ATIS STANDARD

ATIS-1000047

SIGNALING SYSTEM 7 (SS7) AND INTERNET PROTOCOL (IP) TRANSPORT NETWORKS SIGNALING INTERWORKING AND COMPATIBILITY

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ATIS-1000047, *Signaling System 7 (SS7) and Internet Protocol (IP) Transport Networks Signaling Interworking and Compatibility*

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ATIS-1000047

Technical Requirements for

Signaling System 7 (SS7) and Internet Protocol (IP) Transport Networks Signaling Interworking and Compatibility

Alliance for Telecommunications Industry Solutions

Approved November, 2011

Abstract

This ATIS standard provides requirements and guidelines for signaling interworking and compatibility between traditional SS7 transport networks and IP-based transport networks. The primary focus of this ATIS standard is interworking and compatibility between the lower layer transport network protocols, and not the upper layer session control protocols (i.e., TCAP, ISUP, and SIP).

Foreword

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between providers, customers, and manufacturers. The Packet Technologies and Systems Committee (PTSC) develops and recommends standards and technical reports related to services, architectures, and signaling, in addition to related subjects under consideration in other North American and international standards bodies. PTSC coordinates and develops standards and technical reports relevant to telecommunications networks in the U.S., reviews and prepares contributions on such matters for submission to U.S. ITU-T and U.S. ITU-R Study Groups or other standards organizations, and reviews for acceptability or per contra the positions of other countries in related standards development and takes or recommends appropriate actions.

The mandatory requirements are designated by the word *shall* and recommendations by the word *should*. Where both a mandatory requirement and a recommendation are specified for the same criterion, the recommendation represents a goal currently identifiable as having distinct compatibility or performance advantages. The word *may* denotes a optional capability that could augment the standard. The standard is fully functional without the incorporation of this optional capability.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, PTSC 1200 G Street NW, Suite 500, Washington, DC 20005.

At the time of consensus on this document, PTSCwhich was responsible for its development, had the following roster:

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The Signaling, Architecture, and Control (SAC) Subcommittee was responsible for the development of this document.

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Introduction

Interconnection between a Next Generation Network (NGN) based on Internet Protocol (IP) and the Public Switched Telephone Network (PSTN) based on Signaling System 7 (SS7) circuit-switched technology will have to be supported to allow service connectivity, including end-to-end calling. Signaling interconnection between NGN and PSTN segments are facilitated by nodes such as PSTN Gateways and Signaling Gateways (SGs) defined in NGN and IP Multimedia Subsystem (IMS) architectures.

The control mechanisms and procedures of the traditional SS7 of the PSTN and signalling/control mechanisms associated with IP networks are different. Therefore, lower-layer protocol transport network interworking and interoperability will be necessary between these networks to support the end-to-end upper layer protocol communications and applications protocol services. Support of the lower-layer protocol transport network interworking and compatibility functions at PSTN and NGN interconnection nodes is needed for the end-to-end support of critical services such as Emergency Telecommunications Service (ETS).

The objective of this document is to provide guidelines and requirements for traditional lower-layer SS7 transport protocols and IP-based transport network interworking and interoperability, and for the interconnection nodes that will provide this interworking and interoperability. This document also provides guidelines and requirements for gateway support of the relevant lower-layer SS7 and IP protocols.

1 Scope, Purpose, & Application

This ATIS standard provides guidelines and requirements for lower-layer protocol transport network signaling interworking and compatibility between the IP-based NGN and the traditional SS7 signaling network of the PSTN. It describes the architectural concepts, functional capabilities, and requirements to facilitate interoperability and compatibility.

There are multiple possible interconnection scenarios, variations, and end-to-end combinations for NGN and PSTN interconnections. However, this ATIS standard does not address all the possible variations. The focus is on traditional SS7 interconnection to IP-based transport of NGN in a generic manner. Specifically, the scope of this ATIS standard is limited to the interworking and compatibility between the SS7 transport protocols [i.e., the Message Transfer Part (MTP) and Signaling Connection Control Part (SCCP) protocols of SS7] and the IP-based signaling transport protocols [e.g., Stream Control Transport Protocol (SCTP) and the SIGTRAN Adaptation protocols, and IP].

The scope of this document is limited to lower-layer protocol transport network interworking and compatibility. It does not address upper-layer application level protocols such as Integrated Services Digital Network User Part (ISUP), Transaction Capabilities Application Part (TCAP), and Session Initiation Protocol (SIP) interworking.

The purpose of this ATIS standard is to provide the interface requirements and guidelines to minimize interworking and compatibility problems. Interworking and compatibility issues between the signaling transport networks of SS7 and IP-based NGN could result in failure scenarios impacting the upper layer application protocols and services. Specifically, it is important that interworking and compatibility issues be minimized to avoid impacts on Emergency Telecommunications Service (ETS).

1.1 Assumptions

This document is based on the following assumptions:

1. There are multiple possible interconnection scenarios, architectural variations, and end-to-end combinations for IP-based NGN and SS7-based PSTN signaling interconnection. Interworking of the lower-layer protocol transport networks will be architecture-dependent.
2. Signaling transport interworking and compatibility between IP-based NGN and SS7-based PSTN signaling networks is supported by network elements such as the PSTN Gateway and the Signaling Gateway (SG).
3. In some architectural solutions, there is no interworking between the SS7 transport (i.e., MTP) and IP-based transport. This includes the scenario where the SS7 upper layer application protocol (TCAP or ISUP) is terminated at the Gateway Node and the SIP session control protocol is used in the NGN. In such scenarios, compatibility issues between the two transport networks will need to be considered.
4. The Signaling Gateway network elements support standard SS7 (ATIS MTP and SCCP) interfaces on the PSTN side.
5. For practical reasons, this document assumes that requirements will be imposed on the interworking functions of the gateways, avoiding changes or new requirements on the traditional SS7 and IP protocols or corresponding PSTN and NGN networks.

2 References

2.1 ATIS References[1]

[ATIS-1000012]: ATIS-1000012.2006 (R2011), *SS7 Network and NNI Interconnection Security Requirements and Guidelines*.

[ATIS-1000018]: ATIS-1000018, *NGN Architecture*.

[ATIS-1000029]: ATIS-1000029.2008, *NGN Security Requirements*.

[ATIS-1000111]: ATIS-10000111.2005 (R2010), *Signalling System Number 7 (SS7) – Message Transfer Part (MTP)*.

[ATIS-1000112]: ATIS-1000112.2005 (R2010), *Signaling System Number 7 (SS7) - Signaling Connection Control Part (SCCP)*.

[ATIS-1000113]: ATIS-1000113.2005 (R2010), *Signaling System No. 7 (SS7) – Integrated Service Digital Network (ISDN) User Part*.

[ATIS-1000114]: ATIS-1000114.2004 (R2009), *Signalling System Number 7 (SS7) - Transaction Capabilities Application Part (TCAP)*.

[ATIS-1000679]: ATIS-1000679.2006, *Interworking between Session Initiation Protocol (SIP) and Bearer Independent Call Control or ISDN User Part*.

2.2 IETF References[2]

[IETF RFC 768]: *User Datagram Protocol*, J. Postel, ISI.

[IETF RFC 791]: *Internet Protocol – DARPA Internet Program Protocol Specification*.

[IETF RFC 793]: *Transmission Control Protocol – DARPA Internet Program Protocol Specification*.

[IETF RFC 3331]: *Signaling System 7 (SS7) Message Transfer Part 2 (MTP2) - User Adaptation Layer*.

[IETF RFC 3398]: *Integrated Services Digital Network (ISDN) User Part (ISUP) to Session Initiation Protocol (SIP) Mapping.* G. Camarillo, A. B. Roach, J. Peterson, L. Ong. December 2002.

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[1] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005. < https://www.atis.org/docstore/default.aspx >

[2] This document is available from the Internet Engineering Task Force (IETF). < http://www.ietf.org >

[IETF RFC 3578] *Mapping of Integrated Services Digital Network (ISDN) User Part (ISUP) Overlap Signalling to the Session Initiation Protocol (SIP).* G. Camarillo, A. B. Roach, J. Peterson, L. Ong. August 2003.

[IETF RFC 3788]: *Security Considerations for Signaling Transport (SIGTRAN) Protocols*.

[IETF RFC 3868]: *Signaling Connection Control Part User Adaptation (SUA)*.

[IETF RFC 4165]: *Signaling System 7 (SS7) Message Transfer Part 2 (MTP2) - User Peer-to-Peer Adaptation Layer (M2PA)*.

[IETF RFC 4666]: *Signaling System 7 (SS7) Message Transfer Part 3 (MTP3) - User Adaptation Layer (M3UA)*.

[IETF RFC 4960]: *Stream Control Transmission Protocol*.

3 Definitions

3.1 Gateway [ATIS Telecom Glossary[3]] - In a communications network, a network node equipped for interfacing with another network that uses different protocols.

3.2 PSTN Gateway [ATIS-1000018] - A network element providing interworking functions for Next Generation Network (NGN) and Public Switch Telephone Network (PSTN) signaling and bearer interworking connectivity, comprised of the MGCF, SGF, T-MGF, and, optionally, BGCF.

3.3 Signaling Gateway [ATIS-1000018] - A network element providing Signaling Gateway Functions.

3.4 Signaling Gateway Function [ATIS 1000018] - The SGF acts as a gateway between the IP call/session control signaling and the SS7-based PSTN signaling. It can also be used as a signaling gateway between different packet-based carrier domains. It may provide signaling translation, for example between SIP and SS7 or simply signaling transport conversion -- e.g., SS7 over IP to SS7 over TDM.

3.5 T-MGF [ATIS 1000018] - A T-MGF terminates bearer channels from a switched circuit network and media streams from a packet network (e.g., RTP streams in an IP network). It establishes and releases connections between these channels under control of the MGCF in support of calls between PSTN and IP network. The T-MGF supports media conversion and processing (e.g., codec, echo canceller, and conference bridge).

4 Abbreviations

ATM	Asynchronous Transfer Mode
DPC	Destination Point Code
ETS	Emergency Telecommunications Service
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPsec	IP Security
ISUP	Integrated Services Digital Network User Part
M2PA	MTP2 Peer-to-Peer User Adaptation
M2UA	MTP2 User Adaptation
M3UA	MTP3 User Adaptation
MTP	Message Transfer Part
NGN	Next Generation Network
NNI	Network-to-Network Interface
OAM&P	Operation, Administration, Maintenance and Provisioning

[3] See < http://www.atis.org/glossary/ >.

PSTN	Public Switched Telephone Network
UDP	User Datagram Protocol
SAAL	Signaling ATM Adaptation Layer
SCCP	Signaling Connection Control Part
SCTP	Stream Control Transmission Protocol
SEP	Signaling End Point
SG	Signaling Gateway
SGF	Signaling Gateway Function
SIGTRAN	Signaling Transport
SIP	Session Initiation Protocol
SP	Service Provider
SPC	Signaling Point Code
SS7	Signaling System 7
STP	Signaling Transfer Point
SUA	SCCP User Adaptation
TCAP	Transaction Capabilities Application Part
TCP	Transmission Control Protocol
TFA	Transfer Allowed
TFC	Transfer Control
TFP	Transfer Prohibited
TFR	Transfer Restricted
TLS	Transport Layer Security
T-MGF	Trunk Media Gateway Function

5 SS7 Network & IP Network Signaling Interconnection Reference Architectural Models

5.1 Overview

Specific functional entities to support PSTN interconnections are defined for NGN architectures. NGN and PSTN interconnection is supported by network elements providing PSTN Gateway functions. In general, the PSTN Gateway provides two types of functions described by the Signaling Gateway Function (SGF) and Trunk Media Gateway Function (T-MGF) defined in [ATIS-1000018], NGN architecture.

There are multiple protocol and architectural variations, and end-to-end combinations for NGN and PSTN interconnection realization, including the SGF and T-MGF defined in [ATIS-1000018]. This document does not address all possible signaling interconnection variations, nor does it address upper layer (ISUP and TCAP) signalling interconnection. In this document, the term *Signaling Gateway (SG)* is used to refer to a network element that supports the SGF as defined in [ATIS 1000018] and facilitates lower-layer signaling interconnection between the SS7-based PSTN and the IP-based NGN.

For this document, which focuses on the lower-layer transport network signalling interworking and compatibility, signaling interconnections are grouped into the following general architectural models:

1. *SS7 Signaling Termination Architectural Model*: SS7 network and IP network signaling interconnections where the SG terminates the SS7 ISUP and TCAP protocols and interworking with SIP occurs.

2. *SS7 Signaling Backhaul Architectural Model*: SS7 network and IP network signaling interconnections where the SG backhauls SS7 ISUP and TCAP protocol messages to a signaling node in the IP network.

3. *SS7 Signaling Transfer Architectural Model*: SS7 network and IP network signaling interconnections where the SG transfers SS7 ISUP and TCAP protocol messages to and from signaling points in the SS7 network and IP network.

5.2 SS7 Signaling Termination Architectural Model: SG terminates ISUP & TCAP Protocols

5.2.1 Protocol Architecture Overview

The SS7 signaling termination architectural model involves scenarios where the SG acts as a Signaling End Point (SEP) in the SS7/PSTN and terminates the upper layer SS7 application protocols (ISUP and TCAP) for messages that it receives from the SS7/PSTN. Similarly, the SG terminates the corresponding SIP signaling that it receives from the NGN.

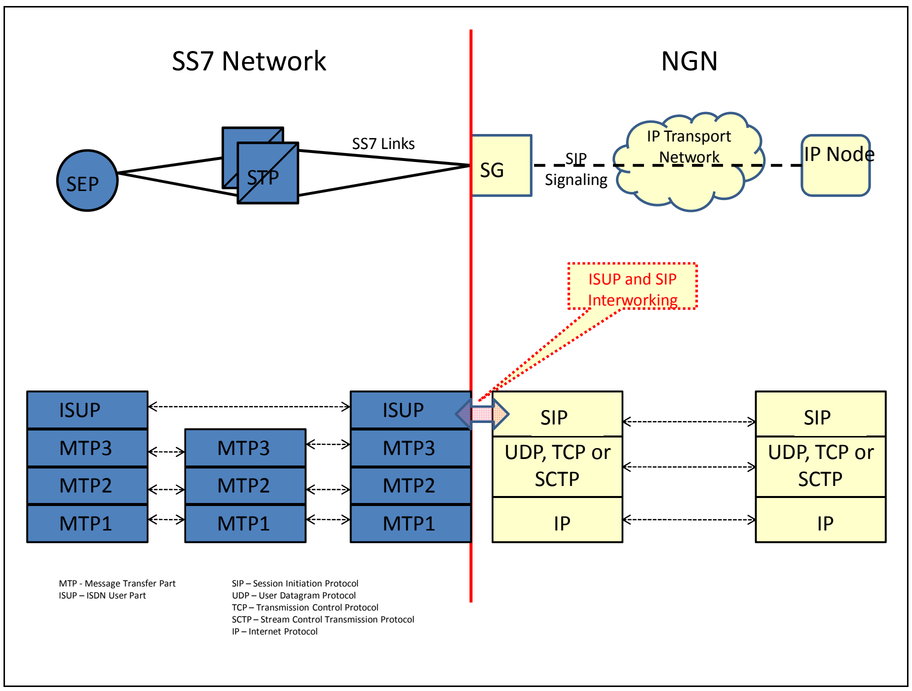

Figure 1 - SG Terminates ISUP

Figure 1 shows an example signaling interconnection where the SG terminates SS7 ISUP messages and processes them at the application level (from the perspective of the PSTN). The following are general characteristics and assumptions related to this signaling interconnection:

1. SS7 links are supported on the SS7/PSTN side. This may be narrowband MTP2 links or ATM-based high speed signaling links. The protocols for MTP2 narrowband links and network layers are MTP3/MTP2/MTP1. The protocols for ATM-based high speed links are MTP3/SAAL/ATM (not shown).
2. This architecture assumes that the upper layer SS7 ISUP protocol is terminated at the SG and interworking with the SIP occurs.

   NOTE: Interworking details between SS7 ISUP protocol and SIP is not within the scope of this document. Refer to [ATIS-1000679]for ISUP and SIP interworking.

3. The signaling lower-layer transport protocols supporting SIP are UDP, TCP, or SCTP/IP.

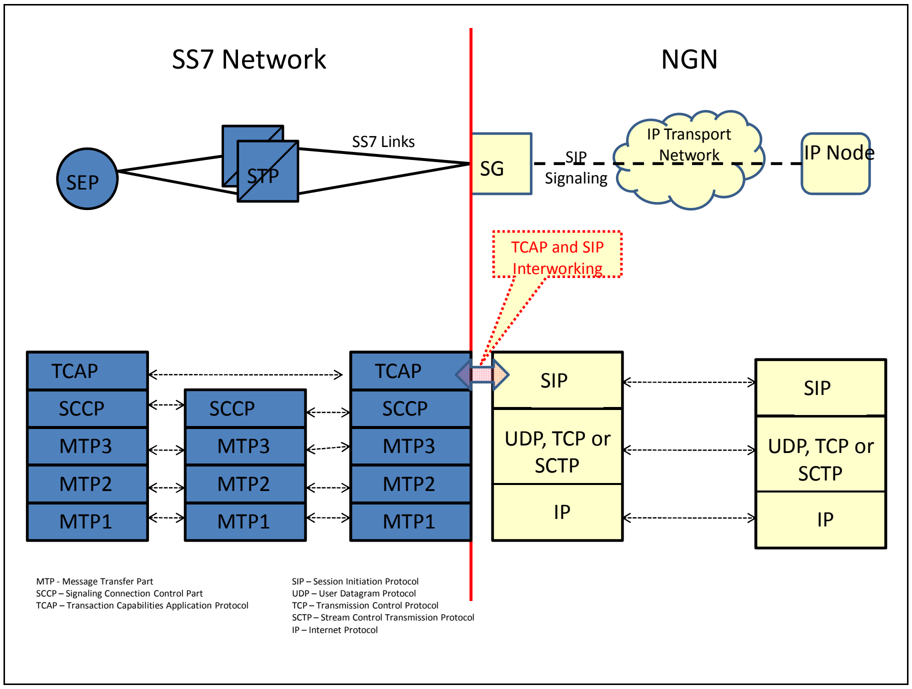

Figure 2 - SG Terminates SS7TCAP

Figure 2 illustrates an example where the SG terminates SS7 TCAP messages and processes them at the application level (from the perspective of the PSTN). The following are general characteristics and assumptions related to this signaling interconnection architectural model:

1. SS7 links are supported on the SS7/PSTN side, and may be narrowband MTP2 links or ATM-based high speed signaling links. The protocols for MTP2 narrowband links are MTP3/MTP2/MTP1. The protocols for ATM-based high speed links are MTP3/SAAL/ATM (not shown).

2. This architecture assumes that upper layer SS7 TCAP protocol is terminated at the SG which interworks with the SIP.

   NOTE: Interworking between TCAP and SIP is not within the scope of this document.

3. The signaling lower-layer transport protocols supporting SIP are UDP, TCP, or SCTP/IP.

5.2.2 Signaling Transport Network Interoperability Considerations

The main characteristic of this architecture is that there is no direct interworking between the transport network lower-layer protocols since the SS7 links and application protocols are terminated on the SG. The SG acts as a Signaling End Point (SEP) in the SS7/PSTN and the interworking occurs at the upper layer level (i.e., TCAP or ISUP interworking with SIP). From the SS7 network perspective, the SG is assigned a unique Signaling Point Code (SPC) and is viewed as a SEP in the SS7 network. SS7 lower level network management is limited to MTP management procedures involving the SG.

In this signaling interconnection, there is no direct interworking between the SS7 transport (i.e., MTP) and the IP-based transport of the NGN. However, because of differences between the SS7 transport network management control procedures (e.g., SS7 congestion, SS7 signaling routes, and SS7 node availability controls) and the interconnected IP-based transport network management control procedures (e.g., IP congestion, IP signaling routes, and IP node availability controls), there are compatibility issues to be taken into consideration to avoid or minimize interoperability problems for end-to-end signaling.

Given the differences between the management control procedures of the SS7 transport network and the IP-based transport network, the following factors need to be considered:

1. *Interoperability between PSTN/SS7 and IP-based signaling transport network congestion control procedures*. This includes the following:

   a. SG actions on the SS7/PSTN side for IP Node congestion in the interconnected NGN.
   b. SG actions on the SS7/PSTN side for SIP/IP signaling route(s) congestion in the interconnected NGN.
   c. SG actions on the NGN side for SS7 node congestion in the interconnected SS7 network.
   d. SG actions on the NGN side for SS7 signaling route(s) congestion in the interconnected SS7 network.

2. *Interoperability between PSTN/SS7 and IP-based signaling transport network availability control procedures*. This includes the following:
   a. SG actions on the SS7/PSTN side for IP Node failure/recovery in the interconnected NGN.
   b. SG actions on the SS7/PSTN side for SIP/IP signaling route(s) failure/recovery in the interconnected NGN.
   c. SG actions on the NGN side for SS7 node failure/recovery in the interconnected SS7 network.
   d. SG actions on the NGN side for SS7 signaling routes failure/recovery in the interconnected SS7 network.

5.3 SS7 Signaling Backhaul Architectural Model: SG Backhauls SS7 ISUP & TCAP Protocols

5.3.1 Protocol Architecture Overview

The SS7 signaling backhaul architectural model involves scenarios where the SS7 TCAP and ISUP protocols are not terminated at the SG, but are passed by the SG into the NGN. The SS7 links are terminated at the SG and the upper layer SS7 protocols (e.g., ISUP and TCAP) are backhauled to an IP Node in the NGN.

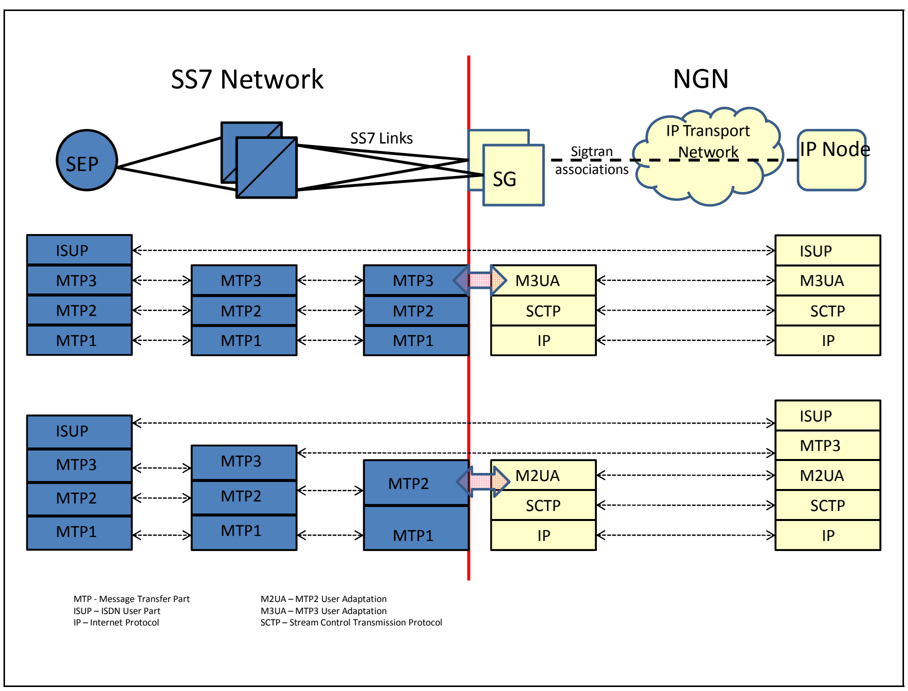

Figure 3 - SG Backhauls ISUP Protocol Messages

Figure 3 illustrates an example where the SG terminates SS7 links and passes (backhauls) ISUP messages to an IP Node in the NGN using a SIGTRAN adaptation protocol over SCTP/IP. The following are characteristics and assumptions related to this signaling interconnection architecture:

1. SS7 lower layer links are supported on the SS7 network side of the SG. These may be narrowband MTP2 links or ATM-based high speed signaling links. The protocols for MTP2 narrowband link are MTP3/MTP2/MTP1. The protocols for ATM-based high speed links are MTP3/SAAL/ATM (not shown).
2. SS7 (Application Protocols) over IP transport mechanisms are supported on the NGN side of the SG. This involves the use of a specific SIGTRAN adaptation protocol (M3UA or M2UA) over SCTP/IP.
3. The SG provides interworking between the SS7 transport network and IP transport network based on the specific Adaptation protocol used. The lower layer SS7 links are terminated at the SG and SIGTRAN M3UA or M2UA adaptation protocols are used to backhaul the upper layer SS7 ISUP messages to the IP Node.
4. An architectural design factor impacting the interworking is whether SG(s) are deployed as standalone or in mated pair configurations similar to SS7 Signaling Transfer Points (STPs).

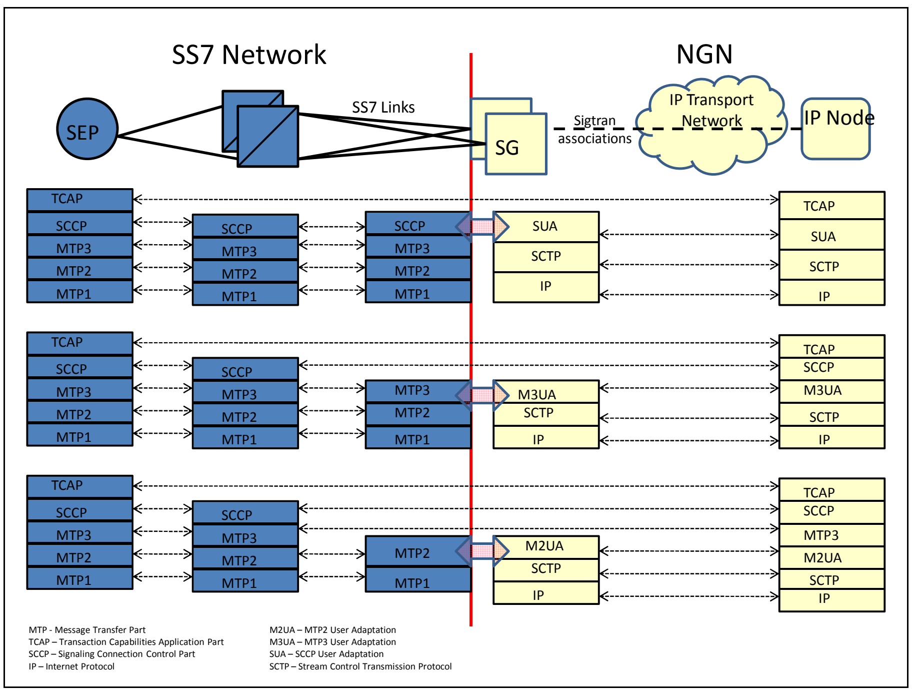

Figure 4 - SG Backhauls TCAP Messages

Figure 4 illustrates an example where the SG terminates SS7 links and backhauls TCAP messages to an IP Node in the NGN using a SIGTRAN adaptation protocol over SCTP/IP. The following are general characteristics and assumptions related to this signaling interconnection architecture:

1. SS7 lower layer links are supported on the SS7 network side of the SG. These may be narrowband MTP2 links or ATM-based high speed signaling links. The protocols for MTP2 narrowband link are MTP3/MTP2/MTP1. The protocols for ATM-based high speed links are MTP3/SAAL/ATM (not shown).
2. SS7 (Application Protocol) over IP transport mechanisms are supported on the NGN side of the SG. This involves the use of a specific SIGTRAN adaptation protocols (SUA, M3UA, or M2UA) over SCTP/IP.
3. The SG provides interworking between the SS7 transport network and IP transport network based on the Adaptation protocol used. The lower layer SS7 links are terminated by at the SG and

SIGTRAN SUA, M3UA, or M2UA adaptation protocols are used to backhaul the upper layer SS7 TCAP protocol messages to the IP Node.

4. An architectural design factors impacting interworking is whether SG(s) are deployed as standalone or mated pair configurations similar to SS7 Signaling Transfer Points (STPs).

5.3.2 Signaling Transport Network Interoperability Considerations

For this signaling interconnection architecture, the SS7 ISUP and TCAP protocols are not terminated in the SG, but are passed to an IP Node. For the “backhaul” signaling interconnection architecture, there is no fixed manner in which the SG is assigned Signaling Point Codes (SPC) as viewed by the SS7 network for network management.

The configuration and assignment of SPCs to the SG could have various implications on interworking between the SS7 transport network management procedures and the IP-based transport network management procedures. Therefore, necessary precautions should be taken to ensure that the MTP network management procedures are effective as intended by the protocol specification.

The following factors are general protocol architecture characteristics associated with each SIGTRAN adaptation protocol option:

1. *M2UA*: The SS7 link is terminated at the SG. Since MTP2 is terminated, the entire MTP3 message header and payload is backhauled to the IP Node using M2UA. In this protocol model, MTP3, including its management controls, is supported at the IP Node.
2. *M3UA*: The SS7 link and MTP3 is terminated at the SG. Since MTP3 is terminated at the SG, the MTP3 User payloads (i.e., TCAP/SCCP and ISUP) are backhauled to the IP Node using M3UA. In this architecture, the M3UA protocol supports interworking with the MTP3 network management procedures.
3. *SUA*: The SS7 link, MTP3 and SCCP are terminated at the SG. Since SCCP is terminated at the SG, the SCCP User payload (i.e., TCAP) is backhauled to the IP Node using SUA.

For each adaptation protocol architecture the following factors should be considered regarding interoperability of the end-to-end lower layer SS7 transport network and IP-based transport network management procedures:

1. *Interoperability between PSTN/SS7 and IP-based signaling transport network congestion control procedures*. This includes the following:
    a. SG actions on the SS7/PSTN side in the presence of IP Node congestion in the interconnected NGN.
    b. SG actions on the SS7/PSTN side in the presence of SS7 over IP signaling route(s) congestion in the interconnected NGN.
    c. SG actions on the NGN side in the presence of SS7 node congestion in the interconnected SS7 network.
    d. SG actions on the NGN side in the presence of SS7 signaling route(s) congestion in the interconnected SS7 network.
2. *Interoperability between PSTN/SS7 and IP-based signaling transport network availability control procedures*. This includes the following:
    a. SG actions on the SS7/PSTN side in the presence of IP Node failure/recovery in the interconnected NGN.
    b. SG actions on the SS7/PSTN side in the presence of SS7 over IP signaling route(s) failure/recovery in the interconnected NGN.
    c. SG actions on the NGN side in the presence of SS7 node failure/recovery in the interconnected SS7 network.
    d. SG actions on the NGN side in the presence of SS7 signaling routes failure/recovery in the interconnected SS7 network.

5.4 SS7 Signaling Transfer Architectural Model: SG Transfers SS7 ISUP & TCAP Protocol Messages

5.4.1 Protocol Architecture Overview

The SS7 signaling transfer architectural model involves scenarios where the SG acts like a SS7 STP and provides routing and transfer functions for MTP3 protocol messages.

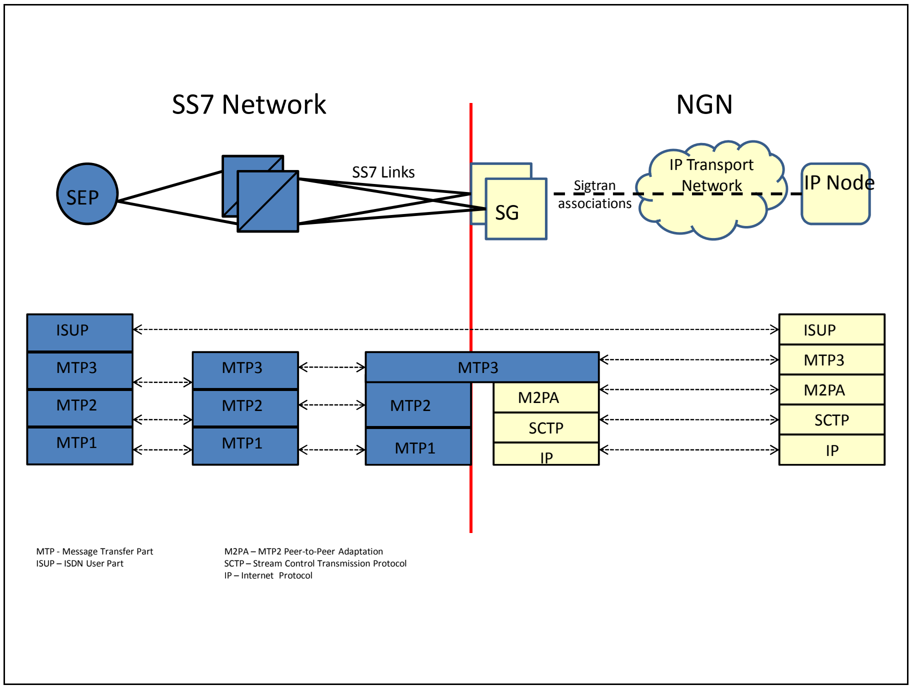

Figure 5 - SG Transfer MTP3 Protocol Messages Carrying ISUP Payload

Figure 5 illustrates an example where the SG transfers MTP3 protocol messages with ISUP payload. The following are general characteristics and assumptions related to this signaling interconnection architecture:

1. SS7 lower layer links are supported on the SS7 network side of the SG. These may be narrowband MTP2 links or ATM-based high speed signaling links. The protocols for MTP2 narrowband link are MTP3/MTP2/MTP1. The protocols for ATM-based high speed links are MTP3/SAAL/ATM (not shown).
2. SS7 over IP virtual links are supported using M2PA over SCTP/IP on the NGN side of the SG.
3. The SG provides routing and transfer function for MTP3 protocol messages (carrying ISUP payload). Messages received on the SS7 side of the SG are transferred to the virtual SS7 links on the NGN side and routed based on the MTP Destination Point Code (DPC). Similarly, messages from the NGN side of the SG are transferred to the SS7 side and routed based on the DPC.
4. The SG may be deployed as standalone or in a mated pair configuration similar to SS7 Signaling Transfer Points (STPs).

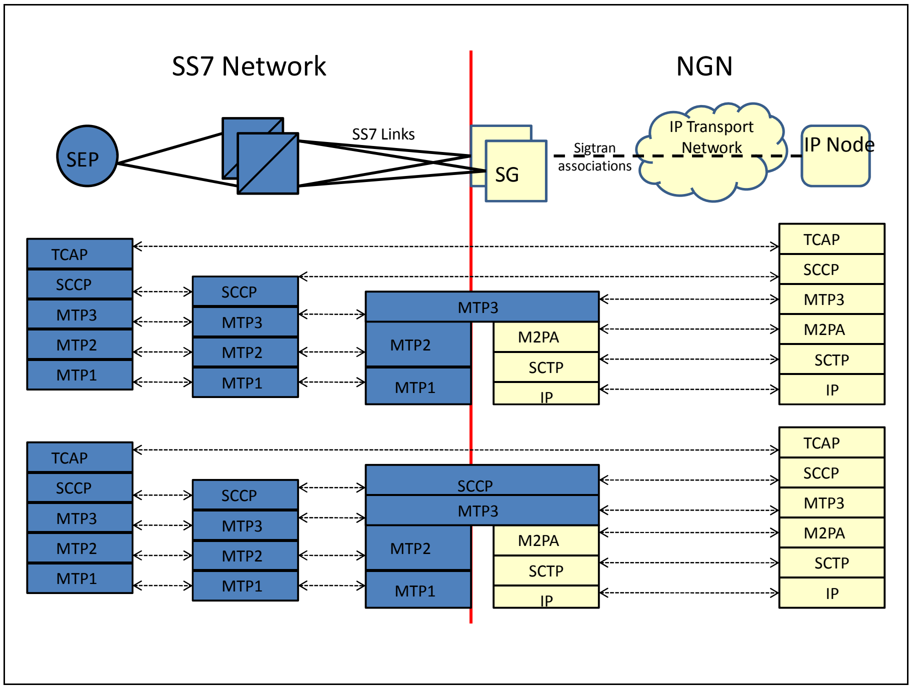

Figure 6 - SG Transfers MTP3 Protocol Messages Carrying TCAP Payload

Figure 6 illustrates an example where the SG transfers MTP3 protocol messages carrying TCAP payload. The following are general characteristics and assumptions related to this signaling interconnection architecture:

1. SS7 lower layer links are supported on the SS7 network side of the SG. This may be narrowband MTP2 links or ATM-based high speed signaling links. The protocols for MTP2 narrowband link are MTP3/MTP2/MTP1. The protocols for ATM-based high speed links are MTP3/SAAL/ATM (not shown).

2. SS7 over IP virtual links are supported using M2PA over SCTP/IP on the NGN side of the SG.

3. The SG provides routing and transfer function for MTP3 protocol messages (carrying TCAP payload). The SG may provide SCCP routing (i.e., a global title translation) to determine the DPC of received messages shown as an option where the SCCP protocol is supported by the SG. Messages received on the SS7 side of the SG are transferred to the virtual SS7 links on the NGN side and routed based on the MTP DPC. Similarly, messages from the NGN side of the SG are transferred to the PSTN/SS7 side and routed based on the DPC.

   NOTE: This DPC may be derived at the SG using global title translation of the SCCP address in the outgoing SS7 message.

4. The SG may be deployed as standalone or in a mated pair configuration similar to SS7 Signaling Transfer Points (STPs).

5.4.2 Signaling Transport Network Interoperability Considerations

This signaling interconnection architecture assumes that the SG acts like a SS7 STP and supports the functionality for STP as specified in [ATIS-1000111] and [ATIS-1000112]. The SGs are viewed as STPs from the SS7 network, and therefore are configured and assigned SPCs in the same manner in which STPs are configured and assigned SPCs in the SS7 network. The IP Nodes are viewed as SEPs from the SS7 network, and therefore are configured and assigned SPCs manner in which SEPs are configured and assigned SPCs in the SS7 network.

For the SS7 transfer architecture, the procedures for signaling message handling, signaling network management, signaling traffic management, and signaling route management are supported at the MTP3 layer end-to-end across the SS7 network and the NGN. Therefore, there should be a minimum of interoperability issues regarding MTP3 management procedures compared to the other architectural models.

6 Requirements & Objectives

6.1 SS7 Transport Network Interface Requirements

The following general requirements are applicable to the SS7 side of the Signaling Gateway (SG) that are providing signaling interconnection between the SS7 network and the IP-based NGN.

R-1 The SG is required to support the MTP network interface to the SS7 network as specified in [ATIS-1000111]. This shall include:

a. **Signaling data link (MTP1) functions and procedures.**
b. **Signaling link (MTP 2 or SAAL Links) functions and procedures.**
c. **Signaling network (MTP3) functions and procedures, if applicable.**

[ATIS-1000111] specifies signaling network management procedures (i.e., MTP3 network management procedures) for traffic management, signaling link management and signaling route management for the control and performance of the SS7 network. The following requirements are applicable:

R-2 The SG supporting MTP 3 is required to support signalling traffic management procedures as specified in [ATIS-1000111] as applicable on the SS7 interface based on the network interconnection configuration:

- **Changeover;**
- **Changeback;**
- **Forced rerouting;**
- **Controlled rerouting;**
- **MTP restart;**
- **Management inhibiting; and**
- **Signalling traffic flow control.**

R-3 SG supporting MTP3 is required to support signalling link management procedures as specified in [ATIS-1000111] on the SS7 network interface:

- **Signalling link activation, restoration, and deactivation;**
- **Link set activation; and**
- **Automatic allocation of signalling terminals and signalling data links.**

R-4 The SG supporting MTP3 is required to support signalling route management procedures as specified in [ATIS-1000111] on the SS7 network interface:

- **Transfer-prohibited procedure.**
- **Transfer-allowed procedure.**
- **Transfer-restricted procedure.**
- **Signalling-route-set-test procedure.**
- **Transfer-controlled procedure .**

- **Signalling-route-set-congestion-test procedure.**

The signaling transport for TCAP applications (e.g., query/response applications) involves support and use of the SCCP protocol in addition to the MTP protocol by network elements providing interconnection for TCAP applications.

R-5 The SG network elements providing signaling SCCP interconnection between the SS7 network and the IP-based NGN for TCAP applications are required to support an SCCP interface as specified in [ATIS-1000112].

6.2 SS7 Application Layer Protocols (TCAP and ISUP)

The application layer is not within the scope of this document. However, for completeness, it is noted that a SG providing signaling interconnection between the SS7 network and the IP-based NGN based on a SS7 Signaling Termination Architecture (see Section 5.2) will support ISUP as specified in [ATIS-1000113]. Also, a SG providing signaling interconnection between the SS7 network and IP-based NGN for TCAP applications based on a SS7 Signaling Termination Architecture (see Section 5.2) will support TCAP as specified in chapters T1.114.1 through T1.114.4 of [ATIS-1000114].

6.3 IP Transport Network Interface Requirements

The following general requirements are applicable to the NGN side of SGs that are providing signaling interconnection between PSTN/SS7 and NGN:

R-6 The SG is required to support the IP-based transport network interface as specified in the applicable protocols:

- **[IETF RFC 791], *Internet Protocol – DARPA Internet Program Protocol Specification*.**
- **[IETF RFC 793], *Transmission Control Protocol – DARPA Internet Program Protocol Specification*.**
- **[IETF RFC 768], *User Datagram Protocol*, J. Postel, ISI.**

R-7 The SG providing SS7 over IP transport signaling associations is required to support an interface to the IP-based transport network using the Stream Control Transmission Protocol (SCTP) as specified in [IETF RFC 4960].

R-8 The SG providing SS7 over IP transport is required to support an interface to the IP-based transport network using applicable SS7 Adaptation protocol(s):

- **[IETF RFC 3331], *Signaling System 7 (SS7) Message Transfer Part 2 (MTP2) - User Adaptation Layer*.**
- **[IETF RFC 4165], *Signaling System 7 (SS7) Message Transfer Part 2 (MTP2) - User Peer-to-Peer Adaptation Layer (M2PA)*.**
- **[IETF RFC 4666], *Signaling System 7 (SS7) Message Transfer Part 3 (MTP3) - User Adaptation Layer (M3UA)*.**
- **[IETF RFC 3868], *Signaling Connection Control Part User Adaptation (SUA)*.**

6.4 IP Network Application Layer (SIP)

The application layer is not within the scope of this document. However, for completeness, it is noted that SG providing signaling interconnection between the SS7 network and IP-based NGN based on a SS7 Signaling Termination Architecture (see Section 5.2) will support the SIP protocol on the interface on the NGN side.

6.5 Interworking Requirements

The SG will terminate SS7 links on its SS7 side and transport the SS7 call control and service control protocols (i.e., ISUP and TCAP) to the IP nodes in the NGN. Similarly, the SG will receive SS7 call control and service control messages from the IP nodes in the NGN, and is responsible for the appropriate formatting of the messages for transmission on the SS7 links. To enable seamless operation end-to-end, the SG has to provide the necessary interworking functions between the transport protocols on its SS7/PSTN side and its IP/NGN side. This also includes necessary functions to interwork the MTP/SCCP network management procedures on its SS7 side with the management procedures of the transport connections between the SG and the IP nodes in the NGN. This function is viewed as an implementation-specific function and will depend on vendor-specific solutions. Specifically, the SG should be capable of taking specific actions based on management events in the SS7 network, provide the necessary interworking actions on the transport connections to the IP nodes in the NGN, and inform the IP Nodes in the NGN to take certain actions depending on these interworking actions.

The following general requirements are applicable to interworking network management protocol and procedures at the SG providing interconnection between the PSTN and the NGN:

R-9 The SG shall support functions and procedures to enable seamless end-to-end interworking and interoperability between SS7 transport and IP transport networks. This includes, but is not limited to, functions and procedures to handle events related to:

- **Signaling node failure and recovery.**
- **Signaling node congestion.**
- **Signaling routes failure and recovery.**
- **SIP signaling routes congestion.**
- **Internal node congestion control.**

Section 7 provides additional guidelines for SS7 and IP Transport Network Signaling Interworking.

6.5.1 Signaling Point Code (SPC) Assignment

The SS7 MTP3 signaling management procedures are based on the use of a unique SPC to identify the affected point code for which the signaling control procedure applies. The IP Nodes in the NGN may not be addressed by SPCs, resulting in difficulties having effective management control procedures end-to-end for certain implementation and deployment scenarios. Consider the example where a SG assigned a single SPC in the PSTN is used to route messages to multiple IP Nodes in the NGN. If a single IP Node was to fail, there is no effective means to control the traffic destined to the failed IP Node back at the source SEPs in the SS7 network without impacting all SS7 traffic arriving at the SG. An example approach to address this problem would be to assign multiple SPCs to the SG and use accordingly to allow signaling management control of the individual signaling relationships with the associated IP Nodes. However, although use of multiple SPCs is possible, there is no mandatory requirement for the support or use of multiple SPCs.

The design and deployment of the SG together with the associated IP Nodes in the NGN should take into account appropriate measures to ensure that the MTP3 signaling route management procedures for availability and congestion control are supported as intended.

O-1 It is an objective that the NGN provider takes into account appropriate measures to ensure that the MTP3 signaling route management procedures for availability and congestion control are supported as intended as part of the design and deployment of the SG together with the associated IP Nodes in the NGN. Specifically, signaling point codes should be assigned to the SG so that the MTP3 management are supported as intended by the protocol specification [ATIS-1000111].

6.6 Performance Objectives

The performance objectives for SS7 transport network are specified in chapter T1.111.6 of [ATIS-1000111]. The SG MTP interface should adhere to the performance requirements specified for MTP in chapter T1.111.6 of [ATIS-1000111] independent of whether the SG is assigned one or multiple SPCs in the PSTN.

6.7 Security Requirements and Objectives

It is necessary that appropriate security measures be taken to protect the integrity, confidentiality, and availability of the signaling control procedures provided by the SG.

[ATIS-1000012] provides SS7 network and NNI interconnection security requirements and guidelines.

> **R-10 The SG shall support the security requirements and objectives specified in [ATIS-1000012] as appropriate based on the NGN provider security policy.**

[IETF RFC 3788] discusses how Transport Layer Security (TLS) and IPsec can be used to secure communication for SIGTRAN protocols.

> **R-11 The SG shall support and use capabilities to secure SIGTRAN communications as appropriate based on the NGN provider security policy.**

[ATIS-1000029] provides NGN security requirements. Given that the SG is viewed as a network element of the NGN, the security requirements are also applicable [ATIS-1000029].

> **R-12 The SG shall support security requirements specified in [ATIS-1000029] as appropriate based on the NGN provider security policy.**

7 Guidelines for SS7 & IP Transport Network Signaling Interworking

7.1 Overview

This section provides guidelines for SS7 and IP Transport Network Signaling Interworking focusing on actions to be taken by SG network elements.

This section is organized based on the following grouping of the SS7 signaling route management procedures:

1. Guidelines for Availability Control.
2. Guidelines for Congestion Control.

7.2 Guidelines for Signaling Route Availability Control

7.2.1 Overview

This section provides guidelines related to signaling route availability procedures. The MTP3 procedures related to signaling route availability control are:

- Transfer-prohibited (TFP) control procedure.
- Transfer-allowed (TFA) control procedure.
- Transfer-restricted (TFR) control procedure.
- Signalling-route-set-test procedure.

The precise criteria for handling interworking of the signaling route availability control procedures between the SS7 transport network and the IP transport network are dependent on the particular SG implementation, the protocols employed (e.g., SCTP, M2PA, M2UA, M3UA, or SUA) and deployment scenario.

7.2.1.1 SS7 Transport Network Availability Control Procedures

As stated in Section 6, the SG is required to support the MTP3 signaling route availability control procedures as specified in chapter T1.111.4 of [ATIS-1000111].

The effectiveness of the MTP signaling route availability control procedures will depend on the network architecture design and signaling point code assignment to the SG.

The following best practice guidelines should be taken into consideration:

1. Appropriate measures should be taken for the SG implementation and the SG deployment architecture design to ensure the effectiveness of the MTP signaling route availability control procedures on the SS7 side.
2. Appropriate engineering measures should be taken in the deployment design of both the SG and associated IP nodes so that the MTP3 signaling route availability control procedures (TFP, TFA, and TFR) in the SS7 network is effective. Specifically:
    a. Measures should be taken to ensure that appropriate action is taken by the SG, or the nodes in the IP network, or both depending on the network architecture design to ensure that the MTP signaling route avaiability control procedure is effective in controlling signaling traffic to the affected destination identified in received TFP, TFR, and TFA as intended by the MTP specification.
    b. If the traffic is not controlled at the sources (i.e., nodes in the NGN/IP network), appropriate engineering measures should be implemented at the SG to ensure that the MTP signaling route availability control procedures are effective in controlling signaling traffic to the affected destination identified in received TFP, TFR, and TFA messages as intended by the MTP specification.
3. Appropriate engineering measures should be taken in the deployment design of both the SG and associated IP nodes to ensure that appropriate action is taken by the SG, or the nodes in the IP network, or both (i.e., SG together with the associated IP node) depending on the network architecture design to ensure that the signalling-route-set-test procedure is effective as intended by the MTP specification.

7.2.1.2 Loss of SS7 Network Connectivity

Failure events are possible resulting in loss of the SG connectivity to the SS7 network. In addition, local failure of the SG's MTP may occur, which result in loss of connectivity to the SS7 network. If loss of connectivity to the SS7 network occurs, appropriate actions must be taken on the SG IP/NGN interface and the IP Node to stop the traffic. Note that the notification from MTP3 that SS7 connectivity has been lost and the detection of local MTP failure are implementation-dependent. The following guidelines should be considered regarding detection and notification of loss of connectivity to the SS7 network:

- The SG should support the capability to monitor the status of the local MTP3 availability and conveying status changes to the IP Nodes. Upon detection of MTP3 failure (and thus loss of connectivity to the SS7 network), the SG should notify the IP Node that connectivity to the SS7 network has been lost. The methods for monitoring the local MTP3 and providing notifications to the IP Node are implementation-dependent.
- Upon detection that the local MTP3 (which has previously failed) has been restored, the SG should notify the IP Node that connectivity to the SS7 network has been restored. The methods for monitoring the local MTP3 and providing notifications to the IP Node are implementation-dependent.

7.2.1.3 Loss of IP/NGN Node Network Connectivity

Failure events are possible that result in the SG loss of connectivity to the IP network. When all SG connectivity to the IP network is lost, action must be taken on the SS7 interface to restrict the traffic being received from the SS7 network. Note that the detection and notification that the IP network connectivity has been lost are implementation-dependent. The following guidelines should be considered regarding the SG loss of connectivity to the IP network:

- The SG should be capable of detecting loss of connectivity to the IP network and notifying MTP3 on the SS7 side to take appropriate actions. The methods for detection of IP network connectivity loss and providing notifications to MTP3 on the SS7 side are implementation-dependent.
- The SG should be capable of detecting that connectivity has been restored to the IP network (which was previously inaccessible) and notifying MTP3 on the SS7 side of the restored connectivity. The methods for detection of connectivity restoral and providing notification to MTP3 on the SS7 side are implementation-dependent.

7.3 Guidelines for Signaling Route Congestion Control

7.3.1 Overview

This section provides guidelines related to signaling route congestion control procedures. The MTP3 procedures related to signaling route congestion control are:

- Transfer-controlled (TFC) procedure.
- Signalling-route-set-congestion-test procedure.

7.3.2 SG Internal Node Congestion Control

Situations can arise in which the signaling message handling functions at a SG cannot handle messages at the rate they are received at the SG. Such situations may result, for example, from a surge of traffic (either to or from the SS7 network) or from failures that reduce message handling capacity (e.g., MTP linkset failures or failures in the IP network). A SG should be able to control the traffic that is destined for the overloaded resources performing message handling functions in these situations. The SS7 protocol provides procedures that should be used to deal with such overload situations. Likewise, protocols (e.g., SCTP) used on the NGN/IP side may offer some congestion avoidance procedures.

A SG's first defense against an overload of the message handling function is to reduce the rate at which incoming messages are accepted to the rate that the message handling functions can process without overload. The precise criteria for handling internal overload situations are dependent on the particular SG implementation and deployment scenario. The following guidelines are applicable:

1. The SG should be able to detect when the resources associated with signaling message handling are in danger of becoming overloaded. The method used to detect overload, while supplier dependent, should be such that congestion controls can be performed by the SG to prevent internal overload conditions to result in failures.
2. If the congestion occurs for traffic directed towards the NGN/IP side (from the SS7 network), the SG should execute congestion control procedures on the SS7 network side (i.e., the MTP Level 2 flow control procedures and/or TFC procedures) as appropriate.
3. If congestion occurs for traffic directed towards the SS7 network (from the nodes in the NGN/IP network side), the SG should execute congestion avoidance/congestion control procedures as appropriate on the NGN/IP network side (e.g., SCTP congestion avoidance procedures if applicable).

NOTE: This ATIS standard does not address upper layer protocol and procedures for congestion control (i.e., ISUP Automatic Call Control and TCAP Automatic Call Gap controls).

7.3.3 Interworking Between SS7 Transport Network and IP Transport Network Congestion Control Procedures

Nodes in the SS7 network or the signaling routes to a destination may become congested resulting in the need to “throttle-back” or reduce traffic. Similarly, it is possible that nodes in the NGN/IP network or the IP routes to the end nodes in the NGN/IP network may become congested resulting in the need to throttle-back or reduce traffic.

The precise criteria for handling interworking of the congestion control procedures between the SS7 transport network and the IP transport network are dependent on the particular SG implementation, the protocols employed (e.g., SCTP, M2PA, M2UA, M3UA, or SUA) and deployment scenario.

7.3.3.1 SS7 Transport Network Congestion Control Procedures

As stated in Section 6, the SG is required to support the MTP congestion control procedures as specified in chapter T1.111.4 of [ATIS-1000111].

The effectiveness of the MTP congestion control procedures will depend on the network architecture design and signaling point code assignment to the SG.

The following best practice guidelines should be taken into consideration:

1. Appropriate measures should be taken for the SG implementation and the SG deployment architecture design to ensure the effectiveness of the MTP congestion control procedures on the SS7 side.
2. Appropriate engineering measures should be taken in the deployment design of both the SG and associated IP nodes so that the TFC procedure in the SS7 network is effective. Specifically:
    a. Measures should be taken to ensure that appropriate action is taken by the SG, the nodes in the IP network, or both depending on the network architecture design, to ensure that the MTP congestion control procedure is effective in controlling signaling traffic to the affected destination identified in received TFCs as intended by the MTP specification.
    b. If the traffic is not controlled at the sources (i.e., nodes in the NGN/IP network), appropriate engineering measures should be implemented at the SG to ensure that the MTP congestion control procedure is effective in controlling signaling traffic to the affected destination identified in received TFCs as intended by the MTP specification.
3. Appropriate engineering measures should be taken in the deployment design of both the SG and associated IP nodes so that the signalling-route-set-congestion-test procedure in the SS7 network is effective. Specifically, Measures should be taken to ensure that appropriate action is taken by the SG, the nodes in the IP network, or both (i.e., SG together with the associated IP node) depending on the network architecture design, to ensure that the signalling-route-set-congestion-test procedure is effective as intended by the MTP specification.

7.3.3.2 NGN/IP Transport Network Congestion Control Procedures

It is possible that the nodes or signaling routes in NGN/IP network may become congested. In such scenarios, it will be better to reduce traffic at the sources (i.e., signaling end points in the SS7 network).

The effectiveness of the MTP congestion control procedures will depend on the network architecture design and signaling point code assignment to the SG.

The following best practice guidelines should be taken into consideration:

1. Appropriate measures should be taken for the SG implementation and deployment architecture design to allow the use and effectiveness of the MTP congestion control procedures on the SS7 side to control signaling traffic at the sources in the SS7 network when the signaling routes and/or nodes in the NGN/IP network is congested.
2. If the SG is deployed as a SEP in the SS7-based PSTN , sending of TFC messages is optional. If it deployed as an STP in the SS7-based PSTN, the capability to send TFC messages is mandatory. Appropriate engineering measures should be taken into consideration in the deployment design of both the SG and associated IP nodes so that the MTP congestion control procedure (i.e., TFC

procedure) can be used in the SS7 network to control traffic at the sources when congestion occurs for the signaling routes in the NGN/IP network or at the nodes in the NGN/IP network. Specifically:

a. Measures should be taken to ensure that appropriate action is taken by the SG, the nodes in the IP network, or both depending on the network architecture design, to ensure that the MTP congestion control procedure is effective in sending TFC messages to control traffic at the sources.

b. If the SG is not using the MTP congestion control procedure on the SS7 side when there is congestion on the IP/NGN side (i.e., nodes in the NGN/IP network), appropriate engineering measures should be implemented at the SG to ensure that the incoming signaling traffic is controlled by the SG to avoid propagating the congestion further.

8 Informative References[4]

Telcordia Technologies GR-3021-CORE, *Generic Requirements for CCS Nodes Supporting M2PA Links*.

Telcordia Technologies GR-3053-CORE, *Voice over Packet (VoP): Next Generation Network (NGN) Signaling Gateway Generic Requirements*.

[4] Telcordia documents are available from Industry Direct Sales, Telcordia, 8 Corporate Place, PYA 3A-184, Piscataway, NJ, 08854-4156, or: < http://telecom-info.telcordia.com >.