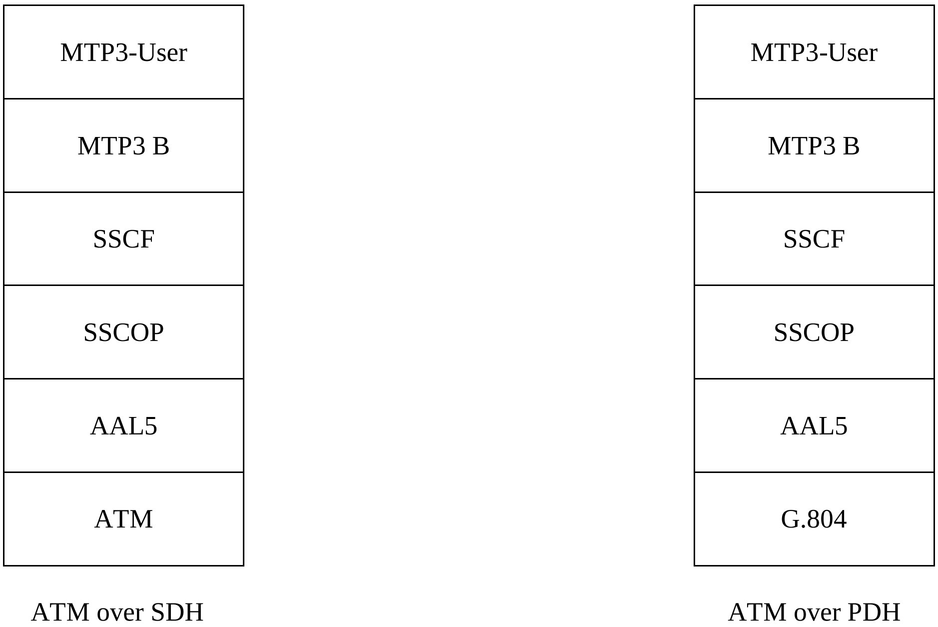

Figure 5.3/1: Protocol architectures in the case of ATM-based SS7 signalling transport network

Annex A (normative): Internet Draft: SS7 MTP3-User Adaption Layer (M3UA)

The document included in this Annex is the latest available Internet-Draft at the time of writing. When the IETF issues the RFC to this Internet-Draft then a change request will be provided to replace the text in Annex A with a reference in section 2

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SS7 MTP3-User Adaptation Layer (M3UA)
<draft-ietf-sigtran-m3ua-06.txt>

Status of This Memo

Abstract

This Internet Draft defines a protocol for supporting the transport of any SS7 MTP3-User signalling (e.g., ISUP and SCCP messages) over IP using the services of the Stream Control Transmission Protocol. Also, provision is made for protocol elements that enable a seamless operation of the MTP3-User peers in the SS7 and IP domains. This

protocol would be used between a Signalling Gateway (SG) and a Media Gateway Controller (MGC) or IP-resident Database. It is assumed that the SG receives SS7 signalling over a standard SS7 interface using the SS7 Message Transfer Part (MTP) to provide transport.

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1. Introduction

1.1 Scope

There is a need for Switched Circuit Network (SCN) signalling protocol delivery from an SS7 Signalling Gateway (SG) to a Media Gateway

Controller (MGC) or IP-resident Database as described in the Framework Architecture for Signalling Transport [1]. The delivery mechanism SHOULD meet the following criteria:

* Support for the transfer of all SS7 MTP3-User Part messages (e.g., ISUP, SCCP, TUP, etc.)
* Support for the seamless operation of MTP3-User protocol peers
* Support for the management of SCTP transport associations and traffic between an SG and one or more MGCs or IP-resident Databases
* Support for MGC or IP-resident Database process fail-over and load-sharing
* Support for the asynchronous reporting of status changes to management

In simplistic transport terms, the SG will terminate SS7 MTP2 and MTP3 protocol layers and deliver ISUP, SCCP and/or any other MTP3-User protocol messages, as well as certain MTP network management events, over SCTP transport associations to MTP3-User peers in MGCs or IP-resident Databases.

1.2 Terminology

Application Server (AS) - A logical entity serving a specific Routing Key. An example of an Application Server is a virtual switch element handling all call processing for a unique range of PSTN trunks, identified by an SS7 DPC/OPC/CIC_range. Another example is a virtual database element, handling all HLR transactions for a particular SS7 DPC/OPC/SCCP_SSN combination. The AS contains a set of one or more unique Application Server Processes, of which one or more is normally actively processing traffic.

Application Server Process (ASP) - A process instance of an Application Server. An Application Server Process serves as an active or standby process of an Application Server (e.g., part of a distributed virtual switch or database). Examples of ASPs are processes (or process instances) of MGCs, IP SCPs or IP HLRs. An ASP contains an SCTP end-point and may be configured to process signalling traffic within more than one Application Server.

Association - An association refers to an SCTP association. The association provides the transport for the delivery of MTP3-User protocol data units and M3UA adaptation layer peer messages.

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IP Server Process (IPSP) - A process instance of an IP-based application. An IPSP is essentially the same as an ASP, except that it uses M3UA in a point-to-point fashion. Conceptually, an IPSP does not use the services of a Signalling Gateway.

Signalling Gateway Process (SGP) - A process instance of a Signalling Gateway. It serves as an active, standby or load-sharing process of a Signalling Gateway.

Signalling Process - A process instance that uses M3UA to communicate with other signalling process. An ASP, a signalling gateway process and an IPSP are all signalling processes.

Routing Key: A Routing Key describes a set of SS7 parameters and parameter values that uniquely define the range of signalling traffic to be handled by a particular Application Server. Parameters within the Routing Key cannot extend across more than a single SS7 Destination Point Code.

Routing Context - A value that uniquely identifies a Routing Key. Routing Context values are either configured using a configuration management interface, or by using the routing key management procedures defined in this document.

Fail-over - The capability to re-route signalling traffic as required to an alternate Application Server Process, or group of ASPs, within an Application Server in the event of failure or unavailability of a currently used Application Server Process. Fail-over also applies upon the return to service of a previously unavailable Application Server Process.

Signalling Point Management Cluster (SPMC) - The complete set of Application Servers represented to the SS7 network under one specific SS7 Point Code of one specific Network Appearance. SPMCs are used to sum the availability / congestion / User_Part status of an SS7 destination point code that is distributed in the IP domain, for the purpose of supporting MTP3 management procedures at an SG. In some cases, the SG itself may also be a member of the SPMC. In this case, the SG availability / congestion / User_Part status must also be taken into account when considering any supporting MTP3 management actions.

MTP - The Message Transfer Part of the SS7 protocol.

MTP3 - MTP Level 3, the signalling network layer of SS7

MTP3-User - Any protocol normally using the services of the SS7 MTP3 (e.g., ISUP, SCCP, TUP, etc.).

Network Appearance - The Network Appearance identifies an SS7 network context for the purposes of logically separating the signalling traffic

between the SG and the Application Server Processes over a common SCTP Association. An example is where an SG is logically partitioned to appear as an element in four separate national SS7 networks. A Network Appearance implicitly defines the SS7 Point Code(s), Network Indicator and MTP3 protocol type/variant/version used within a specific SS7 network partition. A physical SS7 route-set or link-set at an SG can appear in only one network appearance. The Network Appearance is not globally significant and requires coordination only between the SG and the ASP. Therefore, in the case where an ASP is connected to more than one SG, the same SS7 network context may be identified by different Network Appearances depending over which SG a message is being transmitted/received.

Network Byte Order: Most significant byte first, a.k.a Big Endian.

Layer Management - Layer Management is a nodal function that handles the inputs and outputs between the M3UA layer and a local management entity.

Host - The computing platform that the ASP process is running on.

Stream - A stream refers to an SCTP stream; a uni-directional logical channel established from one SCTP endpoint to another associated SCTP endpoint, within which all user messages are delivered in-sequence except for those submitted to the un-ordered delivery service.

1.3 M3UA Overview

1.3.1 Protocol Architecture.

The framework architecture that has been defined for SCN signalling transport over IP [1] uses multiple components, including a common signalling transport protocol and an adaptation module to support the services expected by a particular SCN signalling protocol from its underlying protocol layer.

Within the framework architecture, this document defines an MTP3-User adaptation module suitable for supporting the transfer of messages of any protocol layer that is identified to the MTP Level 3 layer, in SS7 terms, as a user part. The list of these protocol layers include, but is not limited to, ISDN User Part (ISUP) [2,3,4], Signalling Connection Control Part (SCCP) [5,6,7] and Telephone User Part (TUP) [8]. TCAP [9,10,11] or RANAP [12] messages are transferred transparently by the M3UA as SCCP payload, as they are SCCP-User protocols.

It is recommended that the M3UA use the services of the Stream Control Transmission Protocol (SCTP) [13] as the underlying reliable common signalling transport protocol. This is to take advantage of various SCTP features such as:

- Explicit packet-oriented delivery (not stream-oriented);
- Sequenced delivery of user messages within multiple streams, with an option for order-of-arrival delivery of individual user messages,
- Optional multiplexing of user messages into SCTP datagrams;
- Network-level fault tolerance through support of multi-homing at either or both ends of an association;
- Resistance to flooding and masquerade attacks; and
- Data segmentation to conform to discovered path MTU size.

Under certain scenarios, such as back-to-back connections without redundancy requirements, the SCTP functions above MAY NOT be a requirement and TCP can be used as the underlying common transport protocol.

1.3.2 Services Provided by the M3UA Layer

The M3UA Layer at an ASP or IPSP provides the equivalent set of primitives at its upper layer to the MTP3-Users as provided by the MTP Level 3 to its local MTP3-Users at an SS7 SEP. In this way, the ISUP and/or SCCP layer at an ASP or IPSP is unaware that the expected MTP3 services are offered remotely from an MTP3 Layer at an SG, and not by a local MTP3 layer. The MTP3 layer at an SG may also be unaware that its local users are actually remote user parts over M3UA. In effect, the

M3UA extends access to the MTP3 layer services to a remote IP-based application. The M3UA does not itself provide the MTP3 services. However, in the case where an ASP is connected to more than one SG, the M3UA Layer at an ASP must maintain the status of configured SS7 destinations and route messages according to the availability / congestion status of the routes to these destinations via each SG.

The M3UA Layer may also be used for point-to-point signalling between two IP Server Processes (IPSPs). In this case, the M3UA provides the same set of primitives and services at its upper layer as the MTP3. However, in this case the expected MTP3 services are not offered remotely from an SG. The MTP3 services are provided but the procedures to support these services are a subset of the MTP3 procedures due to the simplified point-to-point nature of the IPSP to IPSP relationship.

1.3.2.1 Support for the transport of MTP3-User Messages

The M3UA provides the transport of MTP-TRANSFER primitives across an established SCTP association between an SG and an ASP or between IPSPs.

The MTP-TRANSFER primitive information is encoded as in MTP3-User messages. In this way, the SCCP and ISUP messages received from the SS7 network by the SG are not re-encoded into a different format for transport between the M3UA peers. The MTP3 Service Information Octet (SIO) and Routing Label (OPC, DPC, and SLS) are included, encoded as expected by the MTP3 and MTP3-User protocol layer.

At an ASP, in the case where a destination is reachable via multiple SGs, the M3UA must also choose via which SG the message is to be routed or support load balancing across the SGs, ensuring that no mis-sequencing occurs.

The M3UA does not impose a 272-octet signaling information field (SIF) length limit as specified by the SS7 MTP Level 2 protocol [14] [15] [16]. Larger information blocks can be accommodated directly by M3UA/SCTP, without the need for an upper layer segmentation/re-assembly procedure as specified in recent SCCP or ISUP versions. However, in the context of an SG, the maximum 272-octet block size must be followed when inter-working to a SS7 network that does not support the transfer of larger information blocks to the final destination. This avoids potential ISUP or SCCP fragmentation requirements at the SG. However, if the SS7 network is provisioned to support the Broadband MTP [20] to the final SS7 destination, the information block size limit may be increased past 272 octets.

1.3.2.2 Native Management Functions

The M3UA provides management of the underlying SCTP transport protocol to ensure that SG-ASP and IPSP-IPSP transport is available to the degree called for by the MTP3-User signalling applications.

The M3UA provides the capability to indicate errors associated with received M3UA messages and to notify, as appropriate, local management and/or the peer M3UA.

1.3.2.3 Inter-working with MTP3 Network Management Functions

At the SG, the M3UA must also provide inter-working with MTP3 management functions to support seamless operation of the user SCN signalling applications in the SS7 and IP domains. This includes:

- Providing an indication to MTP3-Users at an ASP that a remote destination in the SS7 network is not reachable.

- Providing an indication to MTP3-Users at an ASP that a remote destination in the SS7 network is now reachable.

- Providing an indication to MTP3-Users at an ASP that messages to a remote MTP3-User peer in the SS7 network are experiencing SS7 congestion.

- Providing an indication to MTP3-Users at an ASP that the routes to a remote MTP3-User peer in the SS7 network are restricted.

- Providing an indication to MTP3-Users at an ASP that a remote MTP3-User peer is unavailable.

The M3UA layer at an ASP may initiate an audit of the availability, the restricted or the congested state of remote SS7 destinations. This information is requested from the M3UA at the SG.

The M3UA layer at an ASP may also indicate to the SG that the M3UA itself or the ASP or the ASP's Host is congested.

1.3.2.4 Support for the management of SCTP associations between the SG and ASPs.

The M3UA layer at the SG maintains the availability state of all configured remote ASPs, in order to manage the SCTP Associations and the traffic between the M3UA peers. As well, the active/inactive and congestion state of remote ASPs is maintained.

The M3UA layer MAY be instructed by local management to establish an SCTP association to a peer M3UA node. This can be achieved using the M-SCTP ESTABLISH primitive to request, indicate and confirm the establishment of an SCTP association with a peer M3UA node. In order to avoid redundant SCTP associations between two M3UA peers, one side (client) must be designated to establish the SCTP association, or M3UA configuration knowledge maintained to detect redundant associations (e.g., via knowledge of the expected local and remote SCTP endpoint addresses).

The M3UA layer MAY also need to inform local management of the status of the underlying SCTP associations using the M-SCTP STATUS request and indication primitive. For example, the M3UA MAY inform local management of the reason for the release of an SCTP association, determined either locally within the M3UA layer or by a primitive from the SCTP.

Also the M3UA layer may need to inform the local management of the change in status of an ASP or AS. This may be achieved using the M-ASP STATUS request or M-AS STATUS request primitives.

1.3.2.5 Support for the management of connections to multiple SGs

As shown in Figure 1 an ASP may be connected to multiple SGs. In such a case a particular SS7 destination may be reachable via more than SG, i.e., via more than one route. As MTP3 users only maintain status on a destination and not on a route basis, M3UA must maintain the status (availability, restriction, and/or congestion of route to destination) of the individual routes, derive the overall availability or congestion status of the destination from the status of the individual routes, and inform the MTP3 users of this derived status whenever it changes.

1.3.3 Signalling Network Architecture

A Signalling Gateway is used to support the transport of MTP3-User signalling traffic received from the SS7 network to multiple

distributed ASPs (e.g., MGCs and IP Databases). Clearly, the M3UA protocol is not designed to meet the performance and reliability requirements for such transport by itself. However, the conjunction of distributed architecture and redundant networks does allow for a sufficiently reliable transport of signalling traffic over IP. The M3UA protocol is flexible enough to allow its operation and management in a variety of physical configurations, enabling Network Operators to meet their performance and reliability requirements.

To meet the stringent SS7 signalling reliability and performance requirements for carrier grade networks, Network Operators SHOULD ensure that no single point of failure is present in the end-to-end network architecture between an SS7 node and an IP-based application. This can typically be achieved through the use of redundant SGs, redundant hosts, and the provision of redundant QOS-bounded IP network paths for SCTP Associations between SCTP End Points. Obviously, the reliability of the SG, the MGC and other IP-based functional elements also needs to be taken into account. The distribution of ASPs within the available Hosts must also be considered. As an example, for a particular Application Server, the related ASPs should be distributed over at least two Hosts.

One example of a physical network architecture relevant to SS7 carrier-grade operation in the IP network domain is shown in Figure 1 below:

```
          SG                                     MGC

  Host#1 **************                          ************** Host#1
     =   *  ********__*__________________________*__********  *   =
    SG1  *  * SGP1 *__*_____      _______________*__* ASP1 *  *  MGC1
         *  ********  *     \    /               *  ********  *
         *  ********__*______\__/________________*__********  *
         *  * SGP2 *__*_______\/______      _____*__* ASP2 *  *
         *  ********  *       /\      |    |     *  ********  *
         *      :     *      /  \     |    |     *      :     *
         *  ********  *     /    \    |    |     *  ********  *
         *  * SGPn *  *     |    |    |    |     *  * ASPn *  *
         *  ********  *     |    |    |    |     *  ********  *
         **************     |    |    |    |     **************
                            |    |    \    /
  Host#2 **************     |    |     \  /      ************** Host#2
     =   *  ********__*_____|    |______\/_______*__********  *   =
    SG2  *  * SGP1 *__*_________________/\_______*__* ASP1 *  *  MGC2
         *  ********  *                /  \      *  ********  *
         *  ********__*_______________/    \_____*__********  *
         *  * SGP2 *__*__________________________*__* ASP2 *  *
         *  ********  *                          *  ********  *
         *      :     *     SCTP Associations    *      :     *
         *  ********  *                          *  ********  *
         *  * SGPn *  *                          *  * ASPn *  *
         *  ********  *                          *  ********  *
         **************                          **************
```

Figure 1 - Physical Model

In this model, each host has many application processes. In the case of the MGC, an ASP may provide service to one or more application server, and is identified as an SCTP end point. In the case of the SG, a pair of signalling gateway processes may represent, as an example, a single network appearance, serving a signalling point management cluster.

This example model can also be applied to IPSP-IPSP signalling. In this case, each IPSP would have its services distributed across 2 hosts or more, and may have multiple server processes on each host.

In the example above, each signalling process (SGP, ASP or IPSP) is the end point to more than one SCTP association, leading to many other signalling processes. To support this, a signalling process must be able to support distribution of M3UA messages to many simultaneous active associations. This message distribution function is based on the status of provisioned routing keys, the availability of signalling points in the SS7 network, and the redundancy model (active-standby, load-sharing, n+k) of the remote signalling processes.

For carrier grade networks, the failure or isolation of a particular signalling process SHOULD NOT cause stable calls or transactions to be lost. This implies that signalling processes need, in some cases, to share the call/transaction state or be able to pass the call state information between each other. In the case of ASPs performing call processing, coordination may also be required with the related Media Gateway to transfer the MGC control for a particular trunk termination. However, this sharing or communication of call/transaction state information is outside the scope of this document.

This model serves as an example. M3UA imposes no restrictions as to the exact layout of the network elements, the message distribution algorithms and the distribution of the signalling processes. Instead, it provides a framework and a set of messages that allow for a flexible and scalable signalling network architecture, aiming to provide reliability and performance.

1.4 Functional Areas

1.4.1 Signalling Point Code Representation

Within an SS7 network, a Signalling Gateway is charged with representing a set of nodes in the IP domain into the SS7 network for routing purposes. The SG itself, as a physical node in the SS7 network, must be addressable with an SS7 Point Code for MTP3 Management purposes. The SG Point Code is also used for addressing any local MTP3-Users at the SG such as an SG-resident SCCP function.

An SG may be logically partitioned to operate in multiple SS7 network Appearances. In such a case, the SG must be addressable with a Point Code in each network appearance, and represents a set of nodes in the IP domain into each SS7 network. Alias Point Codes [15] may also be used within an SG network appearance.

The M3UA places no restrictions on the SS7 Point Code representation of an AS. Application Servers can be represented under the same Point Code of the SG, their own individual Point Codes or grouped with other Application Servers for Point Code preservation purposes. A single Point Code may be used to represent the SG and all the Application Servers together, if desired.

Where Application Servers are grouped under a Point Code address, an SPMC will include more than one AS. If full advantage of SS7 management procedures is to be taken (as is advisable in carrier grade networks) care must be taken that, if one AS of an SPMC becomes unavailable, all Application Servers of the SPMC become unavailable from the SG. Otherwise, usage of SS7 transfer prohibited procedures by the SG becomes problematic as either traffic to the unavailable AS cannot be stopped/diverted or traffic to a still available AS will be unnecessarily stopped/diverted. (Depending on the network configuration it may even be necessary to assign an individual SS7 point code to each AS.)

Observing this principle is of particular importance if alternative routing possibilities exist on the SS7 level (e.g. via mated SGs) or application level (e.g. via another MGC/MG).

If an ASP or group of ASPs is available to the SS7 network via more than one SG, each with its own Point Code, the ASP(s) should be represented by a Point Code that is separate from any SG Point Code. This allows these SGs to be viewed from the SS7 network as "STPs", each having an ongoing "route" to the same ASP(s). Under failure conditions where the ASP(s) become(s) unavailable from one of the SGs, this approach enables MTP3 route management messaging between the SG and SS7 network, allowing simple SS7 re-routing through an alternate SG without changing the Destination Point Code Address of SS7 traffic to the ASP(s).

Where an AS can be reached via more than one SG it is equally important that the corresponding Routing Keys in the involved SGs are identical. (Note: It is possible for the Routing Key configuration data to be temporarily out-of-synch during configuration updates).

```
                           +--------+
                           |        |
              +------------+  SG 1  +--------------+
  +-------+   | SS7 links  | "STP"  |  IP network  |     ----
  |  SEP  +---+            +--------+              +---/      \
  |   or  |                                           |  ASPs  |
  |  STP  +---+            +--------+              +---\      /
  +-------+   |            |        |              |     ----
              +------------+  SG 2  +--------------+
                           | "STP"  |
                           +--------+
```

Note: there is no SG-to-SG communication shown, so each SG can be reached only via the direct linkset from the SS7 network.

The following example shows a signalling gateway partitioned into two network appearances.

```
                                SG
  +-------+              +---------------+
  |  SEP  +--------------| SS7 Ntwk |M3UA|
  +-------+   SS7 links  |   "A"    |    |           ----
                         |__________|    |          /      \
                         |          |    +------------+  ASPs  |
                         |          |    |          \      /
  +-------+              | SS7 Ntwk |    |           ----
  |  SEP  +--------------+   "B"    |    |
  +-------+              +---------------+
```


1.4.2 Routing Contexts and Routing Keys

1.4.2.1 Overview

The distribution of SS7 messages between the SG and the Application Servers is determined by the Routing Keys and their associated Routing Contexts. A Routing Key is essentially a set of SS7 parameters used to filter SS7 messages, whereas the Routing Context parameter is a 4-byte value (integer) that is associated to that Routing Key in a 1:1 relationship. The Routing Context therefore can be viewed as an index into a sending node's Message Distribution Table containing the Routing Key entries.

Possible SS7 address/routing information that comprise a Routing Key entry includes, for example, the OPC, DPC, SIO found in the MTP3 routing label, or other MTP3-User specific fields such as the ISUP CIC, SCCP subsystem number, or TCAP transaction ID. Some example Routing Keys are: the DPC alone, the DPC/OPC combination, the DPC/OPC/CIC combination, or the DPC/SSN combination. The particular information used to define an M3UA Routing Key is application and network dependent, and none of the above examples are mandated.

An Application Server Process may be configured to process signalling traffic related to more than one Application Server, over a single SCTP Association. In ASP Active and Inactive management messages, the signalling traffic to be started or stopped is discriminated by the Routing Context parameter. At an ASP, the Routing Context parameter uniquely identifies the range of signalling traffic associated with each Application Server that the ASP is configured to receive.

1.4.2.2 Routing Key Limitiations

>From an SS7 network perspective, a Routing Key is limited to within a single SS7 Destination Point Code. This is important, as the SG must be able to present this point code to the SS7 network, without compromising the integrity of the Signaling Point Management Cluster.

Some SS7 networks may require the SG to generate UPU messages in failure conditions. In this case, the AS and SG may optionally limit a Routing Key to a single Service Indicator (ISUP, TUP, SCCP, etc.). The SG generation of a UPU message into the SS7 network is implementation dependent, therefore no specific procedures are outlined in this document.

Routing Keys MUST be unique in the sense that a received SS7 signalling message cannot be matched to more than one Routing Key. It is not necessary for the parameter range values within a particular Routing Key to be contiguous. For example, an AS could be configured to

support call processing for multiple ranges of PSTN trunks that are not represented by contiguous CIC values.

1.4.2.3 Managing Routing Contexts and Routing Keys

There are two ways to ways to provision a Routing Key at an SG. A Routing Key may be configured using an implementation dependent management interface, statically or dynamically in full accordance to the M3UA specifications. A Routing Key may also be configured using the

M3UA dynamic registration/deregistration procedures defined in this document. An M3UA element must implement at least one method of Routing Key provisioning.

When using a management interface to configure Routing Keys, the message distribution function within the SG is not limited to the set of parameters defined in this document. Other implementation dependent distribution algorithms may be used.

1.4.2.4 Message Distribution the SG

In order to direct messages received from the SS7 MTP3 network to the appropriate IP destination, the SG must perform a message distribution function using information from the received MTP3-User message.

To support this message distribution, the SG must maintain the equivalent of a network address translation table, mapping incoming SS7 message information to an Application Server for a particular application and range of traffic. This is accomplished by comparing elements of the incoming SS7 message to provisioned Routing Keys in the SG. These Routing Keys in turn make reference to an Application Server that is enabled by one or more ASPs. These ASPs provide dynamic status information on their availability, traffic handling capability and congestion to the SG using various management messages defined in the M3UA protocol.

The list of ASPs in an AS is assumed to be dynamic, taking into account the availability, traffic handling capability and congestion status of the individual ASPs in the list, as well as configuration changes and possible fail-over mechanisms.

Normally, one or more ASPs are active in the AS (i.e., currently processing traffic) but in certain failure and transition cases it is possible that there may be active ASP available. Both load-sharing and backup scenarios are supported.

When there is no Routing Key match, or only a partial match, for an incoming SS7 message, a default treatment MUST be specified. Possible solutions are to provide a default Application Server at the SG that directs all unallocated traffic to a (set of) default ASP(s), or to drop the message and provide a notification to management. The treatment of unallocated traffic is implementation dependent.

1.4.2.5 Message Distribution at the ASP

In order to direct messages to the SS7 network, the ASP must also perform a message distribution function in order to choose the proper SG or SGP for a given message. This is accomplished by observing the Destination Point Code (and possibly other elements of the outgoing message such as the SLS value), together with the SS7 destination availability/restricted/congestion status via the SG(s) and the availability of the SG and SGPs themselves.

A remote Signalling Gateway may be composed of one or more SGPs that are capable of routing SS7 traffic. As is the case with ASPs, a dynamic list of SGPs in an SG can be maintained, taking into account the availability status of the individual SGPs, configuration changes and fail-over mechanisms. There is, however, no M3UA messaging to manage the status of an SGP. Whenever an SCTP association to an SGP exists, it is assumed to be available. Also, every SGP of one SG communicating with one ASP regarding one AS provides identical SS7 connectivity to this ASP.

1.4.3 SS7 and M3UA Interworking

In the case of SS7 and M3UA inter-working, the M3UA adaptation layer is designed to provide an extension of the MTP3 defined user primitives.

1.4.3.1 Signalling Gateway SS7 Layers

The SG is responsible for terminating MTP Level 3 of the SS7 protocol, and offering an IP-based extension to its users.

>From an SS7 perspective, it is expected that the Signalling Gateway (SG) transmits and receives SS7 Message Signalling Units (MSUs) to and from the PSTN over a standard SS7 network interface, using the SS7 Message Transfer Part (MTP) [14,15,16] to provide reliable transport of the messages.

As a standard SS7 network interface, the use of MTP Level 2 signalling links is not the only possibility. ATM-based High Speed Links can also be used with the services of the Signalling ATM Adaptation Layer (SAAL) [17,18]. It is possible for IP-based links to be present, using the services of the MTP2-User Adaptation Layer (M2UA) [19]. These SS7 datalinks may be terminated at a Signalling Transfer Point (STP) or at a Signalling End Point (SEP). Using the services of MTP3, the SG may be capable of communicating with remote SS7 SEPs in a quasi-associated fashion, where STPs may be present in the SS7 path between the SEP and the SG.

Where ATM-based High Speed Links are used in the SS7 network, it is possible for the SG to use the services of the MTP-3b [20] for reliable

transport to and from an SS7 SEP or STP. The maximum SIF length supported by the MTP-3b is 4095 octets compared to the 272-octet maximum of the MTP3. However, for MTP3-Users to take advantage of the larger SDU between MTP3-User peers, network architects should ensure that MTP3-b is used end-to-end between the SG and the SS7-resident peer.

1.4.3.2 SS7 and M3UA Inter-Working at the SG

The SG provides a functional inter-working of transport functions between the SS7 network and the IP network by also supporting the M3UA adaptation layer. It allows the transfer of MTP3-User signalling messages to and from an IP-based Application Server Process where the peer MTP3-User protocol layer exists.

The Signalling Gateway must maintain knowledge of SS7 node and Signalling Point Management Cluster (SPMC) status in their respective domains in order to perform a seamless inter-working of the IP-based signalling and the SS7 domains. For example, SG knowledge of the availability and/or congestion status of the SPMC and SS7 nodes must be maintained and disseminated in the respective networks, in order to ensure that end-to-end operation is transparent to the communicating SCN protocol peers at the SS7 node and ASP.

When the SG determines that the transport of SS7 messages to an SPMC (or possibly to parts of an SPMC) is encountering congestion, the SG should inform the MTP3 route management function (by an implementation-dependent mechanism). This information is used by the MTP3 to mark the "route" to the affected destination as congested and to trigger MTP Transfer Controlled (TFC) messages to any SS7 SEPs generating traffic to the congested DPC, as per current MTP3 procedures.

When the SG determines that the transport of SS7 messages to all ASPs in a particular SPMC is interrupted, then it should similarly inform the MTP3 route management function. This information is used by the MTP3 to mark the "route" to the affected destination as unavailable, and in the case of the SG acting as a signalling transfer point (i.e., the Point Code of the SG is different from that of the SPMC), to send MTP Transfer Prohibited (TFP) messages to the relevant adjacent SS7 nodes, according to the local SS7 network procedures.

When the SG determines that the transport of SS7 messages to an ASP in a particular SPMC can be resumed, the SG should similarly inform the MTP3 route management function. This information is used by the MTP3 to mark the route to the affected destination as available, and in the case of a signalling transfer point, to send MTP Transfer Allowed (TFA) messages to the relevant adjacent SS7 nodes, according to the local SS7 network procedures.

For SS7 user part management, it is required that the MTP3-User protocols at ASPs receive indications of SS7 signalling point availability, SS7 network congestion, and remote User Part unavailability as would be expected in an SS7 SEP node. To accomplish this, the MTP-PAUSE, MTP-RESUME and MTP-STATUS indication primitives received at the MTP3 upper layer interface at the SG need to be propagated to the remote MTP3-User lower layer interface at the ASP. (These indication primitives are, of course, also made available to any existing local MTP3-Users at the SG, if present.)

It is important to clarify that MTP3 management messages such as TFPs or TFAs received from the SS7 network are not "encapsulated" and sent blindly to the ASPs. Rather, the existing MTP3 management procedures are followed within the MTP3 function of the SG to re-calculate the MTP3 route set status and to initiate any required signalling-route-set-test procedures into the SS7 network. Only when an SS7 destination status changes are MTP-PAUSE or MTP-RESUME primitives invoked. These primitives can also be invoked due to local SS7 link set conditions as per existing MTP3 procedures.

In the case where the MTP in the SG undergoes an MTP restart, event communication to the concerned ASPs should be handled as follows:

When the SG discovers SS7 network isolation, the SG sends an indication to all concerned available ASPs (i.e., ASPs in the "active" or "inactive" state), using a DUNA message. For the purposes of MTP Restart, all SPMCs with point codes different from that of the SG with at least one ASP that is active or that has sent an ASPAC message to the SG during the first part of the restart procedure should be considered as available. If the M3UA at the SG receives any ASPAC messages during the restart procedure, it delays the ASPAC-ACK messages until the end of the restart procedure. During the second part of the restart procedure the M3UA at the SG informs all concerned ASPs in the "active" or "inactive" state of any unavailable SS7 destinations. At the end of the restart procedure the M3UA sends an ASPAC-ACK message to all ASPs in the "active" state.

1.4.3.3 Application Server

A cluster of application servers is responsible for providing the overall support for one or more SS7 upper layers. From an SS7 standpoint, a Signalling Point Management Cluster (SPMC) provides complete support for the upper layer service for a given point code. As an example, an SPMC providing MGC capabilities must provide complete support for ISUP (and any other MTP3 user located at the point code of the SPMC) for a given point code, according to the local SS7 network specifications.

This measure is necessary to allow the SG to accurately represent the signalling point on the local SS7 network.

In the case where an ASP is connected to more than one SG, the M3UA must maintain the status of configured SS7 destinations and route messages according to availability/congestion/restricted status of the routes to these destinations.

When an ASP enters the "Inactive" state towards an SG the M3UA must mark all SS7 destinations configured to be reachable via this SG as available.

When the M3UA at an ASP receives a DUNA message indicating SS7 network isolation at an SG, it will stop any affected traffic via this SG and clear any unavailability state of SS7 destinations via this SG. When the M3UA subsequently receives any DUNA messages from an SG it will mark the effected SS7 destinations as unavailable via that SG. When the M3UA receives an ASPAC-ACK message it can resume traffic to available SS7 destinations via this SG, provided the ASP is in the active state towards this SG.

1.4.3.3 IPSP Considerations

Since IPSPs use M3UA in a point-to-point fashion, there is no concept of routing of messages beyond the remote end. Therefore, SS7 and M3UA inter-working is not necessary for this model.

1.4.4 Redundancy Models

The network address translation and mapping function of the M3UA layer supports signalling process fail-over functions in order to support a high availability of call and transaction processing capability.

1.4.4.1 Application Server Redundancy

All MTP3-User messages (e.g., ISUP, SCCP) incoming to an SG from the

SS7 network are assigned to a unique Application Server, based on the information in the message and the provisioned Routing Keys.

The Application Server is, in practical terms, a list of all ASPs configured to process a range of MTP3-User traffic defined by one Routing Key. One or more ASPs in the list are normally active (i.e., handling traffic) while any others may be unavailable or inactive, to be possibly used in the event of failure or unavailability of the active ASP(s).

The fail-over model supports an "n+k" redundancy model, where "n" ASPs is the minimum number of redundant ASPs required to handle traffic and "k" ASPs are available to take over for a failed or unavailable ASP. A "1+1" active/standby redundancy is a subset of this model. A simplex "1+0" model is also supported as a subset, with no ASP redundancy.

At the SG, an Application Server list contains active and inactive ASPs to support ASP load-sharing and fail-over procedures. The list of ASPs within a logical Application Server is kept updated in the SG to reflect the active Application Server Process(es).

To avoid a single point of failure, it is recommended that a minimum of two ASPs be in the list, resident in separate hosts and therefore available over different SCTP Associations. For example, in the network shown in Figure 1, all messages to DPC x could be sent to ASP1 in Host1 or ASP1 in Host2. The AS list at SG1 might look like the following:

```
    Routing Key {DPC=x) - "Application Server #1"
        ASP1/Host1  - State=Up, Active
        ASP1/Host2  - State=Up, Inactive
```

In this "1+1" redundancy case, ASP1 in Host1 would be sent any incoming message with DPC=x. ASP1 in Host2 would normally be brought to the active state upon failure of, or loss of connectivity to, ASP1/Host1. In this example, both ASPs are Up, meaning that the related SCTP association and far-end M3UA peer is ready.

The AS List at SG1 might also be set up in load-share mode:

```
    Routing Key {DPC=x) - "Application Server #1"
        ASP1/Host1 - State = Up, Active
        ASP1/Host2 - State = Up, Active
```

In this case, both the ASPs would be sent a portion of the traffic. For example the two ASPs could together form a database, where incoming queries may be sent to any active ASP.

Care must be exercised by a Network Operator in the selection of the routing information to be used as the Routing Key for a particular AS. For example, where Application Servers are defined using ranges of ISUP CIC values, the Operator is implicitly splitting up control of the related circuit groups. Some CIC value range assignments may interfere with ISUP circuit group management procedures.

In the process of fail-over, it is recommended that in the case of ASPs supporting call processing, stable calls do not fail. It is possible that calls in "transition" MAY fail, although measures of communication between the ASPs involved can be used to mitigate this. For example, the two ASPs MAY share call state via shared memory, or MAY use an ASP to ASP protocol to pass call state information. Any ASP-to-ASP protocol is outside the scope of this document.

1.4.4.2 Signalling Gateway Redundancy

Signalling Gateways MAY also be distributed over multiple hosts. Much like the AS model, SGs may be comprised of one or more SG Processes (SGPs), distributed over one or more hosts, using an active/standby or a load-sharing model. An SGP is viewed as a remote SCTP end-point from an ASP perspective. There is, however, no M3UA protocol to manage the status of an SGP. Whenever an SCTP association to an SGP exists, the SGP is assumed to be available. Also, every SGP within an SG communicating with an ASP provides identical SS7 connectivity to this ASP. Should an SGP lose all or partial SS7 connectivity and other SGPs exist, the SGP must terminate the SCTP associations to the concerned ASPs.

It is therefore possible for an ASP to route signalling messages destined to the SS7 network using more than one SGP. In this model, a Signalling Gateway is deployed as a cluster of hosts acting as a single SG. A primary/back-up redundancy model is possible, where the unavailability of the SCTP association to a primary SGP could be used to reroute affected traffic to an alternate SGP. A load-sharing model is possible, where the signalling messages are load-shared between multiple SGPs.

It may also be possible for an ASP to use more than one SG to access a specific SS7 end point, in a model that resembles an SS7 STP mated pair. Typically, SS7 STPs are deployed in mated pairs, with traffic load-shared between them. Other models are also possible, subject to the limitations of the local SS7 network provisioning guidelines.

>From the perspective of the M3UA at an ASP, a particular SG is capable of transferring traffic to an SS7 destination if an SCTP association with at least one SGP of the SG is established, the SGP has returned an ASPAC Ack message acknowledging to the ASP M3UA that the ASP is actively handling traffic for that destination, and the SG has not indicated that the destination is inaccessible. When an ASP is configured to use multiple SGs for transferring traffic to the SS7 network, the ASP must maintain knowledge of the current capability of the SGs to handle traffic to destinations of interest. This information is crucial to the overall reliability of the service, for both active/standby and load-sharing model, in the event of failures, recovery and maintenance activities. The ASP M3UA may also use this information for congestion avoidance purposes. The distribution of the MTP3-user messages over the SGs should be done in such a way to minimize message mis-sequencing, as required by the SS7 User Parts.

1.4.5 Flow Control
Local Management at an ASP may wish to stop traffic across an SCTP association in order to temporarily remove the association from service or to perform testing and maintenance activity. The function could optionally be used to control the start of traffic on to a newly available SCTP association.

1.4.6 Congestion Management

The M3UA Layer is informed of local and IP network congestion by means of an implementation-dependent function (e.g., an implementation-dependent indication from the SCTP of IP network congestion).

At an ASP or IPSP, the M3UA indicates congestion to local MTP3-Users by means of an MTP-Status primitive, as per current MTP3 procedures, to invoke appropriate upper layer responses.

When an SG determines that the transport of SS7 messages to a Signalling Point Management Cluster (SPMC) is encountering congestion, the SG should trigger SS7 MTP3 Transfer Controlled management messages to originating SS7 nodes, as per current MTP3 procedures. The triggering of SS7 MTP3 Management messages from an SG is an implementation-dependent function.

The M3UA at an ASP or IPSP should indicate local congestion to an M3UA peer with an SCON message. When an SG M3UA receives an SCON message from an ASP, and the SG determines that an SPMC is now encountering congestion, it should trigger SS7 MTP3 Transfer Controlled management messages to concerned SS7 destinations according to current MTP procedures.

1.4.7 SCTP Stream Mapping.

The M3UA at both the SG and ASP also supports the assignment of signalling traffic into streams within an SCTP association. Traffic that requires sequencing must be assigned to the same stream. To accomplish this, MTP3-User traffic may be assigned to individual streams based on, for example, the SLS value in the MTP3 Routing Label or the ISUP CIC assignment, subject of course to the maximum number of streams supported by the underlying SCTP association.

The use of SCTP streams within M3UA is recommended in order to minimize transmission and buffering delays, therefore improving the overall performance and reliability of the signalling elements. The distribution of the MTP3 user messages over the various streams should be done in such a way to minimize message mis-sequencing, as required by the SS7 User Parts.

1.4.8 Client/Server Model

The SG takes on the role of server while the ASP is the client. ASPs MUST initiate the SCTP association to the SG.

In the case of IPSP to IPSP communication, the peer endpoints using M3UA SHOULD be configured so that one always takes on the role of client and the other the role of server for initiating SCTP associations and M3UA messaging.

The SCTP (and UDP/TCP) Registered User Port Number Assignment for M3UA is 2905.

1.5 Sample Configurations

1.5.1 Example 1: ISUP message transport

```
********   SS7   *****************   IP   ********
* SEP  *---------*       SG      *--------* ASP  *
********         *****************        ********

+------+                                  +------+
| ISUP |            (NIF)                 | ISUP |
+------+         +------+-+------+        +------+
| MTP3 |         | MTP3 | | M3UA |        | M3UA |
+------|         +------+ +------+        +------+
| MTP2 |         | MTP2 | | SCTP |        | SCTP |
+------+         +------+ +------+        +------+
|  L1  |         |  L1  | |  IP  |        |  IP  |
+------+         +------+ +------+        +------+
    |________________|          |______________|
```

SEP - SS7 Signalling End Point
SCTP - Stream Control Transmission Protocol
NIF - Nodal Inter-working Function

In this example, the SG provides an implementation-dependent nodal inter-working function (NIF) that allows the MGC to exchange SS7 signalling messages with the SS7-based SEP. The NIF within the SG serves as the interface within the SG between the MTP3 and M3UA. This nodal inter-working function has no visible peer protocol with either the MGC or SEP. It also provides network status information to one or both sides of the network.

For internal SG modeling purposes, at the NIF level, SS7 signalling messages that are destined to the MGC are received as MTP-TRANSFER indication primitives from the MTP Level 3 upper layer interface and are sent to the local M3UA-resident message distribution function for ongoing routing to the final IP destination. MTP-TRANSFER primitives received from the local M3UA network address translation and mapping function are sent to the MTP Level 3 upper layer interface as MTP-TRANSFER request primitives for on-going MTP Level 3 routing to an SS7 SEP. For the purposes of providing SS7 network status information the NIF also delivers MTP-PAUSE, MTP-RESUME and MTP-STATUS indication primitives received from the MTP Level 3 upper layer interface to the local M3UA-resident management function. In addition, as an implementation and network option, restricted destinations are communicated from MTP network management to the local M3UA-resident management function.

1.5.2 Example 2: SCCP Transport between IPSPs

```
       ********    IP    ********
       * IPSP *          * IPSP *
       ********          ********

       +------+          +------+
       |SCCP- |          |SCCP- |
       | User |          | User |
       +------+          +------+
       | SCCP |          | SCCP |
       +------+          +------+
       | M3UA |          | M3UA |
       +------+          +------+
       | SCTP |          | SCTP |
       +------+          +------+
       |  IP  |          |  IP  |
       +------+          +------+
          |________________|
```

This example shows an architecture where no Signalling Gateway is used. In this example, SCCP messages are exchanged directly between two IP-resident IPSPs with resident SCCP-User protocol instances, such as RANAP or TCAP. SS7 network inter-working is not required, therefore there is no MTP3 network management status information for the SCCP and SCCP-User protocols to consider. Any MTP-PAUSE, -RESUME or -STATUS indications from the M3UA to the SCCP should consider the status of the SCTP Association and underlying IP network and any congestion information received from the remote site.

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1.5.3 Example 3: SG resident SCCP layer, with remote ASP

```
  ********   SS7   *****************   IP   ********
  * SEP  *---------*               *--------*      *
  *  or  *         *      SG       *        * ASP  *
  * STP  *         *               *        *      *
```

```
  ********        ****************         ********

  +------+        +---------------+        +------+
  | SCCP-|        |     SCCP      |        | SCCP-|
  | User |        +---------------+        | User |
  +------+          |    _____    |        +------+
  | SCCP |          |   |     |   |        | SCCP |
  +------+        +------+-+------+        +------+
  | MTP3 |        | MTP3 | | M3UA |        | M3UA |
  +------|        +------+ +------+        +------+
  | MTP2 |        | MTP2 | | SCTP |        | SCTP |
  +------+        +------+ +------+        +------+
  |  L1  |        |  L1  | |  IP  |        |  IP  |
  +------+        +------+ +------+        +------+
      |_______________|        |______________|

    STP - SS7 Signalling Transfer Point
```

In this example, the SG contains an instance of the SS7 SCCP protocol layer that may, for example, perform the SCCP Global Title Translation (GTT) function for messages logically addressed to the SG SCCP. If the result of a GTT for an SCCP message yields an SS7 DPC or DPC/SSN address an SCCP peer located in the IP domain, the resulting MTP-TRANSFER request primitive is sent to the local M3UA-resident network address translation and mapping function for ongoing routing to the final IP destination.

Similarly, the SCCP instance in an SG can perform the SCCP GTT service for messages logically addressed to it from SCCP peers in the IP domain. In this case, MTP-TRANSFER messages are sent from the local M3UA-resident network address translation and mapping function to the SCCP for GTT. If the result of the GTT yields the address of an SCCP peer in the SS7 network then the resulting MTP-TRANSFER request is given to the MTP3 for delivery to an SS7-resident node.

It is possible that the above SCCP GTT at the SG could yield the address of an SCCP peer in the IP domain and the resulting MTP-TRANSFER primitive would be sent back to the M3UA for delivery to an IP destination.

For internal SG modeling purposes, this may be accomplished with the use of an implementation-dependent nodal inter-working function within the SG that effectively sits below the SCCP and routes MTP-TRANSFER messages to/from both the MTP3 and the M3UA, based on the SS7 DPC or DPC/SSN

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address information. This nodal inter-working function has no visible peer protocol with either the ASP or SEP.

Note that the services and interface provided by the M3UA are the same as in Example 1 and the functions taking place in the SCCP entity are transparent to M3UA. The SCCP protocol functions are not reproduced in the M3UA protocol.

1.6 Definition of M3UA Boundaries

1.6.1 Definition of the boundary between M3UA and an MTP3-User.

>From ITU Q.701 [14]:

MTP-TRANSFER request
MTP-TRANSFER indication
MTP-PAUSE indication
MTP-RESUME indication
MTP-STATUS indication

1.6.2 Definition of the boundary between M3UA and SCTP

An example of the upper layer primitives provided by the SCTP are provided in Reference [13] Section 10.

1.6.3 Definition of the Boundary between M3UA and Layer Management

M-SCTP ESTABLISH request
Direction: LM -> M3UA
Purpose: LM requests ASP to establish an SCTP association with an SG.

M-STCP ESTABLISH confirm
Direction: M3UA -> LM
Purpose: ASP confirms to LM that it has established an SCTP association with an SG.

M-SCTP ESTABLISH indication
Direction: M3UA -> LM
Purpose: M3UA informs LM that a remote ASP has established an SCTP association.

M-SCTP RELEASE request
Direction: LM -> M3UA
Purpose: LM requests ASP to release an SCTP association with SG.

M-SCTP RELEASE confirm
Direction: M3UA -> LM
Purpose: ASP confirms to LM that it has released SCTP association with SG.

M-SCTP RELEASE indication
Direction: M3UA -> LM
Purpose: M3UA informs LM that a remote ASP has released an SCTP Association or the SCTP association has failed.

M-SCTP STATUS request
Direction: LM -> M3UA
Purpose: LM requests M3UA to report the status of an SCTP association.

M-SCTP STATUS confirm
Direction: M3UA -> LM
Purpose: M3UA reports the status of an SCTP association.

```
   M-ASP STATUS request
   Direction: LM -> M3UA
   Purpose: LM requests M3UA to report the status of a local or remote
            ASP.

   M-ASP STATUS confirm
   Direction: M3UA -> LM
   Purpose: M3UA reports status of local or remote ASP.

   M-AS STATUS request
   Direction: LM -> M3UA
   Purpose: LM requests M3UA to report the status of an AS.

   M-AS STATUS confirm
   Direction: M3UA -> LM
   Purpose: M3UA reports the status of an AS.

   M-NOTIFY indication
   Direction: M3UA -> LM
   Purpose: M3UA reports that it has received a NOTIFY message
            from its peer.

   M-ERROR indication
   Direction: M3UA -> LM
   Purpose: M3UA reports that it has received an ERROR message from
            its peer or that a local operation has been unsuccessful.

   M-ASP UP request
   Direction: LM -> M3UA
   Purpose: LM requests ASP to start its operation and send an ASP-UP
            Message to its peer.
```



```
   M-ASP UP confirm
   Direction: M3UA -> LM
   Purpose: ASP reports that is has received an ASP UP Acknowledgement
            message from the SG.

   M-ASP UP indication
   Direction: M3UA -> LM
   Purpose: M3UA reports it has successfully processed an incoming ASP-
            UP request from its peer.

   M-ASP DOWN request
   Direction: LM -> M3UA
   Purpose: LM requests ASP to stop its operation and send an ASP-DOWN
            Message to its peer.

   M-ASP DOWN confirm
   Direction: M3UA -> LM
   Purpose: ASP reports that is has received an ASP DOWN
            Acknowledgement message from the SG.

   M-ASP DOWN indication
   Direction: M3UA -> LM
   Purpose: M3UA reports it has successfully processed an incoming ASP-
            DOWN request from its peer.
```

M-ASP-ACTIVE request
Direction: LM -> M3UA
Purpose: LM requests ASP to send an ASP-ACTIVE message to its peer.

M-ASP ACTIVE confirm
Direction: M3UA -> LM
Purpose: ASP reports that is has received an ASP ACTIVE Acknowledgement message from the SG.

M-ASP ACTIVE indication
Direction: M3UA -> LM
Purpose: LM reports it has successfully processed an incoming ASP-ACTIVE request from its peer.

M-ASP-INACTIVE request
Direction: LM -> M3UA
Purpose: LM requests ASP to send an ASP- Inactive message to the SG.

M-ASP INACTIVE confirm
Direction: LM -> M3UA
Purpose: ASP reports that is has received an ASP INACTIVE Acknowledgement message from the SG.

M-ASP INACTIVE indication
Direction: M3UA -> LM
Purpose: LM reports it has successfully processed an incoming ASP-INACTIVE request from its peer.

M-AS ACTIVE indication
Direction: M3UA -> LM
Purpose: LM reports that an AS has moved to the ACTIVE state.

M-AS INACTIVE indication
Direction: M3UA -> LM
Purpose: LM reports that an AS has moved to the INACTIVE state.

M-AS DOWN indication
Direction: M3UA -> LM
Purpose: LM reports that an AS has moved to the DOWN state.

2.0 Conventions

The keywords MUST, MUST NOT, REQUIRED, SHALL, SHALL NOT, SHOULD, SHOULD NOT, RECOMMENDED, NOT RECOMMENDED, MAY, and OPTIONAL, when they appear in this document, are to be interpreted as described in [RFC2119].

3.0 M3UA Protocol Elements

The general M3UA message format includes a Common Message Header followed by zero or more parameters as defined by the Message Type. For forward compatibility, all Message Types may have attached parameters even if none are specified in this version.

3.1 Common Message Header

The protocol messages for MTP3-User Adaptation require a message header which contains the adaptation layer version, the message type, and message length.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    |   Reserved    | Message Class | Message Type  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Message Length                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                                                               /
```


All fields in an M3UA message MUST be transmitted in the network byte order, unless otherwise stated.

3.1.1 M3UA Protocol Version: 8 bits (unsigned integer)

The version field contains the version of the M3UA adaptation layer.

The supported versions are the following:

1 Release 1.0

3.1.2 Message Classes and Types

The following list contains the valid Message Classes:

Message Class: 8 bits (unsigned integer)

The following list contains the valid Message Type Classes:

```
     0     Management (MGMT) Message [IUA/M2UA/M3UA/SUA]
     1     Transfer Messages [M3UA]
     2     SS7 Signalling Network Management (SSNM) Messages [M3UA/SUA]
     3     ASP State Maintenance (ASPSM) Messages [IUA/M2UA/M3UA/SUA]
     4     ASP Traffic Maintenance (ASPTM) Messages [IUA/M2UA/M3UA/SUA]
     5     Q.921/Q.931 Boundary Primitives Transport (QPTM) Messages
              [IUA]
     6     MTP2 User Adaptation (MAUP) Messages [M2UA]
     7     Connectionless Messages [SUA]
     8     Connection-Oriented Messages [SUA]
     9     Routing Key Management (RKM) Messages (M3UA)
  10 to 127 Reserved by the IETF
  28 to 255 Reserved for IETF-Defined Message Class extensions
```

Message Type: 8 bits (unsigned integer)

The following list contains the message types for the defined

```
   messages.

     Management (MGMT) Message

         0        Error (ERR)
         1        Notify (NTFY)
      2 to 127    Reserved by the IETF
    128 to 255    Reserved for IETF-Defined MGMT extensions

     Transfer Messages

         0        Reserved
         1        Payload Data (DATA)
      2 to 127    Reserved by the IETF
    128 to 255    Reserved for IETF-Defined Transfer extensions
```



```
     SS7 Signalling Network Management (SSNM) Messages

         0        Reserved
         1        Destination Unavailable (DUNA)
         2        Destination Available (DAVA)
         3        Destination State Audit (DAUD)
         4        SS7 Network Congestion State (SCON)
         5        Destination User Part Unavailable (DUPU)
         6        Destination Restricted (DRST)
      7 to 127    Reserved by the IETF
    128 to 255    Reserved for IETF-Defined SSNM extensions

  ASP State Maintenance (ASPSM) Messages

         0        Reserved
         1        ASP Up (UP)
         2        ASP Down (DOWN)
         3        Heartbeat (BEAT)
         4        ASP Up Ack (UP ACK)
         5        ASP Down Ack (DOWN ACK)
         6        Heatbeat Ack (BEAT ACK)
      7 to 127    Reserved by the IETF
    128 to 255    Reserved for IETF-Defined ASPSM extensions

  ASP Traffic Maintenance (ASPTM) Messages

         0        Reserved
         1        ASP Active (ACTIVE)
         2        ASP Inactive (INACTIVE)
         3        ASP Active Ack (ACTIVE ACK)
         4        ASP Inactive Ack (INACTIVE ACK)
      5 to 127    Reserved by the IETF
    128 to 255    Reserved for IETF-Defined ASPTM extensions

  Routing Key Management (RKM) Messages

         0        Reserved
         1        Registration Request (REG REQ)
         2        Registration Response (REG RSP)
         3        Deregistration Request (DEREG REQ)
         4        Deregistration Response (DEREG RSP)
      5 to 127    Reserved by the IETF
```

128 to 255   Reserved for IETF-Defined ASPTM extensions

3.1.3 Reserved: 8 bits

The Reserved field SHOULD be set to all '0's and ignored by the receiver.

3.1.4 Message Length: 32-bits (unsigned integer)

The Message Length defines the length of the message in octets, including the Common Header. For messages with a final parameter containing padding, the parameter padding MUST be included in the Message Length.

Note: A receiver SHOULD accept the message whether or not the final parameter padding is included in the message length.

3.2 Variable-Length Parameter Format

M3UA messages consist of a Common Header followed by zero or more variable length parameters, as defined by the message type. All the parameters contained in a message are defined in a Tag-Length-Value format as shown below.

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |          Parameter Tag        |       Parameter Length        |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 \                                                               \
 /                       Parameter Value                         /
 \                                                               \
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Where more than one parameter is included in a message, the parameters may be in any order, except where explicitly mandated. A receiver SHOULD accept the parameters in any order.

Parameter Tag: 16 bits (unsigned integer)

The Tag field is a 16-bit identifier of the type of parameter. It takes a value of 0 to 65534. The parameter Tags defined are as follows:

```
      0        Reserved
      1        Network Appearance
      2        Protocol Data 1
      3        Protocol Data 2
      4        Info String
      5        Affected Destinations
      6        Routing Context
      7        Diagnostic Information
      8        Heartbeat Data
      9        User/Cause
```

```
        10         Reason
        11         Traffic Mode Type
```



```
        12         Error Code
        13         Status Type/ID
        14         Congestion Indications
        15         Concerned Destination
        16         Routing Key
        17         Registration Result
        18         De-registration Result
        19         Local_Routing Key Identifier
        20         Destination Point Code
        21         Service Indicators
        22         Subsystem Numbers
        23         Originating Point Code List
        24         Circuit Range
        25         Registration Results
        26         De-Registration Results
     27 to 65534   Reserved by the IETF
```

The value of 65535 is reserved for IETF-defined extensions. Values other than those defined in specific parameter description are reserved for use by the IETF.

Parameter Length: 16 bits (unsigned integer)

The Parameter Length field contains the size of the parameter in bytes, including the Parameter Tag, Parameter Length, and Parameter Value fields. The Parameter Length does not include any padding bytes.

Parameter Value: variable-length.

The Parameter Value field contains the actual information to be transferred in the parameter.

The total length of a parameter (including Tag, Parameter Length and Value fields) MUST be a multiple of 4 bytes. If the length of the parameter is not a multiple of 4 bytes, the sender pads the Parameter at the end (i.e., after the Parameter Value field) with all zero bytes. The length of the padding is NOT included in the parameter length field. A sender SHOULD NEVER pad with more than 3 bytes. The receiver MUST ignore the padding bytes.

3.3 Transfer Messages

The following section describes the Transfer messages and parameter contents.

3.3.1 Payload Data Message (DATA)

The DATA message contains the SS7 MTP3-User protocol data, which is an MTP-TRANSFER primitive, including the complete MTP3 Routing Label. The Data message contains the following variable length parameters:

Network Appearance	Optional
Protocol Data 1 or 2	Mandatory

The following format MUST be used for the Data Message:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag = 1            |          Length = 8           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Network Appearance*                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag = 3            |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                        Protocol Data                          /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Network Appearance: 32-bits (unsigned integer)

The optional Network Appearance parameter identifies the SS7 network context for the message, for the purposes of logically separating the signalling traffic between the SG and the Application Server Process over a common SCTP Association. An example is where an SG is logically partitioned to appear as an element in four different national SS7 networks.

In a Data message, the Network Appearance implicitly defines the SS7 Point Code format used, the SS7 Network Indicator value, and the MTP3 and possibly the MTP3-User protocol type/variant/version used within the SS7 network partition. Where an SG operates in the context of a single SS7 network, or individual SCTP associations are dedicated to each SS7 network context, the Network Appearance parameter is not required.

The Network Appearance parameter value is of local significance only, coordinated between the SG and ASP. Therefore, in the case where an ASP is connected to more than one SG, the same SS7 network context may be identified by different Network Appearances depending over which SG a message is being transmitted/received.

Where the optional Network Appearance parameter is present, it must be the first parameter in the message as it defines the format of the Protocol Data field.

Protocol Data 1 or 2: variable length

One of two possible Protocol Data parameters are included in a DATA message: Protocol Data 1 or Protocol Data 2.

The Protocol Data 1 parameter contains the original SS7 MTP3 message, including the Service Information Octet and Routing Label.

The Protocol Data 1 parameter contains the following fields:

Service Information Octet. Includes:
Service Indicator,
Network Indicator,
and Spare/Priority codes

Routing Label. Includes:
Destination Point Code,
Originating Point Code,
And Signalling Link Selection Code (SLS)

User Protocol Data. Includes:
MTP3-User protocol elements (e.g., ISUP, SCCP, or TUP parameters)

The Protocol Data 2 parameter contains all the information in Protocol Data 1 as described above, plus the MTP2 Length Indicator octet. The MTP2 Length Indicator (LI) octet appears before the SIO and Routing Label information. The MTP2 Length Indicator octet is required for some national MTP variants that use the spare bits in the LI to carry additional information of interest to the MTP3 and MTP3-User (e.g., the Japan TTC standard use of LI spare bits to indicate message priority)

The Payload Data format is as defined in the relevant MTP standards for the SS7 protocol being transported. The format is either implicitly known or identified by the Network Appearance parameter. Note: In the SS7 Recommendations, the format of the messages and fields within the messages are based on bit transmission order. In these recommendations the Least Significant Bit (LSB) of each field is positioned to the right. For this document the received SS7 fields are populated octet by octet as received into the 4-octet word as shown in the examples below.

For the ANSI protocol example, the Protocol Data field format is shown below:

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```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      SIO      |  DPC Member   |  DPC Cluster  |  DPC Network  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  OPC Member   |  OPC Cluster  |  OPC Network  |      SLS      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                         Protocol Data                         /
```

```
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |MSB---------------------------------------------------------LSB|
```

Within each octet the Least Significant Bit (LSB) per the SS7 Recommendations is to the right (e.g., bit 7 of SIO is the LSB).

For the ITU international protocol example, the Protocol Data field is shown below.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      SIO      | DPC      | DPC |OPC| DPC | DPC |   OPC     |@|
   |               | Region *| SP *|SP*|Zone*| reg.|  Region   *| |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |  SLS  | OPC |$|      Protocol                                 |
   |      *| SP *| |        Data                                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   * marks LSB of each field;  @ = OPC SP MSB;  $ = OPC region MSB
```

3.4 SS7 Signalling Network Management (SSNM) Messages

3.4.1 Destination Unavailable (DUNA)

The DUNA message is sent from the SG to all concerned ASPs to indicate that the SG has determined that one or more SS7 destinations are unreachable. It is also sent in response to a message from the ASP to an unreachable SS7 destination. As an implementation option the SG may suppress the sending of subsequent "response" DUNAs regarding a certain unreachable SS7 destination for a certain period in order to give the remote side time to react. The MTP3-User at the ASP is expected to stop traffic to the affected destination through the SG initiating the DUNA as per the defined MTP3-User procedures.

The DUNA message contains the following parameters:

```
     Network Appearance       Optional
     Affected Destinations    Mandatory
     Info String              Optional
```

The format for DUNA Message parameters is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 1            |          Length =8            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Network Appearance*                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
   |            Tag = 5            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Mask      |               Affected DPC 1                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                              ...                              /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Mask      |                Affected DPC n                 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Tag = 4           |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                          INFO String*                         /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Network Appearance: 32-bit unsigned integer

See Section 3.3.1

Affected Destinations: n x 32-bits

The Affected Destinations parameter contains up to sixteen Affected Destination Point Code fields, each a three-octet parameter to allow for 14-, 16- and 24-bit binary formatted SS7 Point Codes. Affected Point Codes that are less than 24-bits, are padded on the left to the 24-bit boundary. The encoding is shown below for ANSI and ITU Point Code examples.

ANSI 24-bit Point Code:

```
       0                   1                   2                   3
       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
      |     Mask      |    Network    |    Cluster    |     Member    |
      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

                      |MSB-----------------------------------------LSB|
```

ITU 14-bit Point Code:

```
       0                   1                   2                   3
       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
      |     Mask      |0 0 0 0 0 0 0 0 0 0|Zone |     Region    | SP  |
      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

                                          |MSB--------------------LSB|
```

It is optional to send an Affected Destinations parameter with more than one Affected DPC but it is mandatory to receive and process it. All the Affected DPCs included must be within the same Network Appearance. Including multiple Affected DPCs may be useful when reception of an MTP3 management message or a linkset event simultaneously affects the availability status of a list of destinations at an SG.

Mask: 8-bits (unsigned integer)

The Mask field associated with each Affected DPC in the Affected Destinations parameter, used to identify a contiguous range of Affected Destination Point Codes, independent of the point code format. Identifying a contiguous range of Affected DPCs may be useful when reception of an MTP3 management message or a linkset event simultaneously affects the availability status of a series of destinations at an SG. For example, if all DPCs in an ANSI cluster are determined to be unavailable due to local linkset unavailability, the DUNA could identify potentially 256 Affected DPCs in a single Affected DPC field.

The Mask parameter represents a bit mask that can be applied to the related Affected DPC field. The bit mask identifies how many bits of the Affected DPC field are significant and which are effectively "wildcarded". For example, a mask of "8" indicates that the least significant eight bits of the DPC is "wildcarded". For an ANSI 24-bit Affected DPC, this is equivalent to signalling that all DPCs in an ANSI Cluster are unavailable. A mask of "3" indicates that the least significant three bits of the DPC is "wildcarded". For a 14-bit ITU Affected DPC, this is equivalent to signaling that an ITU

Region is unavailable. A mask value equal to the number of bits in the DPC indicates that the entire network appearance is affected û this is used to indicate network isolation to the ASP.

Info String: variable length

The optional INFO String parameter can carry any 8-bit ASCII character string along with the message. Length of the INFO String parameter is from 0 to 255 characters. No procedures are presently identified for its use but the INFO String MAY be used by Operators to identify in text form the location reflected by the Affected DPC for debugging purposes.

3.4.2 Destination Available (DAVA)

The DAVA message is sent from the SG to all concerned ASPs to indicate that the SG has determined that one or more SS7 destinations are now reachable (and not restricted), or in response to a DAUD message if appropriate. The ASP MTP3-User protocol is allowed to resume traffic to the affected destination through the SG initiating the DUNA.

The DAVA message contains the following parameters:

Network Appearance	Optional
Affected Destinations	Mandatory
Info String	Optional

The format and description of the Network Appearance, Affected Destinations and Info String parameters is the same as for the DUNA message (See Section 3.4.1.)

3.4.3 Destination State Audit (DAUD)

The DAUD message can be sent from the ASP to the SG to audit the availability/congestion state of SS7 routes to one or more affected destinations.

The DAUD message contains the following parameters:

```
     Network Appearance       Optional
     Affected Destinations    Mandatory
     Info String              Optional
```

The format and description of DAUD Message parameters is the same as for the DUNA message (See Section 3.4.1.)

3.4.4 SS7 Network Congestion (SCON)

The SCON message can be sent from the SG to all concerned ASPs to indicate congestion in the SS7 network to one or more destinations, or

to an ASP in response to a DATA or DAUD message as appropriate. For some MTP protocol variants (e.g., ANSI MTP) the SCON may be sent when the SS7 congestion level changes. The SCON message MAY also be sent from the M3UA of an ASP to an M3UA peer indicating that the M3UA or the ASP is congested.

The SCON message contains the following parameters:

```
     Network Appearance        Optional
     Affected Destinations     Mandatory
     Concerned Destination     Optional     Congestion Indications
Optional
     Info String               Optional
```

The format for SCON Message parameters is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 1            |          Length =8            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Network Appearance*                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 5            |            Length             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Mask     |                 Affected DPC 1                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                              ...                              /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Mask     |                 Affected DPC n                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
   |            Tag = 15           |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    reserved   |                 Concerned DPC                 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 14           |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                   Reserved                    |  Cong. Level* |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 4            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                         INFO String*                          /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


The format and description of the Network Appearance, Affected Destinations, and Info String parameters is the same as for the DUNA message (See Section 3.4.1.)

The Affected Destinations parameter can be used to indicate congestion of multiple destinations or ranges of destinations. However, an SCON MUST not be delayed in order to "collect" individual congested destinations into a single SCON as any delay might affect the timing of congestion indications to the M3UA Users. One use for including a range of Congested DPCs is when the SG supports an ANSI cluster route set to the SS7 network that becomes congested due to outgoing link set congestion.

Concerned Destination: 32-bits

The optional Concerned Destination parameter is only used if the SCON is sent from an ASP to the SG. It contains the point code of the originator of the message that triggered the SCON. The Concerned Destination parameter contains one Concerned Destination Point Code field, a three-octet parameter to allow for 14-, 16- and 24-bit binary formatted SS7 Point Codes. A Concerned Point Code that is less than 24-bits, is padded on the left to the 24-bit boundary. The SG sends a Transfer Controlled Message to the Concerned Point Code using the single Affected DPC contained in the SCON to populate the (affected) Destination field of the TFC message. Normally the Affected DPC will be equal to the point code of the ASP.

Congested Indications: 32-bits

The optional Congestion Indications parameter contains a Congestion Level field. This optional parameter is used to communicate congestion levels in national MTP networks with multiple congestion thresholds, such as in ANSI MTP3. For MTP congestion methods without multiple congestion levels (e.g., the ITU international method) the parameter is not included.

Congestion Level field: 8-bits (unsigned integer)

The Congestion Level field, associated with all of the Affected

DPC(s) in the Affected Destinations parameter, contains one of the Following values:

```
      0     No Congestion or Undefined
      1     Congestion Level 1
      2     Congestion Level 2
      3     Congestion Level 3
```

The congestion levels are defined in the congestion method in the appropriate national MTP recommendations [14,15].

3.4.5 Destination User Part Unavailable (DUPU)

The DUPU message is used by an SG to inform an ASP that a remote peer MTP3-User Part (e.g., ISUP or SCCP) at an SS7 node is unavailable.

The DUPU message contains the following parameters:

```
     Network Appearance        Optional
     Affected Destinations     Mandatory
     User/Cause                Mandatory
     Info String               Optional
```

The format for DUPU Message parameters is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 1            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Network Appearance*                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 5            |          Length = 8           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Mask = 0    |                 Affected DPC                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 9            |          Length = 8           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Cause             |              User             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 4            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                          INFO String*                         /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

User/Cause: 32-bits

The Unavailability Cause and MTP3-User Identity fields, associated with the Affected DPC in the Affected Destinations parameter, are encoded as follows:

Unavailability Cause field: 16-bits (unsigned integer)

The Unavailability Cause parameter provides the reason for the unavailability of the MTP3-User. The valid values for the Unavailability Cause parameter are shown in the following table. The values agree with those provided in the SS7 MTP3 User Part Unavailable message. Depending on the MTP3 protocol used in the

network appearance, additional values may be used - the specification of the relevant MTP3 protocol variant/version recommendation is definitive.

0	Unknown
1	Unequipped Remote User
2	Inaccessible Remote User

MTP3-User Identity field: 16-bits (unsigned integer)

The MTP3-User Identity describes the specific MTP3-User that is unavailable (e.g., ISUP, SCCP, ...). Some of the valid values for the MTP3-User Identity are shown below. The values agree with those provided in the SS7 MTP3 User Part Unavailable message and Service Indicator. Depending on the MTP3 protocol variant/version used in the network appearance, additional values may be used. The relevant MTP3 protocol variant/version recommendation is definitive.

0 to 2	Reserved
3	SCCP
4	TUP
5	ISUP
6 to 8	Reserved
9	Broadband ISUP
10	Satellite ISUP

The format and description of the Affected Destinations parameter is the same as for the DUNA message (See Section 3.4.1.) except that the Mask field is not used and only a single Affected DPC is included. Ranges and lists of Affected DPCs cannot be signaled in a DUPU, but this is consistent with UPU operation in the SS7 network. The Affected Destinations parameter in an MTP3 User Part Unavailable message (UPU) received by an SG from the SS7 network contains only one destination.

The format and description of the Network Appearance and Info String parameters is the same as for the DUNA message (See Section 3.4.1.).

3.4.6 Destination Restricted (DRST)

The DRST message is optionally sent from the SG to all concerned ASPs to indicate that the SG has determined that one or more SS7 destinations are now restricted, or in response to a DAUD message if appropriate. The M3UA at the ASP is expected to send traffic to the affected destination via an alternate SG of equal priority, but only if such an alternate route exists and is available. If the affected destination is currently considered unavailable by the ASP, traffic to the affected destination through the SG initiating the DRST should be resumed.

This message is optional for the SG to send and optional for the ASP to process. It is for use in the "STP" case described in Section 1.4.2.

The DRST message contains the following parameters:

```
Network Appearance       Optional
Affected Destinations    Mandatory
Info String              Optional
```

The format and description of the Network Appearance, Affected Destinations and Info String parameters is the same as for the DUNA message (See Section 3.4.1.)

3.5 Application Server Process Maintenance (ASPM) Messages

3.5.1 ASP Up (ASPUP)

The ASP UP (ASPUP) message is used to indicate to a remote M3UA peer that the Adaptation layer is ready to receive SSNM or ASPM management messages for all Routing Keys that the ASP is configured to serve.

The ASPUP message contains the following parameters:

```
INFO String                   Optional
```

The format for ASPUP Message parameters is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag = 4            |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                          INFO String*                         /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The format and description of the optional Info String parameter is the same as for the DUNA message (See Section 3.4.1.)

3.5.2 ASP Up Ack

The ASP UP Ack message is used to acknowledge an ASP-Up message received from a remote M3UA peer.

The ASPUP Ack message contains the following parameters:

INFO String (optional)

The format for ASPUP Ack Message parameters is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag =4             |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                          INFO String*                         /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The format and description of the optional Info String parameter is the same as for the DUNA message (See Section 3.4.1.)

3.5.3 ASP Down (ASPDN)

The ASP Down (ASPDN) message is used to indicate to a remote M3UA peer that the adaptation layer is NOT ready to receive traffic or maintenance messages.

The ASPDN message contains the following parameters:

```
Reason          Mandatory
INFO String     Optional
```

The format for the ASPDN message parameters is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Tag = 10            |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Reason                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag =4             |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                         INFO String*                          /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


The format and description of the optional Info String parameter is the same as for the DUNA message (See Section 3.4.1.)

Reason: 32-bit (unsigned integer)

The Reason parameter indicates the reason that the remote M3UA

```
   adaptation layer is unavailable.  The valid values for Reason are
   shown in the following table.

         0       Unspecified
         1       User Unavailable
         2       Management Blocking
```

3.5.4 ASP Down Ack

The ASP Down Ack message is used to acknowledge an ASP-Down message received from a remote M3UA peer, or to reply to an ASPM message from an ASP which is locked out for management reasons.

The ASP Down Ack message contains the following parameters:

```
     Reason          Mandatory
     INFO String     Optional
```

The format for the ASPDN Ack message parameters is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag = 10            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             Reason                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 4            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                          INFO String*                         /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The format and description of the optional Info String parameter is the same as for the DUNA message (See Section 3.4.1.)

The format of the Reason parameter is the same as for the ASP-Down message. (See Section 3.4.3)

3.5.5 Registration Request (REG REQ)

The REG REQ message is sent by an ASP to indicate to a remote M3UA peer that it wishes to register one or more given Routing Key with the

remote peer. Typically, an ASP would send this message to an SGP, and expects to receive a REG RSP in return with an associated Routing Context value.

The REG REQ message contains the following parameters:

```
     Routing Key            Mandatory
```

The format for the REG REQ message is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Tag = 16          |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                         Routing Key 1                         /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                              ...                              /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Tag = 16          |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                         Routing Key n                         /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Routing Key: variable length

The Routing Key parameter is mandatory. The sender of this message expects that the receiver of this message will create a Routing Key entry and assign a unique Routing Context value to it, if the Routing Key entry does not already exist.

The Routing Key parameter may be present multiple times in the same message. This is used to allow the registration of multiple Routing Keys in a single message.

The format of the Routing Key parameter is as follows.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Local-RK-Identifier                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Destination Point Code                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Network Appearance (optional)                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       SI (optional)                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         SSN (optional)                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Origination Point Code List (optional)            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Circuit Range List (optional)                 |
```

```
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Local-RK-Identifier: 32-bit integer

The mandatory Local-RK-Identifier field is used to uniquely identify the registration request. The Identifier value is assigned by the ASP, and is used to correlate the response in an REG RSP message with the original registration request. The Identifier value must remain unique until the REG RSP is received.

The format of the Local-RK-Identifier field is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 19           |          Length = 8           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                   Local-RK-Identifier value                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Destination Point Code:

The Destination Point Code parameter is mandatory, and identifies the Destination Point Code of incoming SS7 traffic for which the ASP is registering. The format is the same as described for the Affected Destination parameter in the DUNA Message (See Section 3.4.1). Its format is:


```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 20           |          Length = 8           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Mask = 0   |             Destination Point Code            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Network Appearance:

The optional Network Appearance parameter field identifies the SS7 Network context for the Routing Key, and has the same format as in the Data message (See Section 3.3.1). Its format is:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Tag = 1           |          Length = 8           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                       Network Appearance                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Service Indicators (SI): n X 8-bit integers

The SI field contains one or more Service Indicators from the values as described in the MTP3-User Identity field of the DUPU Message. The absence of the SI parameter in the Routing Key indicates the use of any SI values, excluding of course MTP management. Where an SI parameter does not contain a multiple of four SIs, the parameter is padded out to 32-byte alignment. An SI value of zero is not valid in M3UA. The SI format is:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Tag = 21            |          Length = var.        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      SI #1    |      SI #2    |      SI #3     |     SI #4     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
/                              ...                              /
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      SI #n    |             0 Padding, if necessary           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Subsystem Numbers (SSN): n X 8-bit integers

The optional SSN field contains one or more SCCP subsystem numbers, and is used in conjunction with an SI values of 3 (i.e., SCCP) only. Where an SSN parameter does not contain a multiple of four SSNs, the parameter is padded out to 32-byte alignment. The subsystem number

values associated are defined by the local network operator, and typically follow ITU-T Recommendation Q.713. An SSN value of zero is not valid in M3UA. The format of this field is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Tag = 22            |          Length = var.        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     SSN #1    |     SSN #2    |     SSN #3     |    SSN #4     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
/                              ...                              /
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     SSN #n    |             0 Padding, if necessary           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

OPC List:

The Originating Point Code List parameter contains one or more SS7 OPC entries, and its format is the same as the Destination Point Code parameter.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Tag = 23            |          Length = var.        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Mask = 0   |          Origination Point Code #1            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Mask = 0   |          Origination Point Code #2            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
/                              ...                              /
```

```
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Mask = 0   |           Origination Point Code #n           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Circuit Range:

An ISUP controlled circuit is uniquely identified by the SS7 OPC, DPC and CIC value. For the purposes of identifying Circuit Ranges in an M3UA Routing Key, the optional Circuit Range parameter includes one or more circuit ranges, each identified by an OPC and Upper/Lower CIC value. The DPC is implicit as it is mandatory and already included in the DPC parameter of the Routing Key. The Origination Point Code is encoded the same as the Destination Point Code parameter, while the CIC values are 16-bit integers.

The Circuit Range format is as follows:


```
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Tag = 24             |          Length = var.        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Mask = 0   |           Origination Point Code #1           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       Lower CIC Value #1      |      Upper CIC Value #1       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Mask = 0   |           Origination Point Code #2           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       Lower CIC Value #2      |      Upper CIC Value #2       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   /                              ...                              /
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Mask = 0   |           Origination Point Code #n           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       Lower CIC Value #n      |      Upper CIC Value #n       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

3.5.6 Registration Response (REG RSP)

The REG RSP message is used as a response to the REG REQ message from a remote M3UA peer. It contains indications of success/failure for registration requests and returns a unique Routing Context value for successful registration requests, to be used in subsequent M3UA Traffic Management protocol.

The REG RSP message contains the following parameters:

    Registration Results   Mandatory

The format for the REG RSP message is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
   |             Tag = 25          |         Length = var.         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                    Registration Result 1                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   /                              ...                              /
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                    Registration Result n                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


Registration Results:

The Registration Results parameter contains one or more results, each containing the registration status for a single Routing Key in an REG REQ message. The number of results in a single REG RSP message MAY match the number of Routing Key parameters found in the corresponding REG REQ message. The format of each result is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                  Local-RK-Identifier value                    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Registration Status                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Routing Context                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Local-RK-Identifier: 32-bit integer

The Local-RK-Identifier contains the same value as found in the matching Routing Key parameter found in the REG Req message.

Registration Status: 32-bit integer

The Registration Result Status field indicates the success or the reason for failure of a registration request.

Its values may be:

```
     0           Successfully Registered
     1           Error - Unknown
     2           Error - Invalid DPC
     3           Error - Invalid Network Appearance
     4           Error - Invalid Routing Key
     5           Error - Permission Denied
     6           Error - Overlapping (Non-unique) Routing Key
     7           Error - Routing Key not Provisioned
     8           Error - Insufficient Resources
```

Routing Context: 32-bit integer

The Routing Context field contains the Routing Context value for the associated Routing Key if the registration was successful. It is set to "0" if the registration was not successful.

3.5.7 De-Registration Request (DEREG REQ)

The DEREG REQ message is sent by an ASP to indicate to a remote M3UA peer that it wishes to de-register a given Routing Key. Typically, an ASP would send this message to an SGP, and expects to receive a DEREG RSP in return with the associated Routing Context value.

The DEREG REQ message contains the following parameters:

Routing Context Mandatory

The format for the DEREG REQ message is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag = 6            |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                        Routing Context                        /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Routing Context: n X 32-bit integers

The Routing Context parameter contains (a list of) integers indexing the Application Server traffic that the sending ASP is currently registered to receive from the SG but now wishes to deregister.

3.5.8 De-Registration Response (DEREG RSP)

The DEREG RSP message is used as a response to the DEREG REQ message from a remote M3UA peer.

The DEREG RSP message contains the following parameters:

De-registration Results Mandatory

The format for the DEREG RSP message is as follows:

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |            Tag = 18           |          Length = var         |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                   De-Registration Result 1                    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    /                              ...                              /
    \                                                               \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                   De-Registration Result n                    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

De-Registration Results:

The De-Registration Results parameter contains one or more results, each containing the de-registration status for a single Routing Context in a DEREG REQ message. The number of results in a single DEREG RSP message MAY match the number of Routing Contexts found in the corresponding DEREG REQ message. The format of each result is as follows:

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                        Routing Context                        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                     De-Registration Status                    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Routing Context: 32-bit integer

The Routing Context field contains the Routing Context value of the matching Routing Key to deregister, as found in the DEREG Req.

De-Registration Status: 32-bit integer

The De-Registration Result Status field indicates the success or the reason for failure of the de-registration.

Its values may be:

```
     0           Successfully De-registered
     1           Error - Unknown
     2           Error - Invalid Routing Context
     3           Error - Permission Denied
     4           Error - Not Registered
```

3.5.5 ASP Active (ASPAC)

The ASPAC message is sent by an ASP to indicate to a remote M3UA peer that it is Active and ready to process signalling traffic for a particular Application Server. The ASPAC affects only the ASP state for the routing keys identified by the Routing Contexts, if present.

The ASPAC message contains the following parameters:

```
Traffic Mode Type      Mandatory
Routing Context        Optional
INFO String            Optional
```

The format for the ASPAC message is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag = 11           |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Traffic Mode Type                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Tag = 6           |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                       Routing Context*                        /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Tag = 4            |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
\                                                               \
/                          INFO String*                         /
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Traffic Mode Type: 32-bit (unsigned integer)

The Traffic Mode Type parameter identifies the traffic mode of operation of the ASP within an AS. The valid values for Type are shown in the following table.

```
1          Over-ride
2          Load-share
3          Over-ride (Standby)
4          Load-share (Standby)
```


Within a particular Routing Context, only one Traffic Mode Type can be used. The Over-ride value indicates that the ASP is operating in Over-ride mode, and the ASP takes over all traffic in an Application Server (i.e., primary/back-up operation), over-riding any currently active ASPs in the AS. In Load-share mode, the ASP will share in the traffic distribution with any other currently active ASPs. The Standby versions of the Over-ride and Load-share Types indicate that the ASP is declaring itself ready to accept traffic but leaves it up to the sender as to when the traffic is started. Over-ride (Standby) indicates that the traffic sender continues to use the currently active ASP until it can no longer send/receive traffic (i.e., the currently active ASP transitions to Down or Inactive). At this point the sender MUST move the standby ASP to Active and commence traffic. Load-share (Standby) is similar - the sender continues to load-share to the current ASPs until it is determined that there is insufficient resources in the Load-share group. When there are insufficient ASPs, the sender MUST move the ASP to Active.

Routing Context: n X 32-bit integers

The optional Routing Context parameter contains (a list of) integers indexing the Application Server traffic that the sending ASP is configured/registered to receive.

There is one-to-one relationship between an index entry and an SG Routing Key or AS Name. Because an AS can only appear in one Network Appearance, the Network Appearance parameter is not required in the ASPAC message.

An Application Server Process may be configured to process traffic for more than one logical Application Server. From the perspective of an ASP, a Routing Context defines a range of signalling traffic that the ASP is currently configured to receive from the SG. For example, an ASP could be configured to support call processing for multiple ranges of PSTN trunks and therefore receive related signalling traffic, identified by separate SS7 DPC/OPC/CIC_ranges.

The format and description of the optional Info String parameter is the same as for the DUNA message (See Section 3.4.1.)

3.5.6 ASP Active Ack

The ASPAC Ack message is used to acknowledge an ASP-Active message received from a remote M3UA peer. In the case where an ASPAC (Over-ride (standby)) or ASPAC (load-share (standby) is received, a second ASPACK Ack is sent when the ASP is moved to the "Active" state from "Active (Standby)".

The ASPAC Ack message contains the following parameters:

```
   Traffic Mode Type      Mandatory
   Routing Context        Optional
   INFO String            Optional
```

The format for the ASPAC Ack message is as follows:

```
    0                   1                   2                   3
```

```
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Tag = 11             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Traffic Mode Type                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag = 6             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                       Routing Context*                        /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag = 4             |              Length           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                          INFO String*                         /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The format and description of the optional Info String parameter is the same as for the DUNA message (See Section 3.3.2.1.)

The format of the Traffic Mode Type and Routing Context parameters is the same as for the ASP-Active message. (See Section 3.4.5).

3.5.7 ASP Inactive (ASPIA)

The ASPIA message is sent by an ASP to indicate to a remote M3UA peer that it is no longer an active ASP to be used from within a list of ASPs. The ASPIA affects only the ASP state in the Routing Keys identified by the Routing Contexts, if present.

The ASPIA message contains the following parameters:

```
     Routing Context         Optional
     INFO String             Optional
```

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The format for the ASPIA message parameters is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag = 6             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                       Routing Context*                        /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag = 4             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                          INFO String*                         /
```

```
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The format and description of the optional Routing Context and Info String parameters is the same as for the ASPAC message (See Section 3.5.5.)

3.5.8 ASP Inactive Ack

The ASPIA Ack message is used to acknowledge an ASP-Inactive message received from a remote M3UA peer.

The ASPIA Ack message contains the following parameters:

```
     Routing Context       Optional
     INFO String           Optional
```

The format for the ASPIA Ack message is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 6            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                       Routing Context*                        /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Tag = 4            |              Length           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                          INFO String*                         /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

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The format and description of the optional Info String parameter is the same as for the DUNA message (See Section 3.4.1.)

The format of the Routing Context parameter is the same as for the ASP-Inactive message. (See Section 3.5.7).

3.5.9 Heartbeat (BEAT)

The Heartbeat message is optionally used to ensure that the M3UA peers are still available to each other. It is recommended for use when the M3UA runs over a transport layer other than the SCTP, which has its own heartbeat.

The BEAT message contains the following parameters:

```
     Heatbeat Data         Optional
```

The format for the BEAT message is as follows:

```
    0                   1                   2                   3
```

```
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Tag = 8           |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                       Heartbeat Data *                        /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The Heartbeat Data parameter contents are defined by the sending node. The Heartbeat Data could include, for example, a Heartbeat Sequence Number and/or Timestamp. The receiver of a Heartbeat message does not process this field as it is only of significance to the sender. The receiver MUST respond with a BEAT-Ack message.

3.5.10 Heartbeat Ack (Beat-Ack)

The Heartbeat Ack message is sent in response to a received Heartbeat message. It includes all the parameters of the received Heartbeat message, without any change.

3.6 Management Messages

3.6.1 Error (ERR)

The Error message is used to notify a peer of an error event associated with an incoming message. For example, the message type might be unexpected given the current state, or a parameter value might be invalid.

The ERR message contains the following parameters:

```
     Error Code                   Mandatory
     Diagnostic Information       Optional
```

The format for the ERR message is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Tag = 12          |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Error Code                           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Tag = 7           |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                     Diagnostic Information*                   /
```

```
\                                                               \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Error Code: 32-bits (unsigned integer)

The Error Code parameter indicates the reason for the Error Message. The Error parameter value can be one of the following values:

```
   1      Invalid Version
   2      Invalid Network Appearance
   3      Unsupported Message Class
   4      Unsupported Message Type
   5      Unsupported/Invalid Traffic Handling Mode
   6      Unexpected Message
   7      Protocol Error
   8      Invalid Routing Context
   9      Invalid Stream Identifier
  10      Invalid Parameter Value
```

The "Invalid Version" error is sent if a message was received with an invalid or unsupported version. The Error message contains the

supported version in the Common header. The Error message could optionally provide the supported version in the Diagnostic Information area.

The "Invalid Network Appearance" error is sent by a SG if an ASP sends a message with an invalid (unconfigured) Network Appearance value.

The "Unsupported Message Class" error is sent if a message with an unexpected or unsupported Message Class is received.

The "Unsupported Message Type" error is sent if a message with an unexpected or unsupported Message Type is received.

The "Unsupported/Invalid Traffic Handling Mode" error is sent by a SG if an ASP sends an ASP Active with an unsupported Traffic Handling Mode or a Traffic Handling mode that is inconsistent with the presently configured mode for the Application Server. An example would be a case in which the SG did not support load-sharing.

The "Unexpected Message" error MAY be sent if a defined and recognized message is received that is not expected in the current state(in some cases the ASP may optionally silently discard the message and not send an Error). For example, silent discard is used by an ASP if it received a Transfer message from an SG while it was in the Inactive state.

The "Protocol Error" error is sent for any protocol anomaly(i.e., reception of a parameter that is syntactically correct but unexpected in the current situation.

The "Invalid Routing Context" error is sent by an SG if an Asp sends a message with an invalid (unconfigured) Routing Context value.

The "Invalid Stream Identifier" error is sent if a message was received on an unexpected SCTP stream (e.g., a MGMT message was received on a stream other than "0").

The " Invalid Parameter Value " error is sent if a message was received with an invalid parameter value (e.g., a DUPU message was received with a Mask value other than "0").

Diagnostic Information: variable length

When included, the optional Diagnostic information can be any information germane to the error condition, to assist in identification of the error condition. In the case of an Invalid Network Appearance, Traffic Handling Mode, Routing Context or Parameter Value, the Diagnostic information includes the received parameter. In the other cases, the Diagnostic information may be the first 40 bytes of the offending message.

Error messages are not generated in response to other Error messages.

3.6.2 Notify (NTFY)

The Notify message used to provide an autonomous indication of M3UA events to an M3UA peer.

The NTFY message contains the following parameters:

```
     Status Type/ID              Mandatory
     Routing Context            Optional
     INFO String                Optional
```

The format for the NTFY message is as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Tag = 13             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Status Type            |    Status Identification      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Tag = 6              |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                       Routing Context*                        /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Tag = 4              |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   \                                                               \
   /                          INFO String*                         /
   \                                                               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Status Type: 16-bits (unsigned integer)

The Status Type parameter identifies the type of the Notify message.
The following are the valid Status Type values:

1 Application Server State Change (AS-StateChange)
2 Other

Status Information: 16-bits (unsigned integer)

The Status Information parameter contains more detailed information for the notification, based on the value of the Status Type.

If the Status Type is AS_State_Change the following Status Information values are used:

1 reserved
2 Application Server Inactive (AS-Inactive)
3 Application Server Active (AS-Active)
4 Application Server Pending (AS-Pending)

These notifications are sent from an SG to an ASP upon a change in status of a particular Application Server. The value reflects the new state of the Application Server.

If the Status Type is Other, then the following Status Information values are defined:

1 Insufficient ASP resources active in AS
2 Alternate ASP Active

These notifications are not based on the SG reporting the state change of an ASP or AS. In the Insufficent ASP Resources case, the SG is indicating to an "Inactive" ASP(s) in the AS that another ASP is required in order to handle the load of the AS (Load-sharing mode). For the Alternate ASP Active case, an ASP is informed when an alternate ASP transitions to the ASP-Active state in Over-ride mode.

The format and description of the optional Routing Context and Info String parameters is the same as for the ASPAC message (See Section 3.4.6.)

4.0 Procedures

The M3UA layer needs to respond to various local primitives it receives from other layers as well as the messages that it receives from the peer M3UA layer. This section describes the M3UA procedures in response to these events.

4.1 Procedures to support the services of the M3UA layer

4.1.1 Receipt of primitives from the M3UA-User

On receiving an MTP-Transfer request primitive from an upper layer, or the nodal inter-working function at an SG, the M3UA layer sends a corresponding DATA message (see Section 3) to its M3UA peer. The M3UA peer receiving the Data message sends an MTP-Transfer indication primitive to the upper layer.

The M3UA message distribution function (see Section 1.4.2.1) determines the Application Server (AS) based on comparing the information in the MTP-Transfer request primitive with a provisioned Routing Key.

>From the list of ASPs within the AS table, an Active ASP is selected and a DATA message is constructed and issued on the corresponding SCTP Association. If more than one ASP is active (i.e., traffic is to be load-shared across all the active ASPs), one of the active ASPs from the list is selected. The selection algorithm is implementation dependent but could, for example, be round-robin or based on, for example, the SLS or ISUP CIC. The appropriate selection algorithm must be chosen carefully as it is dependent on application assumptions and understanding of the degree of state coordination between the active ASPs in the AS.

In addition, the message needs to be sent on the appropriate SCTP stream, again taking care to meet the message sequencing needs of the signalling application.

When there is no Routing Key match, or only a partial match, for an incoming SS7 message, a default treatment must be specified. Possible solutions are to provide a default Application Server at the SG that directs all unallocated traffic to a (set of) default ASP(s), or to drop the message and provide a notification to management in an M-Error indication primitive. The treatment of unallocated traffic is implementation dependent.

4.1.2 Receipt of primitives from the Layer Management

On receiving primitives from the local Layer Management, the M3UA layer will take the requested action and provide an appropriate response primitive to Layer Management.

An M-SCTP ESTABLISH request from Layer Management at an ASP or IPSP will initiate the establishment of an SCTP association. The M3UA layer will attempt to establish an SCTP association with the remote M3UA peer at by sending an SCTP-Associate primitive to the local SCTP layer.

When an SCTP association has been successfully established, the SCTP will send an SCTP-Communication Up notification to the local M3UA layer. At the SG or IPSP that initiated the request, the M3UA will send an M-SCTP ESTABLISH confirm to Layer Management when the association set-up is complete. At the peer M3UA layer, an M-SCTP ESTABLISH indication is sent to Layer Management upon successful completion of an incoming SCTP association set-up.

An M-SCTP RELEASE request from Layer Management initates the tear-down of an SCTP association. M3UA accomplishes a graceful shutdown of the SCTP association by sending a SHUTDOWN primitive to the SCTP layer.

When the graceful shutdown of the SCTP association has been accomplished, the SCTP layer returns a SHUTDOWN COMPLETE notification to the local M3UA Layer. At the M3UA Layer that initiated the request, the M3UA will send an M-SCTP RELEASE confirm to Layer Management when the association teardown is complete. At the peer M3UA Layer, an M-SCTP RELEASE indication is sent to Layer Management upon successful tear-down of an SCTP association.

An M-SCTP STATUS request supports a Layer Management query of the local status of a particular SCTP association. The M3UA simply maps the M-SCTP STATUS request to a STATUS primitive to the SCTP. When the SCTP responds, the M3UA maps the association status information to an M-SCTP STATUS confirm. No peer protocol is invoked.

Similar LM-to-M3UA-to-SCTP and/or SCTP-to-M3UA-LM mappings can be described for the various other SCTP Upper layer primitives in RFC2960 such as Initialize, Set Primary, Change Heartbeat, Request Heartbeat, Get SRTT Report, Set Failure Threshold, Set Protocol parameters, Destroy SCTP Instance, Send Failure, and Network Status Change. Alternatively, these SCTP Upper Layer primitives (and Status as well) can be considered for modeling purposes as a Layer Management interaction directly with the SCTP Layer.

M-NOTIFY indication and M-ERROR indication primitives indicate to Layer Management the notification or error information contained in a received M3UA Notify or Error message respectively. These indications can also be generated based on local M3UA events.

An M-ASP STATUS request supports a Layer Management query of the status of a particular local or remote ASP. The M3UA responds with the status in an M-ASP STATUS confirm. No M3UA peer protocol is invoked.

An M-AS STATUS request supports a Layer Management query of the status of a particular AS. The M3UA responds with an M-AS STATUS confirm. No M3UA peer protocol is invoked.

M-ASP-UP request, M-ASP-DOWN request, M-ASP-ACTIVE request and M-ASP-INACTIVE request primitives allow Layer Management at an ASP to initiate state changes. Upon successful completion, a corresponding confirm is provided by the M3UA to Layer Management. If an invocation is unsuccessful, an Error indication is provided.

These requests result in outgoing M3UA ASP-UP, ASP-DOWN, ASP-ACTIVE and ASP-INACTIVE messages to the remote M3UA peer at an SG or IPSP.

4.2 Receipt of M3UA Peer Management messages

Upon successful state changes resulting from reception of M3UA ASP-UP, ASP-DOWN, ASP-ACTIVE and ASP-INACTIVE messages from a peer M3UA, the

M3UA layer MUST invoke corresponding M-ASP UP, M-ASP DOWN, M-ASP ACTIVE and M-ASP INACTIVE, M-AS ACTIVE, M-AS INACTIVE, and M-AS DOWN indications to the local Layer Management.

M-NOTIFY indication and M-ERROR indication indicate to Layer Management the notification or error information contained in a received M3UA Notify or Error message. These indications can also be generated based on local M3UA events.

4.3 Procedures to support the M3UA Management services

These procedures support the M3UA management of SCTP Associations between SGs and ASPs.

4.3.1 AS and ASP State Maintenance

The M3UA layer on the SG maintains the state of each remote ASP, in each Application Server that the ASP is configured to receive traffic, as input to the M3UA message distribution function. Similarly, where IPSPs use M3UA in a point-to-point fashion, the M3UA layer in an IPSP maintains the state of remote IPSPs. For the purposes of the following procedures, only the SG/ASP case is described but the SG side of the procedures also apply to an IPSP sending traffic to an AS consisting of a set of remote IPSPs.

4.3.1.1 ASP States

The state of each remote ASP, in each AS that it is configured to operate, is maintained in the M3UA layer in the SG. The state of a particular ASP in a particular AS changes due to events. The events include:

* Reception of messages from the peer M3UA layer at the ASP;
* Reception of some messages from the peer M3UA layer at other ASPs in the AS (e.g., ASPAC Take-over);
* Reception of indications from the SCTP layer; or
* Local Management intervention.

The ASP state transition diagram is shown in Figure 4. The possible states of an ASP are:

ASP-DOWN: The remote M3UA peer at the ASP is unavailable and/or the related SCTP association is down. Initially all ASPs will be in this state. An ASP in this state should not be sent any M3UA messages.

ASP-INACTIVE: The remote M3UA peer at the ASP is available (and the related SCTP association is up) but application traffic is stopped. In this state the ASP can be sent any non-Data M3UA messages.

ASP-ACTIVE: The remote M3UA peer at the ASP is available and application traffic is active (for a particular Routing Context or set of Routing Contexts).

ASP-STANDBY: The remote M3UA peer at the ASP is available and ready to receive application traffic at any time (for a particular Routing Context or set of Routing Contexts). In this state the ASP can be sent any non-Data M3UA messages.

Figure 4: ASP State Transition Diagram

```
                                  +--------------+
                                  |  ASP-ACTIVE  |
               +------------------|      or      |
               |    Alternate +-------| ASP-STANDBY* |
               |       ASP     |       +--------------+
               |     Takeover |            ^      |
               |              |    ASP     |      | ASP
               |              |    Active  |      | Inact
               |              |            |      v
               |              |       +--------------+
               |              |       |              |
               |              +------>| ASP-INACTIVE |
               |                      +--------------+
               |                           ^      |
  ASP Down/    |                      ASP  |      | ASP Down /
  SCTP CDI     |                      Up   |      | SCTP CDI
               |                           |      v
               |                      +--------------+
               |                      |              |
               +--------------------->|   ASP-DOWN   |
                                      |              |
                                      +--------------+
```

*Note: ASP-ACTIVE and ASP-STANDBY differ only in whether the ASP is currently receiving Data traffic within the AS.

SCTP CDI: The local SCTP layer's Communication Down Indication to the Upper Layer Protocol (M3UA) on an SG. The local SCTP will send this indication when it detects the loss of connectivity to the ASP's peer SCTP layer. SCTP CDI is understood as either a SHUTDOWN COMPLETE notification or COMMUNICATION LOST notification from the SCTP.

4.3.1.2 AS States

The state of the AS is maintained in the M3UA layer on the SG.

The state of an AS changes due to events. These events include:

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* ASP state transitions
* Recovery timer triggers

The possible states of an AS are:

AS-DOWN: The Application Server is unavailable. This state implies that all related ASPs are in the ASP-DOWN state for this AS. Initially the AS will be in this state.

AS-INACTIVE: The Application Server is available but no application traffic is active (i.e., one or more related ASPs are in the ASP-Inactive state, but none in the ASP-Active state). The recovery timer T(r) is not running or has expired.

AS-ACTIVE: The Application Server is available and application traffic is active. This state implies that at least one ASP is in the ASP-ACTIVE state.

AS-PENDING: An active ASP has transitioned to inactive and it was the last remaining active ASP in the AS (and no STANDBY ASPs are available. A recovery timer T(r) will be started and all incoming SCN messages will be queued by the SG. If an ASP becomes active before T(r) expires, the AS will move to AS-ACTIVE state and all the queued messages will be sent to the active ASP.

If T(r) expires before an ASP becomes active, the SG stops queuing messages and discards all previously queued messages. The AS will move to AS-INACTIVE if at least one ASP is in ASP-INACTIVE state, otherwise it will move to AS-DOWN state.

Figure 5: AS State Transition Diagram

```
      +----------+   one ASP trans to ACTIVE   +-------------+
      |          |---------------------------->|             |
      | AS-INACT |                             |  AS-ACTIVE  |
      |          |<---                         |             |
      +----------+    \                        +-------------+
         ^   |         \ Tr Expiry,                ^    |
         |   |          \ at least one             |    |
         |   |           \ ASP in INACT            |    |
         |   |            \                        |    |
         |   |             \                       |    |
         |   |              \                      |    |
 one ASP |   | all ASP       \           one ASP   |    | Last ACT ASP
 trans   |   | trans to       \          trans to  |    | trans to
INACT
 to INACT|   | DOWN            -------\  ACTIVE    |    | or DOWN
         |   |                         \           |    |
         |   |                          \          |    |
```

```
          |   |                          \          |    |
          |   |                           \         |    |
          |   v                            \        |    v
      +-----------+                         \  +-------------+
      |           |                          --|             |
      | AS-DOWN   |                            | AS-PENDING  |
      |           |                            |  (queueing) |
      |           |<---------------------------|             |
      +-----------+       Tr Expiry no ASP     +-------------+
                          in INACT state

    Tr = Recovery Timer
```

4.3.2 M3UA Management procedures for primitives

Before the establishment of an SCTP association the ASP state at both the SG and ASP is assumed to be "Down".

Once the SCTP association is established (See Section 4.1.2) and assuming that the local M3UA-User is ready, the local ASP M3UA Application Server Process Maintenance (ASPM) function will initiate the ASPM procedures, using the ASP-Up/-Down/-Active/-Inactive messages to convey the ASP-state to the SG - see Section 4.3.3.

If the M3UA layer subsequently receives an SCTP-Communication Down indication from the underlying SCTP layer, it will inform the Layer Management by invoking the M-SCTP STATUS indication primitive. The state of the remote ASP will be moved to "Down". At an ASP, the MTP3-User at an ASP will be informed of the unavailability of any affected SS7 destinations through the use of MTP-PAUSE primitives. In the case

of SS7 network isolation, the local MTP3-Users may be informed by implementation-dependent means as there is currently no primitive defined for conveying this information.

At an ASP, the Layer Management may try to re-establish the SCTP association using M-SCTP ESTABLISH request primitive.

4.3.3 M3UA Management procedures for peer-to-peer messages

All M3UA MGMT and ASP Maintenance messages are sent on a sequenced stream to ensure ordering. SCTP stream '0' is used.

4.3.3.1 ASP-Up

After an ASP has successfully established an SCTP association to an SG, the SG waits for the ASP to send an ASP-Up message, indicating that the ASP M3UA peer is available. The ASP is always the initiator of the ASP-Up exchange. This action MAY be initiated at the ASP by an M-ASP UP request primitive from Layer Management or may be initiated automatically by an M3UA management function.

When an ASP-Up message is received at an SG and internally the remote ASP is in the "Down" state and not considered locked-out for local management reasons, the SG marks the remote ASP as "Inactive" and informs Layer Management with an M-ASP-Up indication primitive. If the

SG knows, via current configuration data, which Application Servers the ASP is configured to operate in, it can update the ASP status to "Inactive" in each AS that it is a member. Alternatively, the SG may move the ASP into a pool of Inactive ASPs available for future activation in Application Server(s) denoted in the subsequent ASP-Active Routing Contexts. The SG responds with an ASP-Up Ack message in acknowledgement. The SG sends an ASP-Up Ack message in response to a received ASP-Up message even if the ASP is already marked as "Inactive" at the SG.

If for any local reason (e.g., management lock-out) the SG cannot respond with an ASP-Up Ack, the SG responds to an ASP-Up with an ASP-Down Ack message with Reason "Management Blocking".

At the ASP, the ASP-Up Ack message received is not acknowledged. Layer Management is informed with an M-ASP UP confirm primitive .

When the ASP sends an ASP-Up message it starts timer T(ack). If the ASP does not receive a response to an ASP-Up within T(ack), the ASP MAY restart T(ack) and resend ASP-Up messages until it receives an ASP-Up Ack message. T(ack) is provisionable, with a default of 2 seconds. Alternatively, retransmission of ASP-Up messages may be put under control of Layer Management. In this method, expiry of T(ack) results in a M-ASP-Up confirmation carrying a negative indication.

The ASP must wait for the ASP-Up Ack message before sending any other M3UA messages (e.g., ASPAC, REG REQ). If the SG receives any other M3UA messages before an ASP Up is received, the SG should discard them.

If an ASP-Up is received and internally the remote ASP is in the "Active" or "Standby" state, an Error ("Unexpected Message) is returned and the remote ASP state is not changed.

If an ASP-Up is received and internally the remote ASP is already in the "Inactive" state, and ASP-Up Ack is returned and no action is taken.

4.3.3.2 ASP-Down

The ASP will send an ASP-Down to an SG when the ASP wishes to be removed from service in all Application Servers that it is a member and no longer receive any M3UA traffic or management messages. This action MAY be initiated at the ASP by an M-ASP DOWN request primitive from Layer Management or may be initiated automatically by an M3UA management function.

Whether the ASP is permanently removed from any AS is a function of configuration management.

The SG marks the ASP as "Down", informs Layer Management with an M-ASP-Down indication primitive, and returns an ASP-Down Ack message to the ASP if one of the following events occur:

- an ASP-Down message is received from the ASP,
- another ASPM message is received from the ASP and the SG has locked out the ASP for management reasons.

The SG sends an ASP-Down Ack message in response to a received ASP-Down message from the ASP even if the ASP is already marked as "Down" at the SG.

At the ASP, the ASP-Down Ack message received is not acknowledged. Layer Management is informed with an M-ASP Down confirm primitive.

When the ASP sends an ASP-Down it starts timer T(ack). If the ASP does not receive a response to an ASP-Down within T(ack), the ASP MAY restart T(ack) and resend ASP-Down messages until it receives an ASP-Down Ack message. T(ack) is provisionable, with a default of 2 seconds. Alternatively, retransmission of ASP-Down messages may be put under control of Layer Management. In this method, expiry of T(ack) results in a M-ASP-Down confirmation carrying a negative indication.

4.3.3.3 M3UA Version Control

If an ASP-Up message with an unsupported version is received, the receiving end responds with an Error message, indicating the version the receiving node supports and notifies Layer Management.

This is useful when protocol version upgrades are being performed in a network. A node upgraded to a newer version should support the older versions used on other nodes it is communicating with. Because ASPs initiate the ASP-Up procedure it is assumed that the Error message would normally come from the SG.

4.3.3.4 ASP-Active

Anytime after the ASP has received an ASP-Up Ack from the SG or IPSP, the ASP sends an ASP-Active (ASPAC) to the SG indicating that the ASP is ready to start processing traffic. This action MAY be initiated at the ASP by an M-ASP Active request primitive from Layer Management or may be initiated automatically by an M3UA management function. In the case where an ASP wishes to process the traffic for more than one Application Server across a common SCTP association, the ASPAC contains a list of one or more Routing Contexts to indicate for which Application Servers the ASPAC applies. It is not necessary for the ASP to include all Routing Contexts of interest in the initial ASPAC message, thus becoming active in all Routing Contexts at the same time. Multiple ASPAC messages MAY be used to activate within the Application Servers independently. In the case where an ASP-Active message does not contain a Routing Context parameter, the receiver must know, via configuration data, which Application Server(s) the ASP is a member.

When an ASP Active (ASPAC) message is received, the SG or IPSP responds with an ASPAC Ack message(with the same Type value contained in the received APAC), acknowledging that the ASPAC was received and, depending on the ASPAC Type value, moves the ASP to the "Active" or "Standby" state within the associated Application Server(s). Layer Management is informed with an ASP-Active indication primitive. If the SG or IPSP receives any Data messages before an ASPAC is received, the

SG or IPSP should discard them. By sending an ASPAC Ack, the SG or IPSP is now ready to receive and send traffic for the related Routing Contexts. The ASP MUST not send Data messages before receiving an ASPAC Ack.

Multiple ASPAC Ack messages MAY be used in response to an ASPAC containing multiple Routing Contexts, allowing the SG or IPSP to independently Ack for different (sets of) Routing Contexts. The SG or IPSP sends an Error ("Invalid Routing Context") message for each invalid or un-configured Routing Context value in a received ASPAC message.

The SG MUST send an ASP-Active Ack message in response to a received ASP-Active message from the ASP and the ASP is already marked as "Active" at the SG.

At the ASP, the ASP-Active Ack message received is not acknowledged. Layer Management is informed with an M-ASP Active confirm primitive.

When the ASP sends an ASP-Active it starts timer T(ack). If the ASP does not receive a response to an ASP-Active within T(ack), the ASP MAY restart T(ack) and resend ASP-Active messages until it receives an ASP-Active Ack message. T(ack) is provisionable, with a default of 2 seconds. Alternatively, retransmission of ASP-Active messages may be put under control of Layer Management. In this method, expiry of T(ack) results in a M-ASP-Active confirmation carrying a negative indication.

There are four modes of Application Server traffic handling in the SG M3UA - Over-ride, Over-ride (Standby), Loadshare and Load-share (Standby). The Traffic Mode Type parameter in the ASPAC message indicates the traffic handling mode used in a particular Application Server. If the SG determines that the mode indicated in an ASPAC is unsupported or incompatible with the mode currently configured for the AS, the SG responds with an Error message indicating "Unsupported / Invalid Traffic Handling Mode". If the Traffic Handling mode of the Application Server is not already known via configuration data, then the Traffic handling mode indicated in the first ASPAC message causing the transition of the Application Server state to "Active" MAY be used to set the mode.

In the case of an Over-ride mode AS, reception of an ASPAC message at an SG causes the redirection of all traffic for the AS to the ASP that sent the ASPAC. Any previously active ASP in the AS is now considered Inactive and will no longer receive traffic from the SG within the AS. The SG or IPSP sends a Notify (Alternate ASP-Active) to the previously active ASP in the AS, after stopping all traffic to that ASP.

In the case of Over-ride (Standby) mode the traffic is not started to the ASP until the previously active ASP transitions to "Inactive or "Down" state. At this point the ASP that sent the Over-Ride (Standby) ASPAC is moved to the Active state and the traffic is redirected. A second ASP-Active Ack message with a new Traffic Mode Type ("Over-ride", previously "Over-ride(Standby)") is sent to the ASP. A Notify (Alternate ASP-Active) message is not sent in this case.

In the case of a Load-share mode AS, reception of an ASPAC message at an SG or IPSP causes the direction of traffic to the ASP sending the ASPAC, in addition to all the other ASPs that are currently active in the AS. The algorithm at the SG for load-sharing traffic within an AS

to all the active ASPs is implementation dependent. The algorithm could, for example be round-robin or based on information in the Data message (e.g., such as the SLS, SCCP SSN, ISUP CIC value).

An SG or IPSP, upon reception of an ASPAC for the first ASP in a Loadshare AS, MAY choose not to direct traffic to a newly active ASP until it determines that there are sufficient resources to handle the expected load (e.g., until there are sufficient ASPs "Active" in the AS).

In the case of Load-share (Standby) mode, the traffic is not started to the ASP until the SG or IPSP determines that there are insufficient resources available in the AS. This is likely when one of the active load-sharing ASPs transitions to the "Inactive" or "Down" state. At this point the ASP that sent the Load-share (Standby) ASPAC is moved to the Active state and traffic is started. A second ASP-Active Ack message with a new Traffic Mode Type ("Load-share" - previously "Loadshare(Standby)") is sent to the ASP. A Notify ("Insufficient ASP resources active in AS ") message is not sent in this case.

All ASPs within a load-sharing mode AS must be able to handle any traffic within the AS, in order to accommodate any potential fail-over or rebalancing of the offered load.

4.3.3.5 ASP Inactive

When an ASP wishes to withdraw from receiving traffic within an AS, the ASP sends an ASP Inactive (ASPIA) to the SG or IPSP. This action MAY be initiated at the ASP by an M-ASP INACTIVE request primitive from Layer Management or may be initiated automatically by an M3UA management function. In the case where an ASP is processing the traffic for more than one Application Server across a common SCTP association, the ASPIA contains one or more Routing Contexts to indicate for which Application Servers the ASPIA applies. In the case where an ASP-Inactive message does not contain a Routing Context parameter, the receiver must know, via configuration data, which Application Servers the ASP is a member and move the ASP to the "Inactive" state in each AS.

In the case of an Over-ride mode AS, where another ASP has already taken over the traffic within the AS with an Over-ride ASPAC, the ASP that sends the ASPIA is already considered by the SG to be "Inactive". An ASPIA Ack message is sent to the ASP, after ensuring that all traffic is stopped to the ASP.

In the case of a Load-share mode AS, the SG moves the ASP to the "Inactive" state and the AS traffic is re-allocated across the remaining "active" ASPs per the load-sharing algorithm currently used within the AS. A NTFY(Insufficient ASP resources active in AS) may be sent to all inactive ASPs, if required. However, if a Loadshare

(Standby) ASP is available, it may be now immediately included in the loadshare group and a Notify message is not sent. An ASPIA Ack message is sent to the ASP after all traffic is halted and Layer Management is informed with an ASP-INACTIVE indication primitive.

Multiple ASPIA Ack messages MAY be used in response to an ASPIA containing multiple Routing Contexts, allowing the SG or IPSP to independently Ack for different (sets of) Routing Contexts. The SG or IPSP sends an Error ("Invalid Routing Context") message for each invalid or un-configured Routing Context value in a received ASPIA message.

The SG MUST send an ASP-Inactive Ack message in response to a received ASP-Inactive message from the ASP and the ASP is already marked as "Inactive" at the SG.

At the ASP, the ASP-INACTIVE Ack message received is not acknowledged. Layer Management is informed with an M-ASP INACTIVE confirm primitive. When the ASP sends an ASP-Inactive it starts timer T(ack). If the ASP does not receive a response to an ASP-Inactive within T(ack), the ASP MAY restart T(ack) and resend ASP-Inactive messages until it receives an ASP-Inactive Ack message. T(ack) is provisionable, with a default of 2 seconds. Alternatively, retransmission of ASP-Inactive messages may be put under control of Layer Management. In this method, expiry of T(ack) results in a M-ASP-Inactive confirmation carrying a negative indication.

If no other ASPs are "Active" or "Standby" in the Application Server, the SG sends a NTFY(AS-Pending) to all inactive ASPs of the AS and either discards all incoming messages for the AS or starts buffering the incoming messages for T(r)seconds, after which messages will be discarded. T(r) is configurable by the network operator. If the SG receives an ASPAC from an ASP in the AS before expiry of T(r), the buffered traffic is directed to the ASP and the timer is cancelled. If T(r) expires, the AS is moved to the "Inactive" state.

4.3.3.6 Notify

A Notify message reflecting a change in the AS state is sent to all ASPs in the AS, except those in the "Down" state, with appropriate Status Identification. At the ASP, Layer Management is informed with an M-NOTIFY indication primitive.

In the case where a Notify (AS-Pending) message is sent by an SG that now has no ASPs active to service the traffic, or a NTFY(Insufficient ASP resources active in AS) is sent in the Loadshare mode, the Notify does not explicitly compel the ASP(s) receiving the message to become active. The ASPs remain in control of what (and when) traffic action is taken.

4.3.3.7 Heartbeat

The optional Heartbeat procedures may be used when operating over transport layers that do not have their own heartbeat mechanism for detecting loss of the transport association (i.e., other than the SCTP).

After receiving an ASP-Up Ack message from an M3UA peer in response to an ASP-Up message, an ASP may optionally send Beat messages periodically, subject to a provisionable timer T(beat). Upon receiving a BEAT message, the M3UA peer MUST respond with a BEAT ACK message. If no BEAT ACK message (or any other M3UA message), is received by the ASP within the timer 2*T(beat), the ASP will consider the remote M3UA peer as "Down".

At the ASP, if no BEAT ACK message (or any other M3UA message) is received from the M3UA peer within 2*T(beat), the remote M3UA peer is considered unavailable. Transmission of BEAT messages is stopped and ASP-Up procedures are used to re-establish communication with the SG M3UA peer.

The BEAT message may optionally contain an opaque Heartbeat Data parameter that MUST be echoed back unchanged in the related Beat Ack message. The ASP upon examining the contents of the returned BEAT Ack message MAY choose to consider the remote ASP as unavailable. The contents/format of the Heartbeat Data parameter is implementation-dependent and only of local interest to the original sender. The contents may be used, for example, to support a Heartbeat sequence algorithm (to detect missing Heartbeats), and/or a timestamp mechanism (to evaluate delays).

Note: Heartbeat related events are not shown in Figure 4 "ASP state transition diagram".

4.3.4 Routing Key Management procedures

4.3.4.1 Registration

An ASP MAY dynamically register with an SG as an ASP within an Application Server using the REG REQ message. A Routing Key parameter in the REG REQ specifies the parameters associated with the Routing Key.

The SG examines the contents of the received Routing Key parameter and compares it with the currently provisioned Routing Keys. If the received Routing Key matches an existing SG Routing Key entry, and the ASP is not currently included in the list of ASPs for the related Application Server, the ASP MAY authorize the ASP to be added to the AS. Or, if the Routing Key does not currently exist and the received Routing Key data is valid and unique, an SG supporting dynamic

configuration MAY authorize the creation of a new Routing Key and related Application Server and add the ASP to the new AS. In either case, the SG returns a Registration Response message to the ASP, containing the same Local-RK-Identifier as provided in the initial request, and a Registration Result "Successfully Registered". A unique Routing Context value assigned to the SG Routing Key is included. The method of Routing Context value assignment at the SG/SGP is implementation dependent but must be guaranteed to be unique across all SGPs in an SG.

If the SG determines that the received Routing Key data is invalid, or contains invalid parameter values, the SG returns a Registration Response message to the ASP, containing a Registration Result "Error - Invalid Routing Key", "Error - Invalid DPC, "Error - Invalid Network Appearance" as appropriate.

If the SG determines that the Routing Key parameter overlaps with an existing Routing Key entry, the SG returns a Registration Response message to the ASP, with a Registration Status of "Error - Overlapping (Non-Unique) Routing Key". An incoming signalling message received at an SG cannot match against more than one Routing Key.

If the SG does not authorize the registration request, the SG returns a REG RSP message to the ASP containing the Registration Result "Error û Permission Denied".

If an SG determines that a received Routing Key does not currently exist and the SG does not support dynamic configuration, the SG returns a Registration Response message to the ASP, containing a Registration Result "Error - Routing Key not Provisioned".

If an SG determines that a received Routing Key does not currently exist and the SG supports dynamic configuration but does not have the capacity to add new Routing Key and Application Server entries, the SG returns a Registration Response message to the ASP, containing a Registration Result "Error - Insufficient Resources".

An ASP MAY register multiple Routing Keys at once by including a number of Routing Key parameters in a single REG REQ message. The SG MAY respond to each registration request in a single REG RSP message, indicating the success or failure result for each Routing Key in a separate Registration Result parameter. Alternatively the SG MAY respond with multiple REG RSP messages, each with one or more Registration Result parameters. The ASP uses the Local-RK-Identifier parameter to correlate the requests with the responses.

Upon successful registration of an ASP in an AS, the SG can now send related SSNM messaging, if this did not previously start upon the ASP transitioning to "Inactive".

4.3.4.2 Deregistration

An ASP MAY dynamically deregister with an SG as an ASP within an Application Server using the DEREG REQ message. A Routing Context parameter in the DEREG REQ specifies which Routing Key to de-register.

The SG examines the contents of the received Routing Context parameter and validates that the ASP is currently registered in the Application Server(s) related to the included Routing Context(s). If validated, the ASP is de-registered as an ASP in the related Application Server.

The deregistration procedure does not necessarily imply the deletion of Routing Key and Application Server configuration data at the SG. Other ASPs may continue to be associated with the Application Server, in which case the Routing Key data CANNOT be deleted. If a Deregistration results in no more ASPs in an Application Server, an SG MAY delete the Routing Key data.

The SG acknowledges the de-registration request by returning a DEREG RSP to the requesting ASP. The result of the de-registration is found in the Deregistration Result parameter, indicating success or failure with cause.

An ASP MAY deregister multiple Routing Contexts at once by including a number of Routing Contexts in a single DEREG REQ message. The SG MUST respond to each deregistration request in a single DEREG RSP message, indicating the success or failure result for each Routing Context in a separate Deregistration Result parameter.

4.4 Procedures to support the M3UA services

4.4.1 At an SG

On receiving an MTP-PAUSE, MTP-RESUME, or MTP-STATUS indication primitive from the nodal inter-working function at an SG, the SG M3UA layer will send a corresponding SSNM DUNA, DAVA, SCON, or DUPU message (see Section 2) to the M3UA peers at concerned ASPs. The M3UA layer must fill in various fields of the SSNM messages consistently with the information received in the primitives.

The SG M3UA determines the set of concerned ASPs to be informed based on the SS7 network partition for which the primitive indication is relevant. In this way, all ASPs configured to send/receive traffic within a particular network appearance are informed. If the SG operates within a single SS7 network appearance, then all ASPs are informed.

Optionally, the SG M3UA may filter further based on the Affected Point Code in the MTP-PAUSE, MTP-Resume, or MTP-Status indication primitives. In this way ASPs can be informed only of affected destinations to which they actually communicate. The SG M3UA may also suppress DUPU messages to ASPs that do not implement an MTP3-User protocol peer for the affected MTP3-User.

DUNA, DAVA, SCON messages must be sent on a sequenced stream as these primitives should arrive in order. Stream 0 is used. Sequencing is not required for the DUPU or DAUD message, which may optionally be sent un-sequenced. The same applies for the SCON message if the international congestion method (see Q.704) is used.

4.4.2 At an ASP

4.4.2.1 Single SG configurations

At an ASP, upon receiving an SSNM message from the remote M3UA Peer, the M3UA layer invokes the appropriate primitive indications to the resident M3UA-Users. Local management is informed.

In the case where a local event has caused the unavailability or congestion status of SS7 destinations, the M3UA at the ASP should pass up appropriate indications n the primitives to the M3UA User, as though equivalent SSNM messages were received. For example, the loss of an SCTP association to an SG may cause the unavailability of a set of SS7 destinations. MTP-Pause indications to the M3UA User is appropriate. To accomplish this, the M3UA layer at an ASP maintains the status of routes via the SG, much like an MTP3 layer maintains route-set status.

4.4.2.2 Multiple SG configurations

At an ASP, upon receiving an SSNM message from the remote M3UA Peer, the M3UA layer updates the status of the affected route(s) via the originating SG and determines, whether or not the overall availability or congestion status of the effected destination(s) has changed. In this case the M3UA layer invokes the appropriate primitive indications to the resident M3UA-Users. Local management is informed.

4.4.3 ASP Auditing

An ASP may optionally initiate an audit procedure in order to enquire of an SG the availability and, if the congestion method with multiple congestion levels and message priorities is used, congestion status of an SS7 destination or set of destinations. A Destination Audit (DAUD) message is sent from the ASP to the SG requesting the current availability and congestion status of one or more SS7 Destination Point Codes.

The DAUD may be sent un-sequenced. The DAUD may be sent by the ASP in the following cases:

- Periodic. A Timer originally set upon reception of DUNA or SCON message has expired without a subsequent DAVA, DUNA or SCON updating the availability/congestion status of the affected

  Destination Point Codes. The Timer is reset upon issuing a DAUD. In this case the DAUD is sent to the SG that originally sent the SSNM message.

- the ASP is newly "Inactive" or "Active" or has been isolated from an SG for an extended period. The ASP can request the availability/congestion status of one or more SS7 destinations to which it expects to communicate.

In the first case, the DAUD procedure must not be invoked for the case of received SCON containing a congestion level value of "no congestion" or undefined" (i.e., congestion Level = "0"). This is because the value indicates either congestion abatement or that the ITU MTP3 international congestion method is being used. In the international congestion method, the MTP3 at the SG MTP3 does not maintain the congestion status of any destinations and therefore the SG cannot provide any congestion information in response to the DAUD. For the same reason, in the second case a DAUD cannot reveal any congested destination(s).

The SG MUST respond to a DAUD with the MTP3 status of the routeset associated with each Destination Point Code(s) in the DAUD. The status of each SS7 destination requested is indicated in a DUNA (if unavailable), DAVA (if available/uncongested) or an SCON (if available/congested). Optionally, any DUNA or DAVA message in response to a DAUD may contain a list of up to sixteen Affected Point Codes. Note that from the point of view of an ASP sending an DAUD, the subsequent reception of an SCON implies that the Affected Destination is available. The reception of a DAVA implies that the routeset to the Affected Destination is not congested. Obviously with the reception of an DUNA, the routeset to the Affected Destination can not also be congested.

5.0 Examples of M3UA Procedures

5.1 Establishment of Association and Traffic between SGs and ASPs

5.1.1a Single ASP in an Application Server ("1+0" sparing), No Registration

This scenario shows the example M3UA message flows for the establishment of traffic between an SG and an ASP, where only one ASP is configured within an AS (no backup). It is assumed that the SCTP association is already set-up. The sending of DUNA/SCON messages by the SG is not shown but would be similar to 5.1.2.

```
             SG                              ASP1
              |                                |
              |<-------------ASP Up------------|
              |-----------ASP-Up Ack---------->|
              |                                |
              |<------- ASP Active(RCn)--------|  RC: Routing Context
              |-----ASP Active Ack (RCn)------>|      (optional)
              |                                |
```

Note: If ASPAC contains an optional Routing Context parameter, The ASPAC only applies for the specified RC value. For an unknown RC value, the SG responds with an Error message.

5.1.1b Single ASP in Application Server ("1+0" sparing), With Dynamic

Registration

This scenario is the same as for 5.1.1a but with the optional exchange of registration information. In this case the Registration is accepted by the SG.

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```
             SG                              ASP1
              |                               |
              |<------------ASP Up-------------|
              |----------ASP-Up Ack----------->|
              |                               |
              |<----REGISTER REQ(LRCn,RKn)-----|  LRC: Local Routing
              |                               |       Context
              |----REGISTER RESP(LRCn,RCn)---->|   RK: Routing Key
              |                               |   RC: Routing Context
              |                               |
              |<------- ASP Active(RCn)--------|
              |-----ASP Active Ack (RCn)------>|
              |                               |
```

Note: In the case of an unsuccessful registration attempt (e.g., Invalid RKn), the Register Response will contain an unsuccessful indication and the ASP will not subsequently send an ASPAC.

5.1.1c Single ASP in multiple Application Servers (each with "1+0" sparing), With Dynamic Registration (Case 1 û Multiple Registration Requests)

```
             SG                              ASP1
              |                               |
              |<------------ASP Up-------------|
              |----------ASP-Up Ack----------->|
              |                               |
              |<----REGISTER REQ(LRC1,RK1)-----|  LRC: Local Routing
              |                               |       Context
              |----REGISTER RESP(LRC1,RC1)---->|   RK: Routing Key
              |                               |   RC: Routing Context
              |                               |
              |<------- ASP Active(RC1)--------|
```

```
                |-----ASP Active Ack (RC1)------>|
                |                                |
                :                                :
                :                                :
                |                                |
                |<----REGISTER REQ(LRCn,RKn)-----|
                |                                |
                |----REGISTER RESP(LRCn,RCn)---->|
                |                                |
                |                                |
                |<------- ASP Active(RCn)--------|
                |-----ASP Active Ack (RCn)------>|
                |                                |
```


Note: In the case of an unsuccessful registration attempt (e.g., Invalid RKn), the Register Response will contain an unsuccessful indication and the ASP will not subsequently send an ASPAC. Each LRC/RK pair registration is considered independently.

It is not necessary to follow a Registration Request/Response with an ASP Active before sending the next Registration Request. The ASP Active can happen any time after the related successful Registration.

5.1.1.d Single ASP in multiple Application Servers (each with "1+0" sparing), With Dynamic Registration (Case 2 û Single Registration Request)

```
               SG                              ASP1
                |                                |
                |<------------ASP Up-------------|
                |----------ASP-Up Ack----------->|
                |                                |
                |<---REGISTER REQ({LRC1,RK1},----|
                |                    ...,        |
                |                 {LRCn,RKn}),----|
                |                                |
                |---REGISTER RESP({LRC1,RC1},--->|
                |                   ...,         |
                |                 (LRCn,RCn})    |
                |                                |
                |<------- ASP Active(RC1)--------|
                |-----ASP Active Ack (RC1)------>|
                |                                |
                :                                :
                :                                :
                |                                |
                |<------- ASP Active(RCn)--------|
                |-----ASP Active Ack (RCn)------>|
                |                                |
```

Note: In the case of an unsuccessful registration attempt (e.g., Invalid RKn), the Register Response will contain an unsuccessful indication and the ASP will not subsequently send an ASPAC. Each LRC/RK pair registration is considered independently.

The ASP Active can happen any time after the related successful Registration, and may have more than one RC.

5.1.2 Two ASPs in Application Server ("1+1" sparing)

This scenario shows the example M3UA message flows for the establishment of traffic between an SG and two ASPs in the same Application Server, where ASP1 is configured to be "active" and ASP2 a "standby" in the event of communication failure or the withdrawal from service of ASP1. ASP2 may act as a hot, warm, or cold standby depending on the extent to which ASP1 and ASP2 share call/transaction state or can communicate call state under failure/withdrawal events. The example message flow is the same whether the ASP-Active messages are Over-ride or Load-share mode although typically this example would use an Over-ride mode. In the case of MTP Restart, the SG starts sending any relevant DUNA and SCON messages to the ASPs as soon as they enter the ASP-INACTIVE state. The ASP-Active Ack message is only sent after all relevant DUNA/SCON messages have been transmitted to the concerned ASP.

```
       SG                         ASP1                         ASP2
        |                          |                            |
        |<--------ASP Up----------|                            |
        |-------ASP-Up Ack------->|                            |
        |                          |                            |
        |<-----------------------------ASP Up----------------|
        |----------------------------ASP-Up Ack------------>|
        |                          |                            |
        |                          |                            |
        |<-------ASP Active-------|                            |
        |------ASP-Active Ack---->|                            |
        |                          |                            |
```

5.1.3 Two ASPs in an Application Server ("1+1" sparing, load-sharing case)

This scenario shows a similar case to Section 4.1.2 but where the two ASPs are brought to "active" and load-share the traffic load. In this case, one ASP is sufficient to handle the total traffic load. The sending of DUNA/SCON messages by the SG is not shown but would be similar to 5.1.2.

```
       SG                       ASP1                       ASP2
        |                         |                          |
        |<---------ASP Up---------|                          |
        |--------ASP-Up Ack------>|                          |
        |                         |                          |
        |<------------------------------ASP Up---------------|
        |-----------------------------ASP Up Ack------------>|
        |                         |                          |
        |                         |                          |
        |<--ASP Active (Ldshr)----|                          |
        |-----ASP-Active Ack----->|                          |
        |                         |                          |
        |<----------------------------ASP Active (Ldshr)-----|
        |-------------------------------ASP-Active Ack------>|
        |                         |                          |
```

5.1.4 Three ASPs in an Application Server ("n+k" sparing, load-sharing case)

This scenario shows the example M3UA message flows for the establishment of traffic between an SG and three ASPs in the same Application Server, where two of the ASPs are brought to "active" and share the load. In this case, a minimum of two ASPs are required to handle the total traffic load (2+1 sparing). The sending of DUNA/SCON messages by the SG is not shown but would be similar to 5.1.2.

```
   SG                  ASP1                 ASP2                 ASP3
    |                    |                   |                   |
    |<------ASP Up-------|                   |                   |
    |-----ASP-Up Ack---->|                   |                   |
    |                    |                   |                   |
    |<--------------------------ASP Up-------|                   |
    |-------------------------ASP-Up Ack)--->|                   |
    |                    |                   |                   |
    |<---------------------------------------------ASP Up--------|
    |---------------------------------------------ASP-Up Ack---->|
    |                    |                   |                   |
    |                    |                   |                   |
    |<--ASP Act (Ldshr)--|                   |                   |
    |----ASP-Act Ack---->|                   |                   |
    |                    |                   |                   |
    |<--------------------ASP Act. (Ldshr)---|                   |
    |-----------------------ASP-Act Ack----->|                   |
    |                    |                   |                   |
```

5.2 ASP Traffic Fail-over Examples

5.2.1 (1+1 Sparing, withdrawal of ASP, Back-up Over-ride)

Following on from the example in Section 5.1.2, and ASP1 withdraws from service:

```
       SG                        ASP1                         ASP2
        |                          |                            |
        |<-----ASP Inactive-------|                            |
        |----ASP Inactive Ack---->|                            |
        |-----------------------NTFY(AS-Pending)----------->|
        |                          |                            |
        |<------------------------------ ASP Active----------|
        |------------------------------ASP-Active Ack)------>|
        |                                                       |
```

Note: If the SG detects loss of the M3UA peer (M3UA heartbeat loss or detection of SCTP failure), the initial SG-ASP1 ASP Inactive message exchange would not occur.

5.2.2 (1+1 Sparing, Back-up Over-ride)

Following on from the example in Section 5.1.2, and ASP2 wishes to over-ride ASP1 and take over the traffic:

```
       SG                        ASP1                         ASP2
        |                          |                            |
        |<------------------------------- ASP Active----------|
        |-------------------------------ASP-Active Ack------>|
        |----NTFY(Alt ASP-Act)--->|
        |                          |                            |
```

5.2.3 (n+k Sparing, Load-sharing case, withdrawal of ASP)

Following on from the example in Section 5.1.4, and ASP1 withdraws from service:

```
   SG                    ASP1                    ASP2                    ASP3
    |                     |                      |                      |
    |<----ASP Inact.-----|                      |                      |
    |---ASP-Inact Ack--->|                      |                      |
    |                     |                      |                      |
    |---------------------------------NTFY(Ins. ASPs)----------->|
    |                     |                      |                      |
    |<------------------------------------------ASP Act (Ldshr)---|
    |-------------------------------------------ASP Act (Ack)--->|
    |                     |                      |                      |
```


For the Notify to occur the SG maintains knowledge of the minimum ASP resources required - for example if the SG knows that "n+k" = "2+1" for a load-share AS and "n" currently equals "1".

Note: If the SG detects loss of the ASP1 M3UA peer (M3UA heartbeat loss or detection of SCTP failure), the first SG-ASP1 ASP Inactive message exchange would not occur.

5.3 M3UA/MTP3-User Boundary Examples

5.3.1 At an ASP

This section describes the primitive mapping from the MTP3 User to M3UA at an ASP.

5.3.1.1 Support for MTP-Transfer on the ASP

5.3.1.1.1 Support for MTP-Transfer Request
When the MTP3-User on the ASP has data to send into the SS7 network, it will use the MTP-Transfer Request primitive. The M3UA on the ASP will do the following when it receives an MTP-Transfer Request primitive from the M3UA user:

- Determine the correct SG

- Determine the correct association to the chosen SG

- Determine the correct stream in the association (e.g., based on SLS)

- Determine whether to complete the optional fields of the Data message

- Map the MTP-Transfer Request primitive into the Protocol Data field of an m3ua Data message

- Send the Data message to the remote M3UA peer in the SG, over the SCTP association

```
SG                        ASP
|                          |
|<-----Data Message-------|<--MTP-Transfer req.
|                          |
```

5.3.1.1.2 Support for MTP Transfer Indication

When the M3UA on the ASP has received Data messages from the remote M3UA peer in the SG it will do the following:

- Evaluate the optional fields of the Data message if present

- Map the Payload of a Data message into the MTP-Transfer Indication primitive

- Pass the MTP-Transfer Indication primitive to the user part. In case of multiple user parts, the optional fields of the Data message are used to determine the concerned user part.

```
    SG                        ASP
    |                          |
    |------Data Message------>|-->MTP-Transfer ind.
    |                          |
```

5.3.1.1.3 Support for ASP Querying of SS7 Destination States

There are situations such as temporary loss of connectivity to the SG that may cause the M3UA on the ASP to audit SS7 destination availability states. Note: there is no primitive for the MTP3-User to request this audit from the M3UA as this is initiated by an internal M3UA management function.

The M3UA on the ASP normally sends Destination State Audit (DAUD) messages for each of the destinations that the ASP supports.

```
   SG                         ASP
    |                          |
    |<-----DAUD Message ------|
    |<-----DAUD Message ------|
    |<-----DAUD Message ------|
    |                          |
    |                          |
```

5.3.2 At an SG

This section describes the MTP3 upper layer primitive mapping to the M3UA at the SG.

5.3.2.1 Support for MTP-Transfer Request at the SG

When the M3UA on the SG has received Data messages from its peer destined to the SS7 network it will do the following:

- Evaluate the optional fields of the Data message if present to determine the network appearance

- Map the Protocol data of the Data message into an MTP-Transfer Request primitive

- Pass the MTP-Transfer Request primitive to the MTP3 of the concerned network appearance.


```
                         SG                         ASP
                          |                          |
    <---MTP-Transfer req.|<------Data Message------|
                          |                          |
```

5.3.2.2 Support for MTP-Transfer Indication at the SG

When the MTP3 on the SG has data to pass its user parts, it will use the MTP-Transfer Indication primitive. The M3UA on the SG will do the following when it receives an MTP-Transfer Indication:

- Determine the correct ASP

- Determine the correct association to the chosen ASP

- Determine the correct stream in the association (e.g., based on SLS)

- Determine whether to complete the optional fields of the Data message

- Map the MTP-Transfer Indication primitive into the Protocol Data field of an M3UA Data message

- Send the Data message to the remote M3UA peer in the ASP, over the SCTP association

```
                            SG                          ASP
                             |                           |
   --MTP-Transfer ind.->|------Data Message------>|
                             |                           |
```

5.3.2.3 Support for MTP-PAUSE, MTP-RESUME, MTP-STATUS

The MTP-PAUSE, MTP-RESUME and MTP-STATUS indication primitives from the MTP3 upper layer interface at the SG need to be made available to the remote MTP3 User Part lower layer interface at the concerned ASP(s).

5.3.2.3.1 Destination Unavailable

The MTP3 on the SG will generate an MTP-PAUSE primitive when it determines locally that an SS7 destination is unreachable. The M3UA will map this primitive to a Destination Unavailable (DUNA) message. The SG M3UA determines the set of concerned ASPs to be informed based on internal SS7 network information associated with the MTP-PAUSE primitive indication.


```
                    SG                         ASP
                     |                          |
 --MTP-PAUSE ind.-->|------DUNA Message ----->|--MTP-PAUSE ind.-->
                     |                          |
```

5.3.2.3.2 Destination Available

The MTP3 on the SG will generate an MTP-RESUME primitive when it determines locally that an SS7 destination that was previously unreachable is now reachable. The M3UA will map this primitive to a Destination Available (DAVA) message. The SG M3UA determines the set of concerned ASPs to be informed based on internal SS7 network information associated with the MTP-RESUME primitive indication.

```
                    SG                         ASP
                     |                          |
--MTP-RESUME ind.-->|------DAVA Message ----->|--MTP-RESUME ind.-->
                     |                          |
```

5.3.2.3.3 SS7 Network Congestion

The MTP3 on the SG will generate an MTP-STATUS primitive when it determines locally that the route to an SS7 destination is congested. The M3UA will map this primitive to a SS7 Network Congestion State (SCON) message. It will determine which ASP(s) to send the DUPU to based on the intended Application Server.

```
                     SG                         ASP
                       |                          |
--MTP-STATUS ind.-->|------SCON Message ----->|--MTP-STATUS ind.-->
                       |                          |
```

5.3.2.3.4 Destination User Part Unavailable

The MTP3 on the SG will generate an MTP-STATUS primitive when it receives an UPU message from the SS7 network. The M3UA will map this primitive to a Destination User Part Unavailable (DUPU) message. It will determine which ASP(s) to send the DUPU based on the intended Application Server.

```
                      SG                         ASP
                       |                          |
--MTP-STATUS ind.-->|------DUPU Message ----->|--MTP-STATUS ind.-->
                       |                          |
```


6.0 Security

6.1 Introduction

M3UA is designed to carry signalling messages for telephony services. As such, M3UA must involve the security needs of several parties: the end users of the services; the network providers and the applications involved. Additional requirements may come from local regulation. While having some overlapping security needs, any security solution should fulfill all of the different parties' needs.

6.2 Threats

There is no quick fix, one-size-fits-all solution for security. As a transport protocol, M3UA has the following security objectives:

* Availability of reliable and timely user data transport.
* Integrity of user data transport.
* Confidentiality of user data.

M3UA runs on top of SCTP. SCTP [6] provides certain transport related security features, such as some protection against:

* Blind Denial of Service Attacks
* Flooding

* Masquerade
* Improper Monopolization of Services

When M3UA is running in professionally managed corporate or service provider network, it is reasonable to expect that this network includes an appropriate security policy framework. The "Site Security Handbook" [21] should be consulted for guidance.

When the network in which M3UA runs in involves more than one party, it may not be reasonable to expect that all parties have implemented security in a sufficient manner. In such a case, it is recommended that IPSEC is used to ensure confidentiality of user payload. Consult [22] for more information on configuring IPSEC services.

6.3 Protecting Confidentiality

Particularly for mobile users, the requirement for confidentiality may include the masking of IP addresses and ports. In this case application level encryption is not sufficient; IPSEC ESP should be used instead. Regardless of which level performs the encryption, the IPSEC ISAKMP service should be used for key management.

7.0 IANA Considerations

7.1 SCTP Payload Protocol Identifier

A request will be made to IANA to assign an M3UA value for the Payload Protocol Identifier in SCTP Payload Data chunk. The following SCTP Payload Protocol Identifier will be registered:

M3UA "3"

The SCTP Payload Protocol Identifier is included in each SCTP Data chunk, to indicate which protocol the SCTP is carrying. This Payload Protocol Identifier is not directly used by SCTP but MAY be used by certain network entities to identify the type of information being carried in a Data chunk.

The User Adaptation peer MAY use the Payload Protocol Identifier as a way of determining additional information about the data being presented to it by SCTP.

7.2 M3UA Protocol Extensions

This protocol may also be extended through IANA in three ways:
-- through definition of additional message classes,
-- through definition of additional message types, and
-- through definition of additional message parameters

The definition and use of new message classes, types and parameters is an integral part of SIGTRAN adaptation layers. Thus these extensions are assigned by IANA through an IETF Consensus action as defined in [RFC2434].

The proposed extension must in no way adversely affect the general working of the protocol.

7.2.1 IETF Defined Message Classes

The documentation for a new message class MUST include the following information:
(a) A long and short name for the new message class;
(b) A detailed description of the purpose of the message class.

7.2.2 IETF Defined Message Types

The documentation for a new message type MUST include the following information:
(a) A long and short name for the new message type;
(b) A detailed description of the structure of the message.
(c) A detailed definition and description of intended use for each field within the message.

(d) A detailed procedural description of the use of the new message type within the operation of the protocol.
(e) A detailed description of error conditions when receiving this message type.

When an implementation receives a message type which it does not support, it MUST respond with an Error (ERR) message, with an Error Code = Unsupported Message Type.

7.2.3 IETF-defined TLV Parameter extension

Documentation of the message parameter MUST contain the following information:

(a) Name of the parameter type.
(b) Detailed description of the structure of the parameter field. This structure MUST conform to the general type-length-value format described in Section 3.1.5.
(c) Detailed definition of each component of the parameter value.
(d) Detailed description of the intended use of this parameter type, and an indication of whether and under what circumstances multiple instances of this parameter type may be found within the same message.

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9.0 References

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[2] ITU-T Recommendations Q.761 to Q.767, 'Signalling System No.7 (SS7) - ISDN User Part (ISUP)'

[3] ANSI T1.113 - 'Signaling System Number 7 - ISDN User Part

[4] ETSI ETS 300 356-1 "Integrated Services Digital Network (ISDN); Signalling System No.7; ISDN User Part (ISUP) version 2 for the international interface; Part 1: Basic services"

[5] ITU-T Recommendations Q.711-715, 'Signalling System No. 7 (SS7) - Signalling Connection Control Part (SCCP)'

[6] ANSI T1.112 'Signaling System Number 7 - Signaling Connection Control Part'

[7] ETSI ETS 300 009-1, "Integrated Services Digital Network (ISDN); Signalling System No.7; Signalling Connection Control Part (SCCP) (connectionless and connection-oriented class 2) to support international interconnection; Part 1: Protocol specification"

[8] ITU-T Recommendations Q.720, 'Telephone User Part'

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Annex B: History

Document history		
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