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Architectural Framework for Signaling Transport

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Abstract

This document defines an architecture framework and functional requirements for transport of signaling information over IP. The framework describes relationships between functional and physical entities exchanging signaling information, such as Signaling Gateways and Media Gateway Controllers, and identifies where signaling transport may be used.

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1. Introduction

1.1 Overview

This document defines an architecture framework for transport of signaling information over IP. The framework describes relationships between functional and physical entities used for control of Media Gateways and identifies where signaling transport may be required. The architecture is based on [1].

1.2 Terminology

The following are general terms are used in this document:

Backhaul:

Backhaul refers to the transport of signaling from the point of interface for the associated data stream (i.e., the MGU) back to the point of call processing (i.e., the MGCU), if this is not local.

Switched Circuit Network (SCN):

The term SCN is used to refer to a network that carries traffic within channelized bearers of pre-defined sizes. Examples include Public Switched Telephone Networks (PSTNs) and Public Land Mobile Networks (PLMNs). Examples of signaling protocols used in SCN include Q.931, Signaling System 7 (SS7) ISDN User Part (ISUP) and Global System for Mobile Communication (GSM).

The following are terms for functional entities relating to signaling transport in a distributed gateway model.

Media Gateway (MG):

A MG terminates terminates SCN media streams, packetizes the media data,, if it is not already packetized, and delivers packetized traffic to the packet network.
It performs these functions in reverse order for media streams flowing from the packet network to the SCN.

Media Gateway Controller (MGC):

An MGC handles the registration and management of resources at the MG.
The MGC may have the ability to authorize resource usage based on local policy.

Signaling Gateway (SG):

An SG is a signaling agent [1,4] that receives/sends SCN native signaling at the edge
of the IP network. The SG function may relay, translate or terminate SS7 signaling in an SS7-Internet Gateway. The SG function may also be co-resident

with the MG function to process SCN signaling associated with line or trunk terminations controlled by the MG.

Signaling Transport Gateway (STG):

An SG which transports upper layer signaling information over a different underlying network; for example, ISUP over IP instead of ISUP over lower SS7 layers. In this document, SG should be interpreted as performing STG functions unless otherwise noted.

Signaling Interworking Gateway (SIG):

An SG which interworks both upper and lower layer signaling information, for example, interworking of ISUP/MTP and H.225/IP.

The following are terms for physical entities relating to signaling transport in a distributed gateway model:

Media Gateway Unit (MGU)

An MG-Unit is a physical entity that contains the MG function. It may contain other functions, esp. an SG function for handling facility-associated signaling.

Media Gateway Control Unit (MGCU)

An MGC-Unit is a physical entity containing the MGC function.

Signaling Gateway Unit (SGU)

An SG-Unit is a physical entity containing the SG function.

Signaling End Point (SEP):

This is a node in an SS7 network that originates or terminates signaling messages. Examples include a database or central office.

Signal Transfer Point (STP):

This is a node in an SS7 network that routes signaling messages based on their destination address in the SS7 network

1.3 Scope

Signaling transport focuses on transparent transport of message-based signaling protocols over IP networks. The scope of this work includes definition of encapsulation methods, end-to-end protocol mechanisms and use of IP capabilities
such as differentiated services to support the functional and performance requirements for signaling.

There are several cases where signaling transport may be useful, as described in greater detail in following sections. One example is transport of SCN signaling between a Signaling Gateway Unit and Media Gateway Controller Unit. Other examples include transport of facility-associated SCN signaling between a Media Gateway Unit and Media Gateway Controller Unit, and transport of signaling between two Signaling Gateway Units connection signaling endpoints in the SCN.

Since the focus is on transport, the following items will be outside the scope of the signaling transport work:

- definition of the call control protocols themselves
- definition of protocol conversion for call control, such as conversion from Channel Associated Signaling (CAS) to message signaling protocols
- specification of the functions taking place within the SGU or MGU - in particular, this work does not address whether the SGU provides STG or SIG functions, as this is transparent to the transport function.

The signaling transport will be defined in such a way as to support encapsulation and carriage of a variety of call control protocols. It is defined in such a way as to be independent of any protocol translation functions taking place within the Signaling Gateway Unit or Media Gateway Unit, since its function is limited to the transport of the protocol.

2. Signaling Transport Architecture

2.1 Gateway Component Functions

Figure 1 defines a commonly defined functional model for the VoIP Gateway that separates out the functions of SG, MGC and MG. This model may be implemented in a number of ways, with functions implemented in separate devices or combined in single physical units.

Where physical separation exists between functional entities, Signaling Transport can be applied to ensure that SCN signaling information is transported between entities with the required functionality and performance.

```
        Signaling gateway                      Signaling gateway (opt)
       +---------------+                      +--------------+
       |               |    SG-SG transport   |              |
 SCN<--------->[SG]  <--+---------O------------+--> [SG]  <------> SCN
signal |       |       |                      |     |        |    signal
       +-------|-------+                      +-----|--------+
               |                                    |
               O                                    O
               |                                    |
       +-------|-------+                      +-----|--------+
       |       |       |    MGC-MGC signaling |     |        |
       |      [MGC] <--+--------O-------------+--> [MGC]     |
       |       |       |                      |     |        |
       |       |       |                      |     |        |
       +-------|-------+                      +-----|--------+
       Gateway | controller                 Gateway | Controller (opt)
               O                                    O
               |                                    |
       +-------|-------+                      +-----|--------+
       |       |       |                      |     |        |
<-IMT--+---->[MG]  <---+-----RTP stream-------+-> [MG]  <----+-IMT----->
       |               |                      |              |
       +---------------+                      +--------------+
       Media gateway                           Media gateway
```

Notes:
- IMT stands for Inter-Machine Trunk

Figure 1: Gateway Functional Model

2.2 SS7 Interworking for Connection Control

Figure 2 below shows some example implementations of these functions in physical entities as used for interworking of SS7 and IP networks for Voice over IP. No recommendation is made as to functional distribution and other implementations are possible.

For interworking with SS7-controlled SCN networks, the SG terminates the SS7 link and transfers the signaling information to the MGC using signaling transport. The MG terminates the intermachine trunk and controls the trunk based on the control signaling it receives from the MGC. Depending on implementation, the SG and MGC may be in separate devices or co-located.

An alternative case (c) is the SS7 F-link, where the signaling link is facility-associated, and is terminated by the same device (i.e., the MG) that terminates the intermachine trunk. In this case, the SG function is co-located with the MG function, as shown in Figure 2.

In the latter case, the signaling messages are "backhauled" to the MGC for call processing, using signaling transport functionality.

```
         SGU
        +--------+
SS7<------>[SG]  |
(ISUP)  |   |    |
        +---|----+
         ST |                SGU                       MGCU
        +---|----+           +--------+                +--------+
        | [MGC]  |      SS7---->[SG]  |                | [MGC]  |
        |   |    |           |   |    |                |  | |   |
        +---|----+           +---|----+                +--|-|---+
       MGCU |                 ST |                        | |
            |                    |                     ST | |
        +---|----+           +---|----+                +--|-|---+
IMT------->[MG]  |      IMT-->[MG/MGC]|    SS7 F-link-->[SG]|   |
        |        |           |        |        IMT ------> [MG] |
        +--------+           +--------+                +--------+
        MGU                  MGU                       MGU

         (a)                     (b)                      (c)
Notes: ST = Signaling Transport used to carry SCN signaling
```

Figure 2: Example Implementations

In some implementations, the function of the SG may be divided into multiple physical entities to support scaling and addressing concerns. Signaling Transport can be used between SGs as well as from SG to MGC. This is shown in Figure 3 below.

```
              SGU          MGCU
             +---------+  +---------+
             |         |ST|         |
             |  [SG 2]------>[MGC]  |
             |    ^    |  |    |    |
             +----|----+  +----|----+
                  |            |
               ST |            |
                  |            |
    SS7      +----|------------|--+
   -----------> [SG 1]         |  |
             |                 |  |
   ------------------------->[MG] |
             +--------------------+
              MGU
```

Figure 3: Multiple SG Case

2.3 ISDN Interworking for Connection Control

In ISDN access signaling, the signaling channel is carried along with data channels, so that the SG function for handling Q.931 signaling is co-located with the MG function for handling the data stream. Where **Q.931 is then transported to the MGC for call processing, signaling transport** would be used between the SG function and MGC. This is shown in Figure 3 below.

```
    MGCU
    +-------------+
    |    [MGC]    |
    |      | |    |
    +------|-|----+
           | |
           | O device control
           | |
 Q.931/ST O |
           | |
    +------|-|----+
    |      | |    |
Q.931-->[SG]|     |
D-Chan|     |     |
    |       |     |
B-Chan---->[MG]   |
    |             |
    +-------------+
    MGU
```

Figure 3: Q.931 transport model

2.4 CAS Backhaul

In the case of Channel Associated Signaling (CAS), the signaling is carried coupled with the data stream, and as in the Q.931 case, the SCN signaling gateway function (SG) is co-located with the media gateway function (MG). It is assumed here that the CAS is converted to a packet-based SCN signaling protocol and backhauled to the MGC using signaling transport capabilities. (Need for this tbd with megaco group).

2.5 Architecture for Database Access

Transaction Capabilities (TCAP or TC) is the application part within SS7 that is used for non-circuit-related signaling such as database access. TCAP/TC signaling within IP networks may be used for cross-access between entities in the SS7 domain and the IP domain, such as:

- access from an SS7 network to an IP network database
- access from an SS7 network to an MGC
- access from an MGC to an SS7 network element
- access from an IP Signaling End Point (ISEP) to an SS7 network element

A basic functional model for TCAP/TC over IP is shown in Figure 4.

```
                         +--------------+
                         | ISEP/Database|
                         +--|----|------+
                            |    |
         SGU                |    |                SGU
        +--------------+    |    |    +--------------+
        |              |   /    /     |              |
SS7<--------->[SG] -------/    /      |     [SG]<---------> SS7
(TCAP)  |      |       |      /       |      |       |
        +------|-------+     /        +------|-------+
               |        ____/                |
               O       /                     O
       MGCU    |      /                      | MGCU
       +-------|-----/-+               +-----|--------+
       |       |    /  |               |     |        |
       |      [MGC]    |               |    [MGC]     |
       |       |       |               |     |        |
       +-------|-------+               +-----|--------+
               |                             |
       +-------|----------+            +-----|------+
       |       |          |            |     |      |
<-IMT-------->[MG]<---------RTP stream----->[MG]<--------IMT-->
       |                  |            |            |
       +------------------+            +------------+
       MGU                             MGU
```

Notes: IMT is Inter-Machine Trunk

Figure 4: TCAP Signaling over IP

3. Protocol Architecture

3.1. SS7 access for Media Gateway Control

This section provides a protocol architecture for signaling transport supporting SS7 access for Media Gateway Control.

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

+----+                                       +-----+
|ISUP|                                       | ISUP|
+----+        +-----+      +---------+       +-----+
|MTP |        |MTP  |      |MTP | CTP|       | CTP |
+    +        +     +      +    +----+       +-----+
|    |        |     |      |    | UDP|       | UDP |
|    |        |     |      |    | TCP|       | TCP |
+    +        +     +      +    +----+       +-----+
|    |        |     |      |    | IP |       | IP  |
+----+        +-----+      +---------+       +-----+
```

CO - Telco Central Office
STP - Signal Transfer Point
SG - Signaling Gateway
MGC - Media Gateway Controller
CTP - Common Transport Protocol

Note: Choice of UDP vs. TCP not yet decided.

3.2. Q.931 Access to MGC

This section provides a protocol architecture for signaling transport supporting ISDN access (Q.931) for Media Gateway Control.

```
******    ISDN      *********     IP     *******
* SP *--------------* MG/SG *------------* MGC *
******              *********            *******

+----+                                   +-----+
|Q931|                                   | Q931|
+----+              +---------+          +-----+
|Q921|              |Q921| CTP|          | CTP |
+    +              +    +----+          +-----+
|    |              |    | UDP|          | UDP |
|    |              |    | TCP|          | TCP |
+    +              +    +----+          +-----+
|    |              |    | IP |          | IP  |
+----+              +---------+          +-----+
```

MG/SG - Media Gateway with SG function for backhaul
SP - ISDN Signaling Point

3.3. SS7 Access to IP/SCP

This section identifies a protocol architecture for signaling between an SS7 SEP and an IP domain SEP (ISEP).

```
******   SS7   ******* SS7  ******     IP      *******
*SEP *--------* STP *------* SG *-------------* ISEP*
******        *******      ******             *******

+-----+                                       +-----+
|S7AP |                                       |S7AP |
+-----+        +-----+     +----------+       +-----+
|SCCP*|        |SCCP*|     |   SCCP* |        |SCCP*|
+-----+        +-----+     +----------+       +-----+
|MTP  |        |MTP  |     |MTP | CTP|        |CTP  |
+     +        +     +     +    +-----+       +-----+
|     |        |     |     |    | UDP|        |UDP  |
|     |        |     |     |    | TCP|        |TCP  |
+     +        +     +     +    +-----+       +-----+
|     |        |     |     |    | IP |        |IP   |
+-----+        +-----+     +----------+       +-----+
```

*Note: may or may not be present depending on application

SS7 Application Part (S7AP) is used for generality.

3.4. SG to SG

This section identifies a protocol architecture for support of signaling between two endpoints in an SCN signaling network, using signaling transport directly between two SGs.

The following figure describes protocol architecture for a scenario with two SGs providing different levels of function for interworking of SS7 and IP. This corresponds to the scenario given in Figure 3 above.

```
******  SS7  ******   IP     ******  IP   ******
*SEP *-------* SG1*----------* SG2*-------*MGC *
******       ******          ******       ******

+----+                                    +----+
|S7UP|                                    |S7UP|
+----+                     +----+----+    +----+
|MTP3|                     |MTP3|CTP |    |CTP |
+----+    +---------+      +---------|    +----+
|MTP2|    |MTP2| CTP|      |CTP |    |    |    |
+    +    +    +----+      +----+    |    |    |
```

```
|    |    |    | UDP|      |UDP |UDP |    |UDP |
|    |    |    | TCP|      |TCP |TCP |    |TCP |
|    |    |    |----|      |----|----|    |----|
|    |    |    | IP |      | IP | IP |    | IP |
+----+    +----+----+      +----+----+    +----+
```

The following figure describes a more generic use of SS7-IP interworking for transport of SS7 upper layer signaling across an IP network, where the endpoints are both SS7 SEPs.

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

+----+                                       +-----+
|S7UP|                                       | S7UP|
+----+                                       +-----+
|MTP3|                                       | MTP3|
+----+        +----------+     +----------+    +-----+
|MTP2|        |MTP2| CTP|     |CTP |MTP2|    | MTP2|
+    +        +    +----+     +----+    +    +     +
|    |        |    | UDP|     |UDP |    |    |     |
|    |        |    | TCP|     |TCP |    |    |     |
|    |        |    |----|     |----|    |    |     |
|    |        |    | IP |     | IP |    |    |     |
+----+        +----+----+     +----+----+    +-----+
```

4. Functional Requirements

Signaling transport provides for the transport of native SCN protocol messages over a packet switched network.

Signaling transport shall:

1) Transport of a variety of SCN protocol types, such as the application and user parts of SS7 (including ISUP, SCCP, TCAP, MAP, INAP, IS-41, etc.) and layer 3 of the DSS1/PSS1 protocols (i.e. Q.931 and QSIG).

2) Provide an identifier for the particular SCN protocol being transported.

3) Provide a common base protocol defining header formats, security extensions and generic requirements for signaling transport, and support extensions as necessary to add individual SCN protocols if and when required.

4) In conjunction with the underlying network protocol (IP) and transport protocol (TCP, UDP or other), provide the relevant functionality as defined by the appropriate SCN lower layer.

Relevant functionality may include (according to the protocol being transported):

- flow control
- in sequence delivery of signaling messages (tbd. if this is supported

across multiple SCN signaling sessions)
- logical identification of the entities on which the signaling messages originate or terminate
- logical identification of the physical interface controlled by the signaling message
- load sharing over multiple signaling transport sessions
- retransmission
- information on unavailability of peer entities.

For example:

- if the native SCN protocol is ISUP or SCCP, the relevant functionality provided by MTP2/3 shall be provided.
- if the native SCN protocol is TCAP, the relevant functionality provided by SCCP and MTP 2/3 shall be provided.
- if the native SCN protocol is Q.931, the relevant functionality provided by Q.921 shall be provided.
- if the native SCN protocol is MTP3, the relevant functionality of MTP2 shall be provided.

5) Support the ability to multiplex several higher layer SCN sessions on one underlying signaling transport session. This allows, for example, the output of several DSS1 D-Channel sessions to be carried in one signaling transport session.

6) Be able to transport complete messages of greater length than the underlying SCN segmentation/reassembly limitations. For example, signaling transport should not be constrained by the length limitations defined for SS7 lower layer protocol (e.g. 272 bytes in the case of narrowband SS7) but should be capable of carrying longer messages without requiring segmentation.

7) Allow for a range of suitably robust security schemes to protect signaling information being carried across networks. For example, signaling transport shall be able to operate over proxyable sessions, and be able to be transported through firewalls.

8) Provide for congestion avoidance on the Internet, by supporting appropriate controls on signaling traffic generation (including signaling generated in SCN) and reaction to network congestion.

5. Management

Tbd.

6. Security

Tbd.

7. Acknowledgements

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8. References

[1] F. Cuervo, N. Greene, et al, "SS7-Internet Interworking - Architectural Framework" <draft-greene-ss7-arch-frame-01.txt>, July 1998, work in progress.

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