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Data Models
for use with SS7 User Adaptation Layers
<draft-bidulock-sigtran-datamodel-00.ps>

Status of this Memo

Abstract

This Internet-Draft is for information purposes only and provides information to the Internet Community regarding data models used in the OpenSS7 impelementation of the SS7 User Adaptation Protocols M2UA[M2UA], M3UA[M3UA], SUA[SUA], TUA[TUA], and IUA[IUA].

1. Introduction

Figure 2 illustrates an overview of the data model for the Application Server. Each SS7 user can send and receive message via multiple gateways[1]. Each gateway is composed of multiple Signalling Gateway Processes, but each Signalling Gateway Process can only belong to one Signalling Gateway. Each Signalling Gateway Process (SGP) is associated with one and only one Transport Provider connection.

Figure 3 illustrates the situation at the Signalling Gateway. Each SS7 Provider is associated with one or more[2] Application Servers. An Application Server has a unique Routing Key associated with it. There is one Routing Context assignment per Application Server Process. Each Application Server can be represented through multiple Application Server Processes, each of which correspond directly to a Transport Provider connection.

2. Local Management

Before an SS7 User can use the services of an SS7 Provider, the User must be sasociated with the Provider. This is accomplished by attaching or binding the SS7 User to an SS7 Provider. The attach or bind is performed at the discretion of the SS7 User.

2.1. Local Management of the SS7 User Interface

2.1.1. Openining an SS7 User Interface

When an SS7 User Interface is created, it is treated similar to an Application Server Process (ASP) Proxy. Two datastructures are created:

SS7 User Interface Structure

ASP Proxy Structure

```
    |       |       |        |       |       |
 ___|___ ___|___ ___|___  ___|___ ___|___ ___|___
|       |       |       ||       |       |       |
| SS7-U | Xport | Xport || Xport | Xport | SS7-U |
|_______|_______|_______||_______|_______|_______|
 ___|___ ___|___ ___|___  ___|___ ___|___ ___|___
|       |       |       ||       |       |       |
|  ASP  |  ASP  |  ASP  ||  ASP  |  ASP  |  ASP  |
|_______|_______|_______||_______|_______|_______|
    |_____  |  _____|        |_____  |  _____|      ___   ___
         _|_|_|_                  _|_|_|_          |   | | X |
        |       |                |       |_________|   | | p |
   + - -|  AS   |                |  AS   |        _|SPP|-| o |--
   |    |_______|                |_______|\      / |   | | r |
           | |                        | |  \    /  |___| |_t_|
   |       | |__________  __________| |     \  /
Complex    |            \/            |      \/
Relationship  __________/\__________  |      /\
   |       | |                      | |     /  \    ___   ___
         __|_|__                  __|_|__  /    \  |   | | X |
   |    |       |                |       |/      \_|   | | p |
        |  SG   |                |  SG   |_________|SPP|-| o |--
   |    |_______|                |_______|         |   | | r |
     _____| | |_____          _____| | |_____      |___| |_t_|
 __||___ ___|___ ___|___  ___|___ ___|___ ___|___
|       |       |       ||       |       |       |
|  SGP  |  SGP  |  SGP  ||  SGP  |  SGP  |  SGP  |
|_______|_______|_______||_______|_______|_______|
 ___|___ ___|___ ___|___  ___|___ ___|___ ___|___
|       |       |       ||       |       |       |
| SS7-P | Xport | Xport || Xport | Xport | SS7-P |
|_______|_______|_______||_______|_______|_______|
    |       |       |        |       |       |
    |       |       |        |       |       |
```

Figure 1. General Overview

```
    |                               |
 ___|___                         ___|___
|       |                       |       |
| SS7U  |                       | SS7U  |
|_______|                       |_______|
    |                               |
 ___|___                         ___|___
|       |                       |       |
|  AS   |                       |  AS   |
|_______|                       |_______|
   ||| ____________________________|||
   ||||____________________________ ||
   ||_|____________   _____________|||
   |  |            | |             | |
 __|__|_         __|_|__         __|_|__
|       |       |       |       |       |
|  SG   |       |  SG   |       |  SG   |
|_______|       |_______|       |_______|
    ||              ||              |
    ||______        ||______        |
    |       |       |       |       |
 ___|___ ___|___ ___|___ ___|___ ___|___
|       |       |       |       |       |
|  SGP  | SS7P  |  SGP  | SS7P  |  SGP  |
|_______|_______|_______|_______|_______|
 ___|___    |    ___|___    |    ___|___
|       |   |   |       |   |   |       |
| Xport |   |   | Xport |   |   | Xport |
|_______|   |   |_______|   |   |_______|
    |       |       |       |       |
    |       |       |       |       |
```

Figure 2. Application Server Process Data Model Overview

```
    |      ___|___     ___|___      |
    |     |       |   |       |     |
    |     | Xport |   | Xport |     |
    |     |_______|   |_______|     |
 ___|___   ___|___     ___|___   ___|___
|       | |       |   |       | |       |
| SS7P  | |  SGP  |   |  SGP  | | SS7P  |
|_______| |_______|   |_______| |_______|
    |  _______|           |_______  |
 ___|_|_                         _|_|___
|       |                       |       |
|  SG   |                       |  SG   |
|_______| Multiple      Single  |_______|
   | |    Binds           Bind      |
   | |______________                |
 __|____         ___|___         ___|___
|       |       |       |       |       |
|  AS   |       |  AS   |       |  AS   |
|_______|       |_______|       |_______|
   |||             |||             |||
   || \            |||           / ||
   | \ \           |||         / / |
   |  \ \         / | \         / /  |
   | __\_\_______/  |  \_______/_/__ |
   || __\_\_________|_________/ /   ||
   |||   \ \________|__________/___ ||
   |||    \________ | ________/    |||
   |||             |||             |||
 __|||__         __|||__         __|||__
|       |       |       |       |       |
|  ASP  |       |  ASP  |       |  ASP  |
|_______|       |_______|       |_______|
 ___|___         ___|___         ___|___
|       |       |       |       |       |
| Xport |       | Xport |       | Xport |
|_______|       |_______|       |_______|
    |               |               |
    |               |               |
```

Figure 3. Signalling Gateway Process Data Model Overview

2.1.2. Binding an SS7 User Interface

SS7 Users attach or bind using a Routing (Link) Key.

For example, an M2UA[M2UA] SS7 Signalling Link User attaches using a Signalling Data Terminal Identifier and a Signalling Data Link Identifier. These two identifiers can be combined into a single 32-bit identifier which uniquely describes the signalling link.

When the SS7 Signalling Link User attaches, it provides a Signalling Link Interface Identifier (SDTI/SDLI) as an argument of the attach.

As another example, an M3UA[M3UA] SS7 User binds its interface using a Bind request that includes the local address (NI/PC/UP) to which the SS7 User is binding. This is equivalent to an M3UA[M3UA] Routing Key.

SUA and TUA are similar.

The sequence of events that follow the attach request are as follows:

(1) The SS7 User issues the Attach or Bind request and provides the parameters necessary to build a Routing (Link) Key.

(2) The RK is compared against the RKs of statically and dynamically provisioned Application Servers (AS).

(3) If a statically or dynamically provisioned AS exists that has a matching key, the SS7 User Interface is associated with that Application Server.

(4) If no Application Server exists with the necessary key, and the implementation permits dynamic registration, then an Application Server (AS) is dynamically allocated, and an attempt is make to register the associated Routing (Link) key with all the configured Signalling Gateways that wild-card match against that key.

Note that it is not necessary to wait for a successful registration before returning success on the attach or bind.

M2UA For M2UA, the attach succeeds and registration is only necessary before an enable is confirmed.

M3UA For M3UA, the bind succeeds. Only once registration and activation is complete and a successful audit has occured will the MTP User be permitted to send messages.

SUA For SUA, the bind succeeds. Only once registration and activation is complete and successful will the SCCP User be permitted to send messages.

TUA For TUA, the bind succeeds. Only once registration and activation is complete and successful will the TCAP User be permitted to begin transctions.

The result of the attach or bind operation is that the SS7 User Interface is associated with an Application Server and that Application Server is associated with one or more Signalling Gateways.

For this operation to be peformed, the Application Server Process (ASP) needs to have a number of things provisioned:

(1) Signalling Gateways must be configured and the transport connections to SGP that make up the SG established.

(2) Each SG that supports dynamic registration must have a wildcard mask or list of supported RKs associated with it when it is configured at the ASP, or, a control stream must be listening for queries based on RK to determine the SG to which the SS7 User Interface should be associated.[3]

(3) Each SG that is statically configured must have a list of RKs and RCs associated wtih it (i.e, the Application Server datastructures as pre-configured against the SG), or, a control stream can be listening for registration requests in the same fashion as for dynamic registration above.

Placing registration under the control of the Layer Manager (control stream), the attach/bind process would look like this:

(1) The local SS7 User Interface issues an attach/bind request.

(2) The kernel searches the list of existing Application Server structures and determines if a match exists for the routing key. If a match exists, the SS7 User Interface is associated with the Application Server.

    If the AS is for M2UA, that is all that is done. Activation does not occur until the link is enabled. If the AS is for another UA, activation is initiated.

(3) If an existing Application Server match is not found, the kernel creates a new Application Server structure and then formulates a registration request to layer management on the control stream.

    The layer management process takes the registration request and examines it.

    (1) Test

    (2) Test

(4)

2.2. Local Management of Transport Endpoints

2.2.1. Forming or Accepting a Transport Connection

Figure 4 illustrates the situation when a transport connection is either formed or accepted by layer management.

2.2.1.1. Forming Transport Connections

When layer management forms a transport connection, it performs the following actions:

(1) The Layer Manager forms the transport connection to the distant endpoint.

(2) The LM passes the transport connection to the kernel. For OpenSS7, this is performed by `I_LINK`ing or `I_PLINK`ing the transport STREAM under the UA multiplexing driver. The multiplexing driver does not know at this time whether the transport connection is an ASP or and SGP mode connection.

(3) The Layer Manager is aware of the aspect of the transport connection from internal configuration. That is, the LM knows if the transport connection is a connection to an SGP.[4]

(4) The LM indicates to the kernel, the mode of the transport connection along with an ASP Identifier. This is performed using the `LM_LINK_ADD_REQ` primitive.

(5) The `LM_LINK_ADD_REQ` primitve cause the multiplexing driver to set the mode of the linked transport connection. An SGP proxy structure is located. If no SGP proxy structure can be located, the request fails. The LM must ensure that an SGP proxy structure exists and is associated with an SG structure before issuing the `LM_LINK_ADD_REQ` primitive.

```
    |
 ___|___
|       |
| Xport |
|_______|
 ___|___
|       |
|  ASP  |
|_______|          ___   ___
__  |  __         |   | | X |
 _|_|_|_          |   | | p |
|       |_________|SPP|_| o |__
|  AS   |         |   | | r |
|_______|\       /|   | | t |
__| | |__ \     / |___| |___|
    |      \   /
    |       \ /
    |        X
__  |  __   / \    ___   ___
 _|_|_|_   /   \  |   | | X |
|       |/       \|   | | p |
|  SG   |_________|SPP|_| o |__
|_______|         |   | | r |
__| | |__         |   | | t |
 ___|___          |___| |___|
|       |
|  SGP  |
|_______|
 ___|___
|       |
| Xport |
|_______|
    |
    |
```

Figure 4. Forming or Accepting a Transport Connection

The driver then initiates the following sequence of events:

(1) The driver sends an `ASPUP REQ` message on the transport connection. If the ASP Identifier in the associated SG structure was set to is non-zero, the ASP Identifier from the SG structure is used as the ASP Identifier in the `ASPUP REQ` message. The driver must receive a successful `ASPUP ACK` message for the connection and move to the `ASP-INACTIVE state before other actions are performed.`

(2) When the above procedure has completed successfully, the driver commences registration of all AS that are defined in the driver and associated with the associated SG structure if the SG structure is marked for dynamic registration. For each AS configured against the SG, a `REG REQ` message is send and a successful `REG RSP` message expected.

(3) When the above procedure has completed successfully for a given AS, the driver commences activation of the AS. There are several circumstances, however, in which activation is not performed automatically:

- The AS is an over-ride AS and there is already an SGP that is ACTIVE for this AS. In this case, the driver determines whether the newly available SGP is of a lower cost than the existing ACTIVE ASP. If this is the case, the driver may activate the newly available SGP. Before performing such a switch-over; however, the HEARTBEAT procedure should be used to clear messages to the old SGP before starting traffic on the new SGP.

- The AS already has an SGP that is ACTIVE for this AS in the same load selection group.

(4) When activation completes successfully, the SGP is marked ACTIVE for the AS which has activated and the SGP takes part in the traffic mode selection for the AS.

There are a number of messages that the driver may receive on the transport connection before it has completed any of the above procedures. These are:

`UA_MGMT_ERR`

```
UA_MGMT_NTFY
UA_ASPS_ASPUP_ACK
UA_ASPS_ASPDN_ACK
UA_ASPS_HBEAT_REQ
UA_ASPS_HBEAT_ACK
UA_ASPT_ASPIA_ACK
UA_ASPT_ASPAC_ACK
```

2.2.1.2. Accepting Transport Connection

When the layer manager accepts a transport connection, it performs the following actions:

(1) The Layer Manager accepts the transport connection from the distant endpoint.

(2) The Layer Manager might or might not be aware of the aspect of the transport connection from internal configuration. If the LM is aware of the aspect, it is solely from transport endpoint information (e.g, remote IP address and port number, local IP address and port number).

ASP The LM accepts transport connections from ASP on demand.

SGP The LM does not normally accept transport connections from SGP. The LM normally forms transport connections to an SGP.

SPP The LM accepts transport connection from SPP (peers) when the remote SPP starts up or recovers.

(3)

(4)

(5)

2.2.1.3. Accepting an ASP Transport Connection

Figure 4 illustrates the configuration when accepting an ASP transport connection. At the time that the transport connection is formed, it may not be know what aspect (ASP, SGP or SPP[5]) the transport connection represents. Because the datastructures are similar (almost identical) for ASP and SGP; however, it is possible to allocate an SPP datastructure when the transport connection is accepted/connected by local management. For OpenSS7 this is when the transport *STREAM* is `I_LINK`ed or `I_PLINK`ed under the UA multiplexing driver.

2.2.1.4. Accepting an SGP Transport Connection

2.2.1.5. Accepting an IPC Transport Connection

3. Transfer of Data Messages

When Data Transfer Messages are exchanged between Signalling Gateway Processes and Application Server Processes, any loadsharing which is involved is always performed on the basis of the Signalling Link Selection field in the message. This is because no other rational basis for loadsharing can be used which does not disrupt the sequenced characteristics of an SLS flow.

Signalling Link Selection loadsharing for one User to Provider or Provider to User flow does not have to be done is such a fashion that the entity selected on the basis of SLS is the same entity which would be selected for another User or Provider. This is because the messages within an SLS flow only need be sequence between User and Provider and not between Users nor between Providers.

If traffic routing is changed due to outage situations (e.g. loss of a Transport Connection, the prohibiting of a route), then the sender, whether User or Provider, must either flush messages from the old flow using the BEAT and BEAT Ack UA messages or withold traffic for a time period, before restarting traffic on the new route. This is to ensure that misequencing does not occur at the distant end. That is, it ensures that the head of traffic on the new route does not overtake the tail of the traffic on the old route at the receiver.

It is always the User or Provider function which is performing selection based on Signalling Link Selection value which must perform this flushing or withholding of traffic.

3.1. Outgoing Data Messages

Outgoing Data Messages must be dealt with both at the Application Server and at the Signalling Gateway. The data models described here are based on the presumption that the Routing Context has been included in the message. This is true for many of the messages in SUA[SUA] but not all of the messages. If current proposals are followed[6], it will be true for M3UA[M3UA]. M2UA[M2UA] already includes the Interface Identifier (M2UA's equivalent to a Routing Context) in each message.

3.1.1. Outgoing Data Messages at the Application Server

As illustrated in *Figure 5*, the Application Server performs the following functions on outgoing Data Transfer messages:

(1) The SS7 User supplies a Data Transfer message for delivery within the SS7 newtork.

(2) The SS7 User Interface selects an Application Server to process the outgoing message. For each SS7 interface there is one and only one Application Server. When the SS7 User Interface is bound or attached and enabled, an Application Server is associated with the user interface. Each SS7 User Interface has an associated Interface Id (IID) or Routing Context (RC) which was assigned to it at the time that it was attached or bound.

(3) The UA checks the availability of outgoing routes via Signalling Gateways which it has at its disposal and which it is registered with. This is the same set of Signalling Gateways with which the User was bound when the interface (RC) was activated. The selection of Signalling Gateway is on the basis of loadsharing and routeset status. If no Signalling Gateway has an available route, the User is returned an immediate error message. Loadsharing is perfomed on the basis of the SLS value in the message (as SLS is the only rational basis for loadsharing). SG route availability is considered as the aggregation of Signalling Gateway Process route availability.

In selecting a Signalling Gateway, the User associates the Routing Context it uses via that Signalling Gateway[7] with the message. This has no use within the Application Server, but is used at the Signalling Gateway to screen and authorize outgoing messaging.

(4) After selecting a Signalling Gateway, the AS selects amongst the Signalling Gateway Processes associated with that Signalling Gateway. This selection is based on loadsharing on SLS value, but may also be based on the availability of routes via the different SGP.

```
                            ________      _______    _______
                           |        |    |       |  |       |
                        +->|   SG   |-+  |  SGP  |->| Xport |->
                        |  |________| |  |_______|  |_______|
   _______    ________  |   ________  |   _______    _______
  |       |  |        | |  |        | |  |       |  |       |
->|  ASP  |->|   AS   |-+  |   SG   | |  |  SGP  |->| Xport |->
  |_______|  |________|    |________| |  |_______|  |_______|
           |            |   ________  |   _______    _______
                           |        | |  |       |  |       |
(1)  Msg.  |            |  |   SG   | |  |  SGP  |->| Xport |->
                           |________| |  |_______|  |_______|
(2)  AS is selected     |             |   _______    _______
     depending on                     |  |       |  |       |
     AS activity.       |             +->|  SGP  |->| Xport |->
                                         |_______|  |_______|
(3)  SG is selected - - +             |           |
     based on load-sharing (SLS)
     and routset status.              |           |

(4)  SGP selected based on load - - - +           |
     sharing (SLS), SGP activity,
     and routeset status.                         |

(5)  QOS (stream) is  - - - - - - - - - - - - - - +
     selected based on
     RC/IID and SLS
     value.
```

Figure 5. Outgoing Data Transfer, Application Server

(5) Once an SGP has been selected, there is a specific Transport Provider which is associated with each SGP. If the Transport Provider is an SCTP provider, the stream used is selected on the basis of adding 1 to the SLS value in the message.

For OpenSS7 Application Servers, this model does not reduce (except that the SGP and Transport collapse into a single STREAM head), due to the need to support multiple Signalling Gateways per User and multiple Signalling Gateway Processes per SG.

3.1.2. Outgoing Data Messages at the Signalling Gateway

As illustrated in *Figure 6*, the Signalling Gateway performs the following functions on outgoing Data Transfer messages:

(1) The provider applies the Routing Key to the traffic which results in a Routing Context value. For providers which bind specific Routing Keys at the SS7-Provider level, there will be no need to apply the Routing Key, as the SS7-Provider will perform that function. The Routing Context will be associated with the binding and will be associated with the message before starting.

(2) The Routing Context associated with the message is used to select the Application Server to which the message applies. Each Routing Key binding has exactly on Application Server. For SS7 providers which bind, the Application Server can be associated with the binding and there is no need to index Application Server by Routing Context: the Routing Context is merely an attribute of the Application Server, which is bound to the provider with the Routing Key.

(3) The Application Server has a number of Application Server Processes associated with it. The Application Server selects the appropriate Application Server Process by performing a selection algorithm according to the Application Server's Traffic Mode Type and the state of each of the Application Server Processes **within** the Application Server.

(4) The Application Server Process has one Transport Provider connection associated with it. The Application Server Process structure can be one and the same with the Transport Provider structure. When the Transport Provider is an SCTP association, the stream selected can be based on the SLS value in the message.

For the OpenSS7 Signalling Gateway, the above model reduces to that shown in *Figure 7*. Where each SS7-Provider STREAM is bound to the Routing Key and the Routing Context is an attribute (identifier) of the Application Server. Messages coming off the SS7-Provider STREAM are immediately associated with an Application Server structure. The SG peforms the Application Server's distribution algorithm by keeping the states of ASPs in graph nodes between the AS structures and the ASP structures. The only rational basis for the Load-sharing algorithm is SLS value, so if Load-sharing is required, the SLS value in the message is used to select an active ASP. If Override algorithm is being used, the message is routed to the current master ASP, and if Broadcast algorithm is being used, the message is sent to each of the Active ASPs.

For the OpenSS7 SG, the ASP structure is associated with the Transport Service Provider STREAM, and the STREAM to use is immediately discernable. The message is put on the queue associated with the ASP. The stream selected (if the

```
                     ________       ________     ________
                    |        |     |        |   |        |
                 /->|   AS   |__   |  ASP   |___|Transport_____
                 |  |        |  |  |        |   |        |
      RK --> RC  |  |________|  |  |________|   |________|
      ________   |   ________   |   ________     ________
     |        |  |  |        |  |  |        |   |        |
_____|Provider|__|  |   AS   |  |  |  ASP   |___|Transport_____
     |        |     |        |  |  |        |   |        |
     |________|     |________|  |  |________|   |________|
                     ________   |   ________     ________
                    |        |  |  |        |   |        |
                    |   AS   |  \->|  ASP   |___|Transport_____
                    |        |     |        |   |        |
                    |________|     |________|   |________|

                  AS Selelected  ASP Selected Select Stream
                      by RC          by            by
                                 Traffic Mode   SLS Value
                                     and
                                  ASP State
```

Figure 6. Outgoing Data Transfer, Signalling Gateway

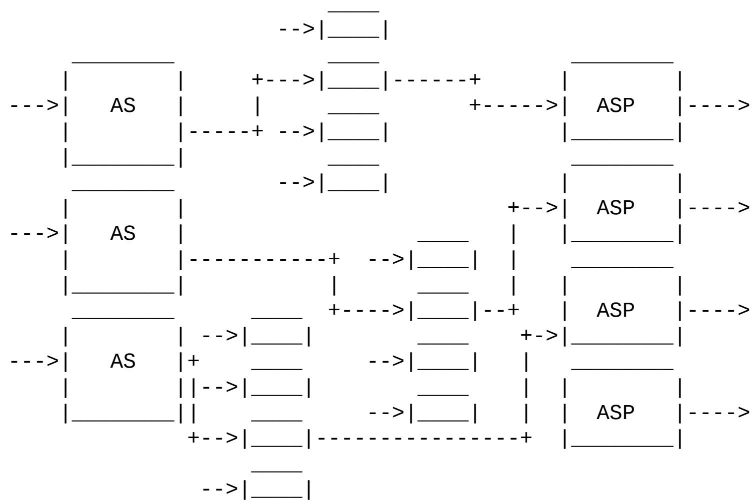

Figure 7. Outgoing Data Transfer, SG (simplified)

transport provider is an SCTP provider) is the SLS contained in the message + 1. (Stream ‘0’ is reserved for ASP manaagement messages.)

3.2. Incoming Data Messages

Incoming Data Messages must be dealt with both at the Application Server and at the Signalling Gateway. The data models described here are based on the presumption that the Routing Context has been included in the message. This is true for many of the messages in SUA[SUA] but not all of the messages. If current proposals are follows, it will be true for M3UA[M3UA]. M2UA[M2UA] already includes the Interface Identifier (M2UA’s equivalent to a Routing Context) in each message.

3.2.1. Incoming Data Messages at the Application Server

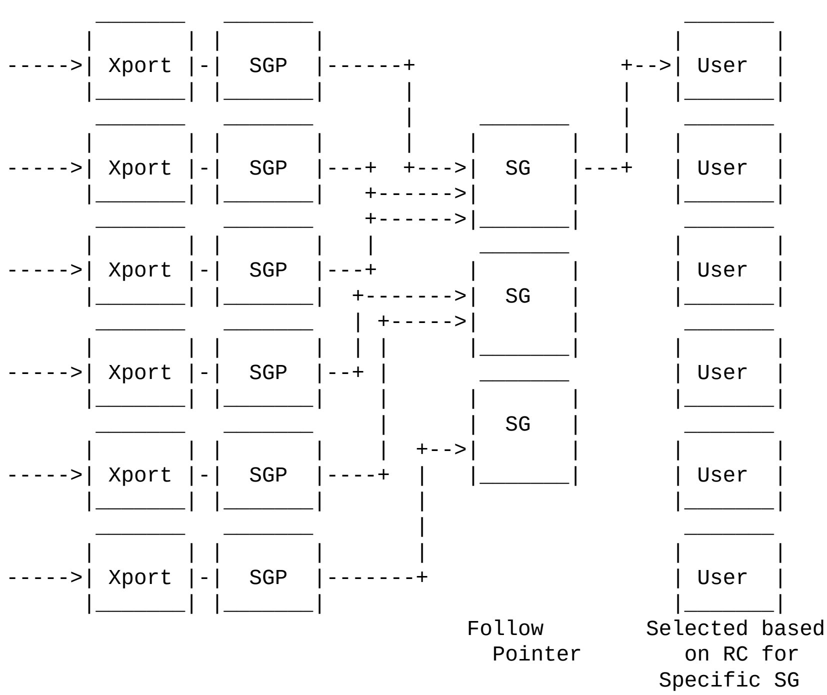

Figure 8. Incoming Data Transfer, Application Server

As illustrated in *Figure 8*, the Application Server performs the following functions on incoming Data Transfer messages:

(1) The Transport Provider connection upon which the Data Transfer message is received determines both the Signalling Gateway Process (SGP) and Signalling Gateway (SG) which are to be used for the message.

(2) Once the Signalling Gateway (SG) which the message has arrived from has been determined by the Application Server, the AS choses the SS7 User to send the message to based on the Routing Context which appears in the message. Note, however, that the Routing Context must be considered in the context of the Signalling Gateway upon which it was received.

For OpenSS7 Application Servers, this model does not collapse except at the Transport Provider and SGP.

3.2.2. Incoming Data Messages at the Signalling Gateway

As illustrated in *Figure 9*, the Signalling Gateway performs the following functions on incoming Data Transfer messages:

(1) The Transport Provider connection upon which the Data Transfer message is received determines the Application Server Process (ASP) associated with the message.

(2) The Signalling Gateway then uses the Routing Context associated with the message to select an Application Server with that Routing Context.

(3) The Application Server maps directly to an SS7 provider.

For OpenSS7, this simplifies greatly at the Signalling Gateway because the Transport Provider connection and the Application Server Process (ASP) can be collapse in to the same STREAM queue-pair. Also the Application Server and the SS7 Provider can also be collapsed into the same STREAM queue-pair. A directed graph is used between the two.

As illustrated in *Figure 10*, for OpenSS7, the ASP structure is associated with the Transport Service Provider STREAM, and a graph is used to look up the Routing Context associated with the message to select the appropriate Application Server.

For OpenSS7, the Application Server is bound directly to the SS7 Provider STREAM and the message is transfer to the SS7-Provider.

4. Transfer of Signalling Network Management Messages

Signalling Network Management Messages (SNMM)[8] must be performed in both directions: from Signalling Gatewa to Application Server, and visa versa. The majority of SNMM messages, however, are sent from Signalling Gateway to Application Server.

```
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |------+       +-->| AS  |-|Provider|
      |_______| |_______|      |       |   |_____| |________|
       _______   _______       |       |    _____   ________
      |       | |       |      |       |   |     | |        |
----->| Xport |-|  ASP  |-->   +--->---+   | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
                                            Selected based
                                                 on RC
```

Figure 9. Incoming Data Transfer, Signalling Gateway

```
                         ____
                     -->|____|
     ________            ____               ________
    |        |     +--->|____|------+      |        |
--->|  ASP   |     |     ____       +----->|   AS   |---->
    |        |-----+ -->|____|             |________|
    |________|           ____               ________
     ________        -->|____|             |        |
    |        |                         +-->|   AS   |---->
--->|  ASP   |                  ____   |   |________|
    |        |-----------+  -->|____|  |    ________
    |________|           |      ____   |   |        |
     ________      ____  +---->|____|--+   |   AS   |---->
    |        | -->|____|        ____    +->|________|
--->|  ASP   |+    ____     -->|____|   |    ________
    |        ||-->|____|        ____    |  |        |
    |________||    ____     -->|____|   |  |   AS   |---->
              +-->|____|----------------+  |________|
                   ____
               -->|____|
```

Figure 10. Incoming Data Transfer, SG (Simplified)

In SUA[SUA] and M3UA[M3UA] these messages apply to one or more Routing Contexts. In M2UA[M2UA], link control messages apply to a single Interface Identifier[9].

4.1. Outgoing SNMM at the Signalling Gateway

Outgoing Signalling Network Management Messages (SNMM) may apply to more than one Routing Context. Because of this, a list of Routing Contexts is included in the message[10]. Under the current OpenSS7 mode, however, multiple Routing Contexts will never be included in the message. Instead, mutliple SNMM messages, one for each Routing Context will be sent. The nature of the STREAMS model is such that a Transport Provider will have the ablity to bundle these messages together into a single transmission.

Figure 11 illustrates the steps that the Signalling Gateway goes through to generate an SNM message and transfer it to the Application Server. The process is almost identical to the process used for outgoing data transfer; however, it differs in the selection of ASP. The Signalling Gateway performs the following functional steps on the message:

(1) The provider determines the Signalling Point Management Cluster to which the SNMM message corresponds. The provider then looks up the list of Application Servers which belong to the Signalling Point Management Cluster. It compiles a list of Routing Contexts which it uses for sending the SNM message.

For providers which are bound to a Routing Key, the provider will determine the list of Application Servers

```
                     ________       ________     ________
                    |        |     |        |   |        |
                 /->|   AS   |__   |  ASP   |___|Transport_____
                 |  |        |  |  |        |   |        |
      RK --> RC  |  |________|  |  |________|   |________|
      ________   |   ________   |   ________     ________
     |        |  |  |        |  |  |        |   |        |
_____|Provider|__|  |   AS   |  +->|  ASP   |___|Transport_____
     |        |     |        |  |  |        |   |        |
     |________|     |________|  |  |________|   |________|
                     ________   |   ________     ________
                    |        |  |  |        |   |        |
                    |   AS   |  +->|  ASP   |___|Transport_____
                    |        |     |        |   |        |
                    |________|     |________|   |________|
                  AS Selelected   ASP Selected Select Stream
                      by RC           by         based on
                                   ASP State    SNMM type
```

Figure 11. Outgoing SNM Messages, Signalling Gateway

automatically and provide an SNMM indication to each of the Application Servers.

(2) The Routing Context(s) associated now with the message is used to select the Application Server(s) to which the message applies. Each Routing Context has exactly one Application Server. For SS7 providers which bind, the Application Server is associated with the binding and there is no need to index the Application Server by Routing Context. Each Application Server will receive the appropriate SNMM indication with its Routing Context as a key.

(3) The Application Server(s) have a number of Application Server Processes associated with them. Each Application Server selects the appropriate Application Server Processes by considering the selection algorithm according to the Application Server's Trafic Mode Type and the state of each of the Application Server Processes **within** each Application Server.

It is important to note that SNM messages should be sent to all Active Application Server Processes, regardless of whether the ASP is in standby or not. This is because of restart procedures. ASPs are given all pertinent SNM messages when they move to the Active state, but after that point, they must keep their management configuration up to date by receiving managemnt messages. For M2UA[M2UA], only one Application Server Process is active at one time.

(4) The Application Server Process has only one Transport Provider connection associated with it. The Application Server Process structure can be one and the same with the Transport Provider structure. When the Transport Provider is an SCTP association, the stream selected and whether the Unordered bit is set on the message is determined. Transport Providers supporting expedited data transfer to the medium may be invoked with expedited data for some SNM messages.

Figure 12 illustrates the steps that the Application Server goes through to generate an SNM message and transfer it to the Signalling Gateway. At the Application Server, the processing of outgoing SNM messages is almost identical to that for Data Transfer messages, with the exception being SGP selection. The Application Server performs the following functional steps on the message:

(1) The Application Server receiving a SNM from a User checks the activity of all registered SGs and selectes each of the SGs which are actively transferring traffic to the User[11]. The AS associates the Routing Context of each SG and associates it with the message.

(2) After selection of Signalling Gateway(s), the AS selects amongst the Signalling Gateway Processes associated with those Signalling Gateways. This selection is based on activity: that is, all SGPs which are actively transferring traffic to the AS are selected.

(3) Once the set of SGP have been selected, there is a specific Transport Provider associated with each of the SGP selected. The message is transmitted with the associated Routing Context to each of the Transport Providers selected. If the Transport Provider is an SCTP provider, the stream used and the decision to use the Unordered bit is based upon the type of the SNM message.

```
                     ________       ________     ________
               RC   |        |     |        |   |        |
                 +->|   SG   |---->|  SGP   |___|Transport_____
                 |  |        |__   |        |   |        |
                 |  |________|  |  |________|   |________|
      ________   |   ________   |   ________     ________
     |        |  |  |        |  |  |        |   |        |
_____|  User  |__|  |   SG   |  |  |  SGP   |___|Transport_____
     |        |__   |        |  +->|        |   |        |
     |________|  |  |________|     |________|   |________|
                 |   ________       ________     ________
                 |  |        |     |        |   |        |
                 |  |   SG   |     |  SGP   |___|Transport_____
                 +->|        |---->|        |   |        |
                    |________|     |________|   |________|
                  SG Selelected   SGP Selected Select Stream
                   by activity     by activity      by
                                                  SNM type
```

Figure 12. Outgoing SNM Messages, Application Server

4.2. Incoming SNMM at the Application Server

Figure 13 illustrates the steps that the Signalling Gateway goes through when it receives an SNM message from the Application Server. The Signalling Gateway performs the following functional steps on the message:

(1) The Transport Provider connection upon which the Data Transfer message is received determines the Aplication Server Process (ASP) associated with the message.

(2) The Signalling Gateway then uses the Routing Context associated with the message to select an Application Server with that Routing Context.

(3) The Application Server maps directly to an SS7 provider.

(4) If so equipped, the SS7 provider deals with the Management message[12].

Figure 14 illustrates the steps that the Application Server goes through when it receives an SNM message from the Signalling Gateway. The process is almost identical to the Data Transfer process. The Application Server performs the following functional steps on the message:

(1) The Transport Provider connection upon which the SNM Message is receive determines both the Signalling Gateway Process (SGP) and the Signalling Gateway (SG) which are to be used for the message.

(2) The AS, upon determining the SGP and SG, store whatever state information concerning the Management message that is necessary as this may have a bearing on routeing of outgoing data messages.

(3) Once the Signalling Gateway upon which the message has arrived has been determined by the Application Server, the AS choses the SS7 User to send the message to based on the Routing Context which appears in the message. Note, however, that the Routing Context must be considered in the context of the Signalling Gateway upon which it was received.

(4)

(5)

Security Considerations

Acknowledgements

```
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |------+       +-->| AS  |-|Provider|
      |_______| |_______|      |       |   |_____| |________|
       _______   _______       |       |    _____   ________
      |       | |       |      |       |   |     | |        |
----->| Xport |-|  ASP  |-->   +--->---+   | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
       _______   _______                    _____   ________
      |       | |       |                  |     | |        |
----->| Xport |-|  ASP  |-->               | AS  |-|Provider|
      |_______| |_______|                  |_____| |________|
                                            Selected based
                                                 on RC
```

Figure 13. Incoming SNM Messages, Signalling Gateway

```
       _______   _______                             _______
      |       | |       |                           |       |
----->| Xport |-|  SGP  |------+                +-->| User  |
      |_______| |_______|      |                |   |_______|
       _______   _______       |     _______    |    _______
      |       | |       |      |    |       |   |   |       |
----->| Xport |-|  SGP  |---+  +--->|  SG   |---+   | User  |
      |_______| |_______|   +------>|       |       |_______|
       _______   _______    +------>|_______|        _______
      |       | |       |   |        _______        |       |
----->| Xport |-|  SGP  |---+       |       |       | User  |
      |_______| |_______|  +------->|  SG   |       |_______|
       _______   _______   | +----->|       |        _______
      |       | |       |  | |      |_______|       |       |
----->| Xport |-|  SGP  |--+ |       _______        | User  |
      |_______| |_______|    |      |       |       |_______|
       _______   _______     |      |  SG   |        _______
      |       | |       |    |  +-->|       |       |       |
----->| Xport |-|  SGP  |----+  |   |_______|       | User  |
      |_______| |_______|       |                   |_______|
       _______   _______        |                    _______
      |       | |       |       |                   |       |
----->| Xport |-|  SGP  |-------+                   | User  |
      |_______| |_______|                           |_______|
                                    Follow        Selected based
                                      Pointer        on RC for
                                                   Specific SG
```

Figure 14. Incoming SNM Messages, Application Server

Endnotes

[1] There is a minor difference here for M2UA, which does not have the concept of being able to bind to multiple gateways. This is because SS7 links are terminated on a single gateway for M2UA. Nevertheless, the model which works for mulitple gateways will also work for M2UA's single gateway case.

[2] There is no need to associate more than one SS7 Provider with an Application Server, except in the case of M2UA. Even this, however, can be avoid in M2UA, where the assignment of multiple IIDs per Application Server is just as a convenience for activating multiple linksets.

[3] This last one is much better. There is little difference between the registration process at the SG and the registration process at the ASP. At the SG, the RK in the registration request must be resolved to a RC that identifiers an SS7 Provider. At the ASP, the RK that will go in a registration request must be resolved to an SG to which to send the request.

The LM does not normally form connections to ASP, normally the LM listens for connection from ASP.

[5] An SPP is a combination of an ASP and SGP which acts in the capacity of both. This can be accomplished by associating both an ASP and and SGP datastructure with the SPP and discriminating messages to one or the other. The SIGTRAN UAs[M2UA, M3UA, SUA, TUA] are such that, except for data messages, it can always be determined to which aspect (ASP or SGP) a message corresponds. Data messages will cause some problems. It might be necessary to require that a separate transport connection be established for each aspect, if only to determine whether the data messages are bound for the ASP or SGP component. This is related to much of the discussion on ISPS and peer-to-peer operation that occurred on the SIGTRAN WG list.

[6] The proposals to place RC in DATA and SNMM for M3UA were followed after the initial writing of this draft.

[7] The Routing Context used here is the same Routing Context with with the User registered with the Signalling Gateway to *receive* traffic.

[8] Or, in the case of M2UA, link control messages.

[9] The Interface Identifier in M2UA[M2UA] is a direct equivalent for Routing Context in the other UAs.

[10] This is true of SUA[SUA] and M2UA[M2UA], but not as of yet for M3UA[M3UA]. There are currently proposals to make M3UA also place Routing Context lists in Signalling Network Management Messages.

[11] Note that for M2UA[M2UA] there is only ever one SG and one SGP which are active for a given Interface Identifier.

[12] Only the M2UA SG is equipped to deal with management messages. SCONs from received from the AS are purely advisory, and ill advised. SCTP congestion towards the User process (from the User process failing to service its SCTP receive buffer, resulting in a small receive window) is a far better indication of User congestion. User congestion will be signalled in that case back to the SS7 Provider because the queues will back up that far. The SS7 provider can then determine the appropriate action (probably sending TFC for the affected users upon receipt of messages below a given priority.)

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