Network Working Group
INTERNET-DRAFT

Ken Morneault
Cisco Systems
Mallesh Kalla
Telcordia
Greg Sidebottom
Nortel Networks
Ram Dantu
IPMobile
Tom George
Alcatel

Expires in six months
March 2000

SS7 MTP2-User Adaptation Layer
<draft-ietf-sigtran-m2ua-03.txt>

Status of This Memo

Abstract

This Internet Draft defines a protocol for backhauling of SS7 MTP2 User signaling messages over IP using the Simple Control Transmission

Protocol (SCTP). This protocol would be used between a Signaling Gateway (SG) and Media Gateway Controller (MGC). It is assumed that the SG receives SS7 signaling over a standard SS7 interface using the SS7 Message Transfer Part (MTP) to provide transport. The Signaling Gateway would act as a Signaling Link Terminal.

TABLE OF CONTENTS

1. Introduction

1.1 Scope

There is a need for SCN signaling protocol delivery from an Signaling Gateway (SG) to a Media Gateway Controller (MGC) or IP Signaling Point (IPSP). The delivery mechanism should meet the following criteria:

* Support for MTP Level 2 / MTP Level 3 interface boundary
* Support for communication between Layer Management modules on SG and MGC
* Support for management of active associations between the SG and MGC

In other words, the Signaling Gateway will transport MTP Level 3 messages to a Media Gateway Controller (MGC) or IP Signaling Point (IPSP). In the case of delivery from an SG to an IPSP, both the SG and IPSP function as traditional SS7 nodes using the IP network as a new type of SS7 link. This allows for full MTP Level 3 message handling and network management capabilities.

1.2 Terminology

MTP2-User - A protocol that normally uses the services of MTP Level 2 (i.e. MTP3).

Interface - For the purposes of this document, an interface is a SS7 signaling link.

Association - An association refers to a SCTP association. The association will provide the transport for the delivery of protocol data units for one or more interfaces.

Backhaul - Refers to the transport of signaling from the point of interface for the associated data stream (i.e., SG function in the MGU) back to the point of call processing (i.e., the MGCU), if this is not local [4].

Application Server (AS) - A logical entity serving a specific application instance. An example of an Application Server is a MGC handling the MTP Level 3 and call processing for SS7 links terminated by the Signaling Gateways. Practically speaking, an AS is modeled at the SG as an ordered list of one or more related Application Server Processes (e.g., primary, secondary, tertiary, ...).

Application Server Process (ASP) - A process instance of an Application Server. Examples of Application Server Processes are primary or backup MGC instances.

Application Server Process Path (ASP Path or just Path) - A Path to a remote Application Server Process instance. A Path maps 1:1 to an SCTP association.

Fail-over - The capability to re-route signaling 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-back may apply upon the return to service of a previously unavailable Application Server Process.

Signaling Link Terminal (SLT) - Refers to the means of performing all of the functions defined at MTP level 2 regardless of their implementation [2].

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

Layer Management - Layer Management is a nodal function in an SG or ASP that handles the inputs and outputs between the M2UA 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.

1.3 Signaling Transport Architecture

The framework architecture that has been defined for SCN signaling transport over IP [5] uses multiple components, including a signaling common transport protocol and an adaptation module to support the services expected by a particular SCN signaling protocol from its underlying protocol layer.

Within this framework architecture, this document defines a SCN adaptation module that is suitable for the transport of SS7 MTP2 User messages. The only SS7 MTP2 User is MTP3. The M2UA uses the services of the Simple Common Transport protocol [6] as the underlying reliable signaling common transport protocol.

In a Signaling Gateway, it is expected that the SS7 MTP2-User signaling is transmitted and received from the PSTN over a standard SS7 network interface, using the SS7 Message Transfer Part Level 1 and Level 2 [3,4] to provide reliable transport of the MTP3-User signaling messages to and from an SS7 Signaling End Point (SEP) or Signaling Transfer Point (STP). The SG then provides a functional inter-working of transport functions with the IP transport, in order to transfer the MTP2-User signaling messages to and from an Application Server Process where the peer MTP2-User protocol layer exists.

1.3.1 Example - SG to MGC

In a Signaling Gateway, it is expected that the SS7 signaling is received over a standard SS7 network termination, using the SS7 Message Transfer Part (MTP) to provide transport of SS7 signaling messages to and from an SS7 Signaling End Point (SEP) or SS7 Signaling Transfer Point (STP). In other words, the SG acts as a Signaling Link Terminal (SLT) [2]. The SG then provides interworking of transport functions with IP Signaling Transport, in order to transport the MTP3 signaling messages to the MGC where the peer MTP3 protocol layer exists, as shown below:

```
    ******    SS7    ******      IP     *******
    *SEP *-----------* SG *-------------* MGC *
    ******           ******             *******

    +----+                              +----+
    |S7UP|                              |S7UP|
    +----+                              +----+
    |MTP +                              |MTP |
    | L3 |          (NIF)               |L3  |
    +----+         +----+----+          +----+
    |MTP |         |MTP |M2UA|          |M2UA|
    |    |         |    +----+          +----+
    |L2  |         |L2  |SCTP|          |SCTP|
    |L1  |         |L1  +----+          +----+
    |    |         |    |IP  |          |IP  |
    +----+         +---------+          +----+

    NIF  - Nodal Interworking Function
    SEP  - SS7 Signaling Endpoint
    IP   - Internet Protocol
    SCTP - Simple Control Transmission Protocol
           (Refer to Reference [5])
```

Figure 1 M2UA in the SG to MGC Application

Note: STPs may be present in the SS7 path between the SEP and the SG.

1.3.2 Signaling Network Architecture

A Signaling Gateway will support the transport of MTP2-User signaling traffic received from the SS7 network to one or more distributed ASPs (e.g., MGCs). Clearly, the M2UA protocol description cannot in itself meet any performance and reliability requirements for such transport. A physical network architecture is required, with data on the availability and transfer performance of the physical nodes involved in any particular exchange of information. However, the M2UA protocol must be flexible enough allow its operation and management in a variety of physical configurations that will enable Network Operators to meet their performance and reliability requirements.

To meet the stringent SS7 signaling reliability and performance requirements for carrier grade networks, these Network Operators should ensure that there is no single point of failure provisioned in the end-to-end network architecture between an SS7 node and an IP ASP. Depending of course on the reliability of the SG and ASP functional elements, this can typically be met by the spreading links in a linkset across SGs, the provision of redundant QOS-bounded IP network paths for SCTP Associations between SCTP End Points, and redundant Hosts. The distribution of ASPs within the available Hosts is also important. For a particular Application Server, the related ASPs should be distributed over at least two Hosts.

An example physical network architecture relevant to carrier-grade operation in the IP network domain is shown in Figure 2 below:

```
  ********                                         **************
  *      *_________________________________________*  ********  * Host1
  *      *                                __________*  * ASP1 *  *
  *  SG1 *   SCTP Associations           |         *  ********  *
  *      *_______________________        |         *            *
  ********                       |       |         **************
                                 |       |
  ********                       |       |
  *      *_______________________________|
  *      *                       |
  *  SG2 *    SCTP Associations  |
  *      *____________           |
  *      *           |           |
  ********           |           |                 **************
                     |           |_________________*  ********  * Host2
                     |_____________________________*  * ASP1 *  *
                                                   *  ********  *
                                                   *            *
                                                   **************
                                                           .
                                                           .
                                                           .
```

Figure 2 - Physical Model Example

For carrier grade networks, Operators should ensure that under failure or isolation of a particular ASP, stable calls or transactions are not lost. This implies that ASPs need, in some cases, to share the call/-transaction state or be able to pass the call/transaction state between each other. Also, in the case of ASPs performing call processing, coordination may be required with the related Media Gateway to transfer the MGC control for a particular trunk termination. However, this sharing or communication is outside the scope of this document.

1.3.4 ASP Fail-over Model and Terminology

The M2UA supports ASP fail-over functions in order to support a high availability of call and transaction processing capability. All MTP2-User messages incoming to an SG from the SS7 network are assigned to a unique Application Server, based on the Interface Identifier of the message.

The Application Server is in practical terms a list of all ASPs currently registered to process MTP2-User messages from certain Interface Identifiers. 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 ôn+kö redundancy model, where ônö ASPs is the minimum number of redundant ASPs required to handle traffic and ôkö ASPs are available to take over for a failed or unavailable ASP. Note that ô1+1ö active/standby redundancy is a subset of this model. A simplex ô1+0ö model is also supported as a subset, with no ASP redundancy.

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 this:

```
    Interface Identiers - Application Server #1
        ASP1/Host1  - State=Up, Active
        ASP1/Host2  - State=Up, Inactive
```

In this ô1+1ö redundancy case, ASP1 in Host1 would be sent any incoming message for the Interface Identifiers registered. 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 M2UA peer is ready.

The AS List at SG1 might also be set up in loadshare mode:

```
    Interface Identifiers - 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.

In the process of fail-over or fail-back, it is recommended that in the case of ASPs supporting call processing, stable calls do not fail. It is possible that calls in ôtransitionö 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.

1.3.5 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.

The SCTP (and UDP/TCP) Registered User Port Number Assignment for M2UA is 2904.

1.4 Services Provided by the M2UA Adaptation Layer

The SS7 MTP3/MTP2(MTP2-User) interface is retained at the termination point in the IP network, so that the M2UA protocol layer is required to provide the equivalent set of services to its users as provided by the MTP Level 2 to MTP Level 3.

This includes the following services:

1.4.1 Support for MTP Level 2 / MTP Level 3 interface boundary

Also provision is made for protocol elements that enable a seamless, or as seamless as possible, operation of the MTP2-User peers in the SS7 and IP domains. This includes

Data

Provides the ability to transport MTP2 User information (in this case, MTP Level 3 PDUs).

Link Establish

Provides the ability to request MTP Level 2 to bring SS7 links in-service.

Link Release

Provides the ability to request MTP Level 2 to take SS7 links out-of-service. Also, provides mechanism for MTP2 to autonomously indicate that SS7 link(s) have gone out-of-service.

Link State

Provides the ability to request state change or information on a per link basis. Some examples would be the forcing of Local Processor Outage or flushing buffers.

Link Status

Provides a means for asynchronous notification of link state changes to be reported to the upper layer (MTP Level 3). An example would be the reporting of remote processor outage event.

Data Retrieval

Provides a mechanism to perform SS7 link changeover procedure in the case of a SS7 link failure.

1.4.2 Support for communication between Layer Management modules on SG and MGC

It is envisioned that the M2UA layer needs to provide some messages that will facilitate communication between Layer Management modules on the SG and MGC.

To facilitate reporting of errors that arise because of backhauling MTP Level 3 scenario, the following primitive is defined:

M-ERROR

The M-ERROR message is used to indicate an error with a received M2UA message (e.g., interface identifier value is not known to the SG).

1.4.3 Support for management of active associations between SG and MGC

The M2UA layer on the SG keeps the state of various ASPs it is associated with. A set of primitives between M2UA layer and the Layer Management are defined below to help the Layer Management manage the association(s) between the SG and the MGC.

M-SCTP ESTABLISH

The M-SCTP ESTABLISH primitive is used to request, indicate and confirm the establishment of SCTP association to a peer M2UA node.

The M2UA layer may also need to inform the status of the SCTP association(s) to the Layer Management. This can be achieved using the following primitive.

M-SCTP STATUS

The M-SCTP STATUS primitive is used to request and indicate the status of underlying SCTP association(s).

The Layer Management may need to inform the M2UA layer of a user status (i.e., failure, active, etc.), so that messages can be exchanged between M2UA layer peers to stop traffic to the local M2UA user. This can be achieved using the following primitive.

M-ASP STATUS

The M-ASP STATUS primitive is used by the Layer Management to indicate the status of the local M2UA user to the M2UA layer.

1.5 Functions Provided by the M2UA Layer

1.5.1 Mapping

The M2UA layer must maintain a map of a Interface ID to a physical interface on the Signaling Gateway. A physical interface would be a **V.35 line, T1 line/timeslot, E1 line/timeslot, etc.   The M2UA layer** must also maintain a map of Interface Identifier to SCTP association and to the related stream within the association.

1.5.2 Flow Control / Congestion

It is possible for the M2UA layer to be informed of IP network congestion by means of an implementation-dependent function (i.e. an indication from the SCTP). If the M2UA layer receives this indication, the action(s) taken are implementation dependent.

1.5.3 SCTP Stream Management

SCTP allows user specified number of streams to be opened during the initialization. It is the responsibility of the M2UA layer to ensure proper management of these streams. SCTP streams provide a means for avoiding head of line blocking. For that reason, a stream should be used per SS7 signaling link terminated by the Signaling Gateway. The SS7 signaling link can be identified by the optional Interface Identifier in the M2UA specific message header (refer to Section 2.2).

1.5.4 Seamless SS7 Network Management Interworking

If the SG loses the SCTP association to the MGC, it should follow MTP 2 processor outage procedures [2].

1.5.5 Management Inhibit/Uninhibit

Local Management at an ASP or SG 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.

1.5.6 Active Association Control

At an SG, an Application Server list may contain active and inactive ASPs to support ASP loads-haring and fail-over procedures. When, for example, both a primary and a back-up ASP are available, M2UA peer protocol is required to control which ASP is currently active. The ordered list of ASPs within a logical Application Server is kept updated in the SG to reflect the active Application Server Process(es).

1.6 Definition of the M2UA Boundaries

1.6.1 Definition of the M2UA / MTP Level 3 boundary

DATA
ESTABLISH
RELEASE
STATE
STATUS
RETRIEVAL
DATA RETRIEVAL
DATA RETRIEVAL COMPLETE

1.6.2 Definition of the M2UA / MTP Level 2 boundary

DATA
ESTABLISH
RELEASE
STATE
STATUS
RETRIEVAL
DATA RETRIEVAL
DATA RETRIEVAL COMPLETE

1.6.3 Definition of the Lower Layer Boundary between M2UA and SCTP

The upper layer and layer management primitives provided by SCTP are provided in Reference [6] Section 9.

1.6.4 Definition of Layer Management / M2UA Boundary

M-ERROR
M-SCTP ESTABLISH
M-SCTP STATUS
M-ASP STATUS

2.0 Protocol Elements

This section describes the format of various messages used in this protocol.

2.1 Common Message Header

The protocol messages for MTP2-User Adaptation require a message structure which contains a version, message type, message length, and message contents. This message header is common among all signaling protocol adaptation layers:

```
    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    |     Spare     |         Message Type          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Message Length                         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3 Common Message Header

All fields in an M2UA message MUST be transmitted in the network byte order, unless otherwise stated.

2.1.1 Version

The version field (vers) contains the version of the M2UA adapation layer. The supported versions are:

      0000 0001   Release 1.0 protocol

2.1.2 Message Type

The valid message types are defined in Section 2.2.2 and the message contents are described in Section 2.3. Each message can contain parameters.

The following list contains the message types for the defined messages.

MTP2 User Adaptatation (MAUP) Messages

Data	0601
Establish Request	0602
Establish Confirm	0603
Release Request	0604
Release Confirm	0605
Release Indication	0606
State Request	0607
State Confirm	0608
State Indication	0609
Data Retrieval Request	060a
Data Retrieval Confirm	060b

Data Retrieval Indication	060c
Data Retrieval Complete Indication	060d

Application Server Process Maintenance (ASPM) Messages

ASP Up (ASPUP)	0301
ASP Down (ASPDN)	0302
ASP Active (ASPAC)	0401
ASP Inactive (ASPIA)	0402

Management (MGMT) Messages

Error	0000

2.1.3 Message Length

The Message length defines the length of the message in octets, not including the header.

2.2 M2UA Message Header

In addition to the common message header, there will be a M2UA specific message header. The M2UA specific message header will immediately follow the common message header, but will only be used with MAUP and MGMT messages.

This message header will contain the Interface Identifier. The Interface Identifier identifies the physical interface at the SG for which the signaling messages are sent/received. The format of the Interface Identifier parameter is an integer, the values of which are assigned according to network operator policy. The values used are of local significance only, coordinated between the SG and ASP.

```
 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 (0x1)           |           Length=4            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Interface Identifier                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4 M2UA Message Header

The Tag value for Interface Identifier is 0x1. The length is always set to a value of 4.

2.3 M2UA Messages

The following section defines the messages and parameter contents. The M2UA messages will use the common message header (Figure 3) and the M2UA message header (Figure 4).

2.3.1 MTP2 User Adaptation Messages

2.3.1.1 Data

The Data message contains an SS7 MTP2-User Protocol Data Unit (PDU). The Data message contains the protocol data.

The format for the Data 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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                        Protocol Data                          |

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

The Protocol Data field contains the MTP2-User application message in network byte order.

2.3.1.2 Establish (Request, Confirmation)

The Establish Request message is used to establish the link or to indicate that the channel has been established. Note that the gateway may already have the SS7 link established at its layer. If so, upon receipt of an Establish Request, the gateway takes no action except to send an Establish Confirm.

The mode (Normal of Emergency) for bringing the link in service is defaulted to Normal. The State Request (described in Section 2.3.1.4 below) can be used to change the mode to Emergency.

2.3.1.3 Release (Request, Indication, Confirmation)

This Release Request message is used to release the channel. The Release Confirm and Indication messages are used to indicate that the channel has been released.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             Reason                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The valid values for Reason are shown in the following table.

Define	Value	Description
RELEASE_MGMT	0x0	Management layer generated release
RELEASE_PHYS	0x1	Physical layer alarm generated release
RELEASE_SIOS	0x2	Receipt of SIOS
RELEASE_T6	0x3	Release due to expiration of Timer T6
RELEASE_T7	0x4	Release due to expiration of Timer T7
RELEASE_BSN	0x5	Release due to invalid BSN (2 of 3)
RELEASE_FIB	0x6	Release due to invalid FIB (2 of 3)

RELEASE_SUERM	0x7	Release due to failure reported by SUERM
RELEASE_IAC	0x8	Release due to initial alignment failed
RELEASE_OTHER	0x9	Other reason SS7 link out-of-service

2.3.1.4 State (Request, Confirm)

The State Request message can be sent from a MGC to cause an action on a particular SS7 link supported by the Signaling Gateway. The gateway sends a State Confirm to the MGC if the action has been successfully completed. The State Confirm reflects that state value received in the State Request 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             State                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The valid values for State are shown in the following table.

Define	Value	Description
STATUS_LPO_SET	0x0	Request local processor outage
STATUS_LPO_CLEAR	0x1	Request local processor outage recovered
STATUS_EMER_SET	0x2	Request emergency alignment procedure
STATUS_EMER_CLEAR	0x3	Request normal alignment (cancel emergency) procedure
STATUS_FLUSH_BUFFERS	0x4	Flush transmit and retransmit buffers
STATUS_CONTINUE	0x5	Continue

2.3.1.5 State Indication

The MTP2 State Indication message can be sent from a gateway to an ASP to indicate a condition on a link.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             State                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The valid values for State are shown in the following table.

Define	Value	Description
EVENT_ENTER_LPO	0x0	Entered local processor outage
EVENT_EXIT_LPO	0x1	Exited local processor outage
EVENT_ENTER_CONG	0x2	Entered a congested state
EVENT_EXIT_CONG	0x3	Exited a congested state
EVENT_PHYS_UP	0x4	Physical interface up
EVENT_PHYS_DOWN	0x5	Physical interface down
EVENT_PROTOCOL_ERR	0x6	Protocol error occurred
EVENT_REM_ENTER_CONG	0xc	Remote entered congestion
EVENT_REM_EXIT_CONG	0xd	Remote exited congestion
EVENT_REM_ENTER_PO	0xe	Remote entered processor outage
EVENT_REM_EXIT_PO	0xf	Remote exited processor outage

2.3.1.6 Retrieval (Request, Confirm)

The MTP2 Retrieval Request message is used during the MTP Level 3 changeover procedure to request the BSN, to retrieve PDUs from the retransmit queue or to flush PDUs from the retransmit queue.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             Action                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             fsn_bsn                           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The valid values for Action are shown in the following table.

Define	Value	Description
ACTION_RTRV_BSN	0x1	Retrieve the backward sequence number
ACTION_RTRV_MSGS	0x2	Retrieve the PDUs from the retransmit queue
ACTION_DROP_MSGS	0x3	Drop the PDUs in the retransmit queue

In the Retrieval Request message, the fsn_bsn field contains the FSN of the far end if the action is ACTION_RTRV_MSGS.

When the Signaling Gateway sends a Retrieval Confirm to this request, it echos the action and puts the BSN in the fsn_bsn field if the action was ACTION_RTRV_BSN. If there is a failure in retrieving the BSN, the fsn_bsn should contain a -1 (0xffffffff).

2.3.1.7 Retrieval Indication

The Retrieval Indication message is sent by the Signaling Gateway with a PDU from the retransmit queue. The Retrieval Indication message does not contain the Action or fsn_bsn fields, just a PDU from the retransmit queue.

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

   |                      PDU from retransmit queue                |

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

2.3.1.8 Retrieval Complete Indication

The MTP2 Retrieval Complete Indication message is exactly the same as the MTP2 Retrieval Indication message except that it also indicates that it contains the last PDU from the retransmit queue.

2.3.2 Application Server Process Maintenance (ASPM) Messages

The ASPM messages will only use the common message header.

2.3.2.1 ASP UP (ASPUP)

The ASP UP (ASPUP) message is used to indicate to a remote M2UA peer that the Adaptation layer is ready to receive traffic or maintenance messages.

The ASPUP message contains the following parameters:

     Adaptation Layer Identifer (optional)
     Protocol Identifier (optional)
     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 (0x2)            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                 Adaptation Layer Identifier*                  |

   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Tag (0x4)            |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                          INFO String*                         |

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

The optional INFO String parameter can carry any meaningful 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 for debugging purposes.

The optional Adaptation Layer Identifier (ALI) is a string that identifies the adaptation layer. This string must be set to "M2UA" which results in a length of 4. The ALI would normally only be used in the initial ASP Up message across a new SCTP association to ensure both peers are assuming the same adaptation layer protocol.

Note: Strings are padded to 32-bit boundaries. The length field indicates the end of the string.

2.3.2.2 ASP Down (ASPDN)

The ASP Down (ASPDN) message is used to indicate to a remote M2UA peer that the adaptation layer is not ready to receive traffic or maintenance messages.

The ASPDN message contains the following parameters:

    Reason
    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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                             Reason                            |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |           Tag (0x4)           |             Length            |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

    |                         INFO String*                          |

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

The format and description of the optional Info String parameter is the same as for the ASP Up message (See Section 2.3.2.1.)

The Reason parameter indicates the reason that the remote M2UA adaptation layer is unavailable. The valid values for Reason are shown in the following table.

Value	Description
0x1	Management Inhibit

2.3.2.3 ASP Active (ASPAC)

The ASPAC message is sent by an ASP to indicate to an SG that it is Active and ready to be used.

The ASPAC message contains the following parameters:

    Type
    Interface Identifier (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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             Type                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag (0xx)           |            Length             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                     Interface Identifiers*                    |

   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         Tag (0x4)             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                          INFO String*                         |

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

The 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.

Value	Description
0x1	Over-ride
0x2	Load-share
0x3	New traffic

Within a particular Routing Context, only one Type can be used. The Over-ride value indicates that the ASP is operating in Over-ride mode, where 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 loadshare mode, the ASP will share in the traffic distribution with any other currently active ASPs. In New Traffic mode the ASP wishes to take on traffic in the AS but does not expect to receive messages related to calls/transactions that are pending completion in another ASP.

An SG that receives an ASPAC with an incorrect type for a particular Interface Identifier will respond with an Error Message.

The optional Interface Identifiers parameter contains a list of Interface Identifier integers indexing the Application Server traffic that the sending ASP is configured/registered to receive. There is one-to-one relationship between an Interface Identifier and an AS Name. If no Interface Identifiers are present, then the message is intended for all Interface Identifiers supported by the SG.

The format and description of the optional Info String parameter is the same as for the ASP Up message (See Section 2.3.2.1.)

2.3.2.4 ASP Inactive (ASPIA)

The ASPIA message is sent by an ASP to indicate to an SG that it is no longer an active ASP to be used from within a list of ASPs. The SG will respond with an ASPIA message and either discard incoming messages or buffer for a timed period and then discard.

The ASPIA message contains the following parameters:

     Type
     Interface Identifiers (Optional)
     INFO String (Optional)

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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             Type                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag (0xx)           |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                     Interface Identifiers*                    |

   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag (0x4)           |             Length            |
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          INFO String*                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The 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.

Value	Description
0x1	Over-ride
0x2	Load-share
0x3	Graceful Withdrawal

The format and description of the optional Interface Identifiers and Info String parameters is the same as for the ASP Active message (See Section 2.3.2.3.) If no Interface Identifiers are present, then the message is intended for all Interface Identifiers supported by the SG.

2.3.3 Layer Management (MGMT) Messages

2.3.3.1 Error (ERR)

The ERR message is sent when an invalid value is found in an incoming message.

The ERR message contains the following parameters:

    Error Code
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Error Code                           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Tag (0xx)           |            Length             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                     Diagnostic Information*                   |

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

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

```
     Invalid Version                       0x1
     Invalid Interface Identifier          0x2
     Invalid Adaptation Layer Identifier   0x3
     Invalid Message Type                  0x4
     Invalid Traffic Handling Mode         0x5
     Invalid Stream Identifier             0x5
```

The optional Diagnostic information can be any information germain to the error condition, to assist in identification of the error condition. In the case of an Invalid Version Error Code the Diagnostic information includes the supported Version parameter. In the other cases, the Diagnostic information may be the first 40 bytes of the offending message.

2.3.3.2 Notify (NTFY)

The Notify message used to provide autonomous notification of M2UA events.

The NTFY message contains the following parameters:

Status Type
Status Identification
Interface Identifiers (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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Status Type            |    Status Identification      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         Tag (0xx)             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                      Interface Identifiers*                   |

   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         Tag (0x4)             |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

   |                          INFO String*                         |

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

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

Value	Description
0x1	Application Server state change (AS_State_Change)
0x2	Application Server Process state change (ASP_State_Change)
0x3	Other

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:

Value	Description
0x1	Application Server Down (AS_Down)
0x2	Application Server Up (AS_Up)
0x3	Application Server Active (AS_Active)
0x4	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 ASP_State_Change, the Status Information values are:

Value	Description
0x1	Application Server Process (ASP) Down
0x2	Application Server Process (ASP) Up
0x3	Application Server Process (ASP) Active
0x4	Application Server Process (ASP) Active_Old
0x5	Application Server Process (ASP) Active_New

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

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

Value	Description
0x1	Insufficient ASP resources active in AS

This notification is not based on the SG reporting the state change of an ASP or AS. For the value defined the SG is indicating to an ASP(s) in the AS that another ASP is required in order to handle the load of the AS.

The format and description of the optional Interface Identifiers and Info String parameters is the same as for the ASP Active message (See Section 2.3.2.3.)

3.0 Procedures

The M2UA layers needs to respond to various primitives it receives from other layers as well as messages it receives from the peer-to-peer messages. This section describes various procedures involved in response to these events.

3.1 Procedures to Support Service in Section 1.4.1

These procedures achieve the M2UA layer's "Transport of MTP Level 2 / MTP Level 3 boundary" service.

3.1.1 MTP Level 2 / MTP Level 3 Boundary Procedures

On receiving a primitive from the local upper layer, the M2UA layer will send the corresponding MAUP message (see Section 2) to its peer. The M2UA layer must fill in various fields of the common and specific headers correctly. In addition the message needs to be sent on the SCTP stream that corresponds to the SS7 link.

3.1.2 MAUP Message Procedures

On receiving MAUP messages from a peer M2UA layer, the M2UA layer on an SG or MGC needs to invoke the corresponding layer primitives to the local MTP Level 2 or MTP Level 3 layer.

3.2 Procedures to Support Service in Section 1.4.2

These procedures achieve the M2UA layer's "Support for Communication between Layer Managements" service.

3.2.1 Layer Management Primitives Procedure

On receiving these primitives from the local layer, the M2UA layer will send the corresponding MGMT message (Error) to its peer. The M2UA layer must fill in the various fields of the common and specific headers correctly.

3.2.2 MGMT message procedures

Upon receipt of MGMT messages the M2UA layer must invoke the corresponding Layer Management primitives (M-ERROR) to the local layer management.

3.3 Procedures to Support Service in Section 1.4.3

These procedures achieve the M2UA layer's "Support for management of active associations between SG and MGC" service.

3.3.1 State Maintenance

The M2UA layer on the SG maintains the state of each AS, in each Appliction Server that it is configured to receive traffic.

3.3.1.1 ASP States

The state of each ASP, in each AS that it is configured, is maintained in the M2UA 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 M2UA layer at the ASP
* Reception of some messages from the peer M2UA layer at other ASPs in the AS
* Reception of indications from the SCTP layer
* Switch-over Time triggers

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

ASP-DOWN: The remote M2UA peer at the ASP is unavailable and/or the SCTP association is down. Initially all ASPs will be in this state.

ASP-UP: The remote M2UA peer at the ASP is available (and the SCTP association is up) but application traffic is stopped.

ASP-ACTIVE: The remote M2UA peer at the ASP is available and application traffic is active (for a particular Routing Context or set of Routing Contexts).

ASP-ACT-OLD: The remote M2UA peer at the ASP is available and application traffic is active (for a particular Routing Context or set of Routing Contexts), but for draining of current call/transactions only (i.e., no new calls/transactions)

ASP-ACT-NEW: The remote M2UA peer at the ASP is available and application traffic is active (for a particular Routing Context or set of Routing Contexts), but for new calls/transactions only (i.e., not for traffic related to completing calls/transactions in another ASP).

```
                                  +-------------+
           +----------------------|             |
           |       Some other    /|  ASP-ACTIVE |<--------\
           |       ASP        /   +-------------+         |
           |       Takeover  /        ^     |             | Ts
           |               /   ASP    |     | ASP         |
           |              /    Active |     | Inactive    |
           |             v            |     v             |
           | +-------------+      +-------------+       +-------------+
           | |             |      |             |       |             |
           | | ASP-ACT-OLD |----->|  ASP-UP     |------>| ASP-ACT-NEW |
           | +-------------+ Ts / +-------------+ ASP   +-------------+
           |    |    ASP Inactive  ^    |        Takeover   |
           |<---|                  |    |                   |
           |                       |    |                   |
 ASP Down/ |                  ASP  |    | ASP Down /        | ASP
 SCTP CDI  |                  Up   |    | SCTP CDI          | Down/
           |                       |    v                   | SCTP
           |                   +-------------+              | CDI
           |                   |             |              |
           +------------------>|             |<-------------+
                               |  ASP-DOWN   |
                               +-------------+
```

SCTP CDI: The local SCTP layer's Communication Down Indication to the Upper Layer Protocol (M2UA) on an SG. The local SCTP will send this indication when it detects the loss of connectivity to the ASP's peer SCTP layer.

Ts: Switch-over Time Triggers. This timer is configurable by the Operator on a per AS basis.

3.3.1.2 AS States

The state of the AS is maintained in the M2UA layer on the SG. The state of an AS changes due to events. These events include:

* 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-UP: The Application Server is available but no application traffic is active (i.e., one or more related ASPs are in the ASP-UP state, but none in the ASP-Active state).

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

AS-PENDING: An active ASP has transitioned from active to inactive or down and it was the last remaining active ASP in the AS. 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-UP if at least one ASP is in ASP-UP state, otherwise it will move to AS-DOWN state.

```
      +----------+  one ASP trans ACTIVE   +-------------+
      |          |------------------------>|             |
      |  AS-UP   |                         |  AS-ACTIVE  |
      |          |                         |             |
      |          |<                       -|             |
      +----------+ \                     / +-------------+
         ^   |      \ Tr Trigger        /       ^    |
         |   |       \ at least one    /        |    |
         |   |        \ ASP in UP     /         |    |
         |   |         \             /          |    |
         |   |          \           /           |    |
         |   |           \     /---/            |    |
 one ASP |   |            \   /         one ASP |    | ACTIVE ASP
 trans   |   | all ASP     \-/----\     trans   |    | trans to UP or
 to UP   |   | trans to     /      \    ACTIVE  |    | ACTIVE ASP
```

```
         |   | DOWN        /        \           |    | SCTP CLN
         |   |            /          \          |    |
         |   |           /            \         |    |
         |   |          /all ASP       \        |    |
         |   v         / trans to       \       |    v
      +----------+    /  DOWN            \ +-------------+
      |          |<--/                    -|             |
      | AS-DOWN  |                         | AS-PENDING  |
      |          |                         |  (queueing) |
      |          |<------------------------|             |
      +----------+    Tr Trigger no ASP    +-------------+
                       in UP state

      Tr = Recovery Timer

                 Figure 5: AS State Transition Diagram
```

3.3.2 ASPM procedures for primitives

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

As the ASP is responsible for initiating the setup of an SCTP association to an SG, the M2UA layer at an ASP receives an M-SCTP ESTABLISH request primitive from the Layer Management, the M2UA layer will try to establish an SCTP association with the remote M2UA peer at an SG. Upon reception of an eventual SCTP-Communication Up confirm primitive from the SCTP, the M2UA layer will invoke the primitive M-SCTP ESTABLISH confirm to the Layer Management.

At the SG, the M2UA layer will receive an SCTP Communication Up indication primitive from the SCTP. The M2UA layer will then invoke the primitive M-SCTP ESTABLISH indication to the Layer Management.

Once the SCTP association is established, The M2UA layer at an ASP will then find out the state of its local M2UA-user from the Layer Management using the primitive M-ASP STATUS. Based on the status of the local M2UA-User, the local ASP M2UA 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 3.3.3.

If the M2UA 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 ASP will be moved to "Down" at both the SG and ASP.

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

3.3.3 ASPM procedures for peer-to-peer messages

All ASPM messages are sent on a sequenced stream to ensure ordering. SCTP stream æ0Æ is used.

3.3.3.2 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 M2UA peer is available. The ASP is always the initiator of the ASP-Up exchange.

When an ASP-Up message is received at an SG and internally the ASP is not locked-out for local management reasons, the SG marks the remote ASP as æUpÆ. The SG responds with an Notify (ASP-Up) message to the ASP in acknowledgement. The SG sends a Notify (ASP-Up) message in response to a received ASP-Up message from the ASP even if the ASP is already marked as ôUpö at the SG.

If for any local reason the SG cannot respond with an ASP-Up, the SG responds to a ASP-Up with a ASP-Down message.

At the ASP, the Notify (ASP-Up) message received from the SG is not acknowledged by the ASP. If the ASP does not receive a response from the SG, or an ASP-Down is received, the ASP may resend ASP-Up messages every 2 seconds until it receives a Notify (ASP-Up) message from the SG. The ASP may decide to reduce the frequency (say to every 5 seconds) if a Notify (ASP-Up) is not received after a few tries.

The ASP must wait for the Notify (ASP-Up) message from the SG before sending any ASP traffic control messages (ASPAC or ASPIA) or Data messages or it will risk message loss. If the SG receives Data messages before an ASP Up is received, the SG should discard.

3.3.3.2 ASP-Down

The ASP will send an ASP-Down to an SG when the ASP is to be removed from the list of ASPs in all Application Servers that it is a member.

The SG marks the ASP as ôDownö and returns an Notify (ASP-Down) 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 a Notify (ASP-Down) message in response to a received ASP-Down message from the ASP even if the ASP is already marked as ôDownö at the SG.

If the ASP does not receive a response from the SG, the ASP may send ASP-Down messages every 2 seconds until it receives a ASP-Down message from the SG or the SCTP association goes down. The ASP may decide to reduce the frequency (say to every 5 seconds) if an ASP-Down is not received after a few tries.

3.3.3.3 M2UA Version Control

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

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.

3.3.3.4 ASP-Active

Anytime after the ASP has received a Notify (ASP-Up) acknowledgement from the SG, the ASP sends an ASP-Active (ASPAC) to the SG indicating that the ASP is ready to start processing traffic. In the case where an ASP is configured/registered to process the traffic for more than one Application Server across an SCTP association, the ASPAC contains one or more Interface Identifiers to indicate for which Application Servers the ASPAC applies.

When an ASP Active (ASPAC) message is received, the SG responds to the ASP with a Notify message acknowledging that the ASPAC was received and starts sending traffic for the associated Application Server(s) to that ASP.

There are two modes of Application Server traffic handling in the SG M2UA - Over-ride, Load-balancing and New Traffic. The Type parameter in the ASPAC messge indicates the mode used in a particular Application Server. If the SG determines that the mode indicates in an ASPAC is incompatible with the traffic handling mode currently used in the AS, the SG responds with an Error message indicating ôInvalid Traffic Handling Modeö.

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 which sent the ASPAC. Any previously active ASP in the AS is now considered Inactive and will no longer receive traffic within the AS. The SG responds to the ASPAC with a Notify (ASP-Active) message to the ASP. The SG sends a Notify (ASP-Inactive) to any previously active ASP in the AS.

In the case of a Loadshare mode AS, reception of an ASPAC message at an SG 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 loadsharing traffic within an AS to all the active ASPs is application and network dependent. The SG responds to the ASPAC with a Notify (ASP-Active) message to the ASP.

In the case of a New Traffic mode AS, reception of an ASPAC message at an SG causes the direction of traffic to the ASP sending the ASPAC. However, traffic related to completing calls/transactions in another ASP is not sent to the new ASP (i.e., new calls/transactions only). How an SG accomplishes the differentiation of old and new transactions and any loadsharing of traffic is application and implementation dependent. The SG responds to the ASPAC with a Notify (ASP-Active_New) message to the ASP. After a configurable time Ts, the ASP is moved to the ASP-Active state and a Notify (ASP-Active) is sent to the ASP. Most likely, the New Traffic mode would not be used in M2UA.

3.3.3.5 ASP Inactive

When an ASP wishes to withdraw from receiving traffic the ASP sends an ASP Inactive (ASPIA) to the SG. In the case where an ASP is configured/-registered to process the traffic for more than one Application Server across an SCTP association, the ASPIA contains one or more Routing Contexts to indicate for which Application Servers the ASPIA applies.

There are two modes of Application Server traffic handling in the SG M2UA when withdrawing an ASP from service - Over-ride, Load-balancing and Graceful Withdrawal. The Type parameter in the ASPIA messge indicates the mode used in a particular Application Server. If the SG determines that the mode indicates in an ASPAC is incompatible with the traffic handling mode currently used in the AS, the SG responds with an Error message indicating ôInvalid Traffic Handling Modeö.

In the case of an Over-ride mode AS, where normally another ASP has already taken over the traffic within the AS with an Over-ride ASPAC, the ASP which sent the ASPIA is already considered by the SG to be ôInactiveö. A Notify (ASP_Up) message is resent to the ASP.

In the case of a Loadshare mode AS, the SG moves the ASP to the ôInactiveö state and the AS traffic is re-allocated across the remaining ôactiveö ASPs per the laoadsharing algorithm currently used within the AS. A Notify (ASP-Up) message is sent to the ASP after the traffic is halted to the ASP.

In the case of Graceful Withdrawal, the SG diverts all traffic related to new calls/transactions to other "active" ASPs and therafter sends only traffic related to incomplete transactons to the ASP. A Notify (ASP-Act_Old) is sent to the ASP and the ASP is moved to the "Active_Old" state. When the outstanding calls/transactions are drained, or after a configurable time Ts, the SG moves the ASP to the "Up" state and sends a Notify (ASP-Up) message to the ASP. Most likely, Graceful Withdrawal will not be used with M2UA.

If no other ASPs are ôActiveö in the Application Server, the SG either discards all incoming messages (except messages related to an ôActive_Oldö ASP) 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.

4.0 Examples of MTP2 User Adaptation (M2UA) Procedures

4.1 Establishment of associations between SG and MGC examples

4.1.1 Single ASP in an Application Server (ô1+0ö sparing)

This scenario shows the example M2UA 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.

```
             SG                      ASP1
              |
              |<---------ASP Up----------|
              |------NTFY (ASP-Up)------>|
              |                          |
              |<-------ASP Active--------|
              |----NTFY (ASP_Active)---->|
              |                          |
```

4.1.2 Two ASPs in Application Server (ô1+1ö sparing)

This scenario shows the example M2UA message flows for the establishment of traffic between an SG and two ASPs in the same Application Server, where ASP1 is configured to be ôactiveö and ASP2 a ôstandbyö 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.

```
       SG                        ASP1                         ASP2
        |                          |                            |
        |<--------ASP Up----------|                            |
        |-------TFY (ASP-Up)----->|                            |
        |                          |                            |
        |<----------------------------ASP Up----------------|
        |----------------------------NTFY (ASP-Up)---------->|
        |                          |                            |
        |                          |                            |
```

```
        |<-------ASP Active-------|                           |
        |----NTFY(ASP-Active)---->|                           |
        |                         |                           |
```

4.1.3 Two ASPs in an Application Server (ô1+1ö sparing, load-sharing case)

This scenario shows a similar case to Section 4.1.2 but where the two ASPs are brought to ôactiveö and loadshare the traffic load. In this case, one ASP is sufficient to handle the total traffic load.

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

4.1.4 Three ASPs in an Application Server (ôn+kö sparing, load-sharing case)

This scenario shows the example M2UA 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 ôactiveö and share the load. In this case, a minimum of two ASPs are required to handle the total traffic load (2+1 sparing).

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

| | | |

4.2 ASP Traffic Fail-over Examples

4.2.1 (1+1 Sparing, withdrawal of ASP, Back-up Over-ride)

Following on from the example in Section 4.1.2, and ASP withdraws from service:

```
       SG                        ASP1                        ASP2
        |                          |                           |
        |<-----ASP Inactive-------|                           |
        |---NTFY(ASP Inactive)--->|                           |
        |--------------------NTFY(ASP-Inactive) (Optional)-->|
        |                          |                           |
        |<------------------------------- ASP Active----------|
        |----------------------------NTFY(ASP-Active)------>|
        |                                                      |
```

Note: If the SG detects loss of the M2UA peer (M2UA heartbeat loss or detection of SCTP failure), the initial SG-ASP1 ASP Inactive message exchange would not occur.

4.2.2 (1+1 Sparing, Back-up Over-ride)

Following on from the example in Section 4.1.2, and ASP2 wishes to over-ride ASP1 and take over the traffic:

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

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

Following on from the example in Section 4.1.4, and ASP1 withdraws from service:

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

The Notify message to ASP3 is optional, as well as the ASP-Active from ASP3. The optional Notify can only occur if the SG maintains knowledge of the minimum ASP resources required - for example if the SG knows that ôn+kö = ô2+1ö for a loadshare AS and ônö currently equals ô1ö.

Note: If the SG detects loss of the ASP1 M2UA peer (M2UA heartbeat loss or detection of SCTP failure), the first SG-ASP1 ASP Inactive message exchange would not occur.

4.3 SG to MGC, MTP Level 2 to MTP Level 3 Boundary Procedures

4.3.1 SS7 Link Alignment

The MGC can request that a SS7 link be brought into alignment using the normal or emergency procedure. An example of the message flow to bring a SS7 link in-service using the normal alignment procedure is shown below.

```
          SG                                    ASP
           |                                     |
           |<---------Establish Req--------------|
           |                                     |
           |----------Establish Cfm------------->|
           |                                     |
```

An example of the message flow to bring a SS7 link in-service using the emergency alignment procedure.

```
          SG                                    ASP
           |                                     |
           |<----State Req (STATUS_EMER_SET)-----|
           |                                     |
           |-----State Cfm (STATUS_EMER_SET)---->|
           |                                     |
           |<---------Establish Req--------------|
           |                                     |
           |----------Establish Cfm------------->|
           |                                     |
```

4.3.2 SS7 Link Release

The MGC can request that a SS7 link be taken out-of-service. It uses the Release Request message as shown below.

```
          SG                                     ASP
           |                                      |
           |<-----Release Req (RELEASE_MGMT)-----|
           |                                      |
           |------------Release Cfm------------->|
           |                                      |
```

The SG can autonomously indicate that a SS7 link has gone out-of-service as shown below.

```
          SG                                     ASP
           |                                      |
           |------Release Ind (RELEASE_PHYS)---->|
           |                                      |
```

4.3.3 Set and Clear Local Processor Outage

The MGC can set a Local Processor Outage condition. It uses the State Request message as shown below.

```
          SG                                     ASP
           |                                      |
           |<-----State Req (STATUS_LPO_SET)-----|
           |                                      |
           |------State Cfm (STATUS_LPO_SET)---->|
           |                                      |
```

The MGC can clear a Local Processor Outage condition. It uses the State Request message as shown below.

```
          SG                                     ASP
           |                                      |
           |<----State Req (STATUS_LPO_CLEAR)----|
           |                                      |
           |-----State Cfm (STATUS_LPO_CLEAR)--->|
           |                                      |
```

4.3.4 Notification of Processor Outage (local or remote)

The SG can indicate a Local or Remote Processor Outage condition. It uses the State Indication message as shown below.

```
          SG                                     ASP
           |                                      |
```

```
           |-----State Ind (EVENT_ENTER_LPO)---->|
           |                                     |
           |-----State Ind (EVENT_EXIT_LPO)----->|
           |                                     |

          SG                                    ASP
           |                                     |
           |-----State Ind (EVENT_ENTER_RPO)---->|
           |                                     |
           |-----State Ind (EVENT_EXIT_RPO)----->|
           |                                     |
```

4.3.5 SS7 Link Changeover

An example of the message flow for a changeover is shown below. In this example, there were three messages in the retransmission queue that needed to be retrieved.

```
           SG                                    ASP
           |                                      |
           |----Retrieval Req (MTP2_RTRV_BSN)--->|
           |                                      |
           |------Retrieval Cfm (with BSN)------>|
           |                                      |
           |---Retrieval Req (MTP2_RTRV_MSGS)--->|
           |                      with FSN        |
           |                                      |
           |-----------Retrieval Cfm------------>|
           |                                      |
           |-----------Retrieval Ind------------>|
           |-----------Retrieval Ind------------>|
           |-------Retrieval Complete Ind------->|
           |                                      |
```

Note: The number of Retrieval Indication is dependent on the number of messages in the retransmit queue that have been requested. Only one Retrieval Complete Indication should be sent.

5.0 Security

5.1 Introduction

M2UA is designed to carry signaling messages for telephony services. As such, M2UA 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.

5.2 Threats

There is no quick fix, one-size-fits-all solution for security. As a transport protocol, M2UA has the following security objectives:

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

M2UA runs on top of SCTP. SCTP [6] provides certain transport related security features, such as:

* Blind Denial of Service Attacks
* Flooding
* Masquerade
* Improper Monopolization of Services

When M2UA 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" [9] should be consulted for guidance.

When the network in which M2UA 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 [10] for more information on configuring IPSEC services.

5.3 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.

6.0 IANA Considerations

A request will be made to IANA to assign an M2UA value for the Payload Protocol Identifier in SCTP Payload Data chunk. The following SCTP Payload Protocol Identifier will be registered:

```
        M2UA    tbd
```

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.

7.0 Acknowledgements

The authors would like to thank Ian Rytina, Hanns Juergen Schwarzbauer and ZhangYi for their valuable comments and suggestions.

8.0 References

[1] ITU-T Recommendation Q.700, 'Introduction To ITU-T Signalling System No. 7 (SS7)'

[2] ITU-T Recommendation Q.701-Q.705, 'Signalling System No. 7 (SS7) - Message Transfer Part (MTP)'

[3] ANSI T1.111 'Signalling System Number 7 - Message Transfer Part'

[4] Bellcore GR-246-CORE 'Bell Communications Research Specification of Signaling System Number 7', Volume 1, December 1995

[5] Framework Architecture for Signaling Transport, draft-ietf-sigtran-framework-arch-03.txt, June 1999

[6] Simple Control Transmission Protocol, draft-ietf-sigtran-sctp-07.txt, March 2000

[7] Media Gateway Control Protocol (MGCP), draft-huitema-megaco-mgcp-v1-03.txt, August 1999

[8] ITU-T Recommendation Q.2210, 'Message transfer part level 3 functions and messages using the services of ITU-T Recommendation Q.2140'

[9] RFC 2196, "Site Security Handbook", B. Fraser Ed., September 1997

[10] RFC 2401, "Security Architecture for the Internet Protocol", S. Kent, R. Atkinson, November 1998.

9.0 Author's Addresses

Ken Morneault Tel: +1-703-484-3323
Cisco Systems Inc. EMail: kmorneau@cisco.com
13615 Dulles Technology Drive
Herndon, VA. 20171
USA

Malleswar Kalla Tel: +1-973-829-5212
Telcordia Technologies EMail: kalla@research.telcordia.com
MCC 1J211R
445 South Street
Morristown, NJ 07960
USA

Greg Sidebottom Tel: +1-613-763-7305
Nortel Networks EMail: gregside@nortelnetworks.com
3685 Richmond Rd,
Nepean, Ontario
Canada K2H5B7

Ram Dantu, Ph.D. Tel +1-972-234-6070 extension 211
IPmobile EMail rdantu@ipmobile.com
1651 North Glenville, Suite 216
Richardson, TX 75081
USA

Tom George Tel: +1-972-519-3168
Alcatel USA EMail: tom.george@usa.alcatel.com
1000 Coit Road
Plano, TX 74075
USA

This Internet Draft expires September 2000.