ATIS-1000051

TCAP GATEWAY FUNCTIONALITY

TECHNICAL REPORT

As a leading technology and solutions development organization, ATIS brings together the top global ICT companies to advance the industry's most-pressing business priorities. Through ATIS committees and forums, nearly 200 companies address cloud services, device solutions, M2M communications, cyber security, ehealth, network evolution, quality of service, billing support, operations, and more. These priorities follow a fast-track development lifecycle—from design and innovation through solutions that include standards, specifications, requirements, business use cases, software toolkits, and interoperability testing.

ATIS is accredited by the American National Standards Institute (ANSI). ATIS is the North American Organizational Partner for the 3rd Generation Partnership Project (3GPP), a founding Partner of oneM2M, a member and major U.S. contributor to the International Telecommunication Union (ITU) Radio and Telecommunications sectors, and a member of the Inter-American Telecommunication Commission (CITEL). For more information, visit < www.atis.org >.

ATIS-1000051, *TCAP Gateway Functionality*

Is an ATIS Standard developed by the **Signaling, Architecture, and Control (SAC) Subcommittee** under the **ATIS Packet Technologies and Systems Committee (PTSC)**.

Published by

Alliance for Telecommunications Industry Solutions
1200 G Street, NW, Suite 500
Washington, DC 20005

ATIS-1000051

Technical Report on

TCAP Gateway Functionality

Alliance for Telecommunications Industry Solutions

Approved July 2012

Abstract

This Technical Report (TR) addresses the complementary interworking between SS7 TCAP and IP for the purposes of remote operations application-level messaging.

Foreword

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers. 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, PTSC, which was responsible for its development, had the following leadership:

M.Dolly, PTSC Chair (AT&T)

V. Shaikh, PTSC Vice-Chair (Applied Communications Sciences)

M. Dolly, PTSC SAC Chair (AT&T)

R. Singh, Technical Editor (Applied Communications Sciences)

M.Dolly, Technical Editor (AT&T)

Z. Zeltsan, Technical Editor (Alcatel-Lucent)

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

Table of Contents

Table of Figures

Technical Report on –

TCAP Gateway Functionality

1 Introduction

Interworking between SS7 ISUP and IP for the purposes of call setup is described in [ATIS-1000679]. Interworking between SS7 routing and management at the MTP/SCCP level is described in [ATIS-1000047]. This Technical Report (TR) addresses the complementary interworking between SS7 TCAP and IP for the purposes of remote operations application-level messaging.

By nature, Remote Operations signaling is end-to-end. As such, there is no inherent need for mapping the standard TCAP operations, parameters, and error codes of the TCAP Component Portion at the SS7/IP interface, as long as the IP-based application implements those operations, parameters, and error codes using the TCAP encoding. Similarly, the Dialogue Portion primarily provides information that could be used in securing the Component Portion. As such, the information is used at the end points and is not needed at the Gateway.

Both ISUP and TCAP require an association between the two end points; in the case of ISUP, a call identifier. The TCAP association is established at two levels:

- *At the component level*, there is a need to associate the response to the original request for performance of the TCAP operation.
- *At the transaction level*, there is a need to associate all of the TCAP messages of the conversation with each other. This may, for example, include multiple requests for the performance of TCAP operations or responses to requests that invoke TCAP operations in their own right.

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

[ATIS-1000110.1999] ATIS-1000110.1999 (R2010), *Signalling System Number 7 (SS7) — General Information*.[1]

[ATIS-1000114] ATIS-1000114.2004 (R2009), *Signalling System Number 7 (SS7) – Transaction Capabilities Application Part (TCAP)*.[1]

[ATIS-1000679] ATIS-1000679.2004 (R2010), *Interworking between Session Initiation Protocol (SIP) and Bearer Independent Call Control or ISDN User Part*.[1]

[ATIS-1000047] ATIS-1000047, *Signaling System 7 (SS7) and Internet Protocol (IP) Transport Networks Signaling Interworking and Compatibility*.[1]

[RFC 3868] RFC 3868, *Signalling Connection Control Part User Adaptation Layer (SUA)*.[2]

[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 >

3 Acronyms

ACG	Automatic Code Gap
AS	(IP) Application Server
ATM	Asynchronous Transfer Mode
CLDT	Connectionless Data Transfer
DB	Database
ID	Identifier
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISUP	(SS7) ISDN User Part
MTP	(SS7) Message Transfer Part
NGN	(IP-based) Next Generation Network
SAAL	Signaling ATM Adaptation Layer
SCCP	(SS7) Signalling Connection Control Part
SIP	Session Initiation Protocol
SS7	(ANSI) Signalling System 7
SUA	SCCP User Adaptation
TC	Transaction Capabilities
TCAP	(SS7) Transaction Capabilities Application Part
TR	Technical Report

4 Scope

Interworking between SS7 ISUP and IP for the purposes of call setup is described in [ATIS-1000679]. This Technical Report (TR) addresses the complementary interworking between SS7 TCAP and IP. Therefore, this TR considers the cases of:

1. An IP Application Server transaction to a circuit domain Data Base (DB), where the application information is conveyed in SS7 TCAP.
2. A circuit domain originated transaction to an IP Application Server (AS), where the application information is conveyed in the circuit domain using SS7 TCAP.

The scope of this TR includes inter-domain interoperability under normal and abnormal or error situations.

Inter-domain transport protocol interworking between SS7 MTP/SCCP and IP is described in [ATIS-1000047].

5 Architecture

The SS7 protocol stack is shown in Figure 1.

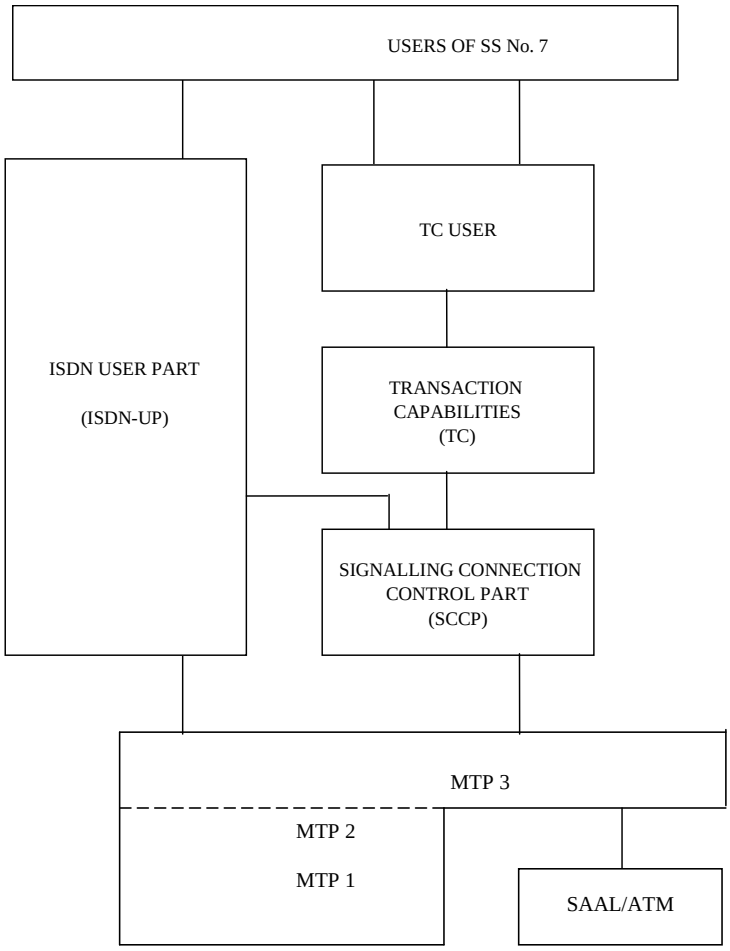

Figure 1 - Architecture of SS7

As detailed in [ATIS-1000114], the Transaction Capabilities Application Part is further decomposed into three Portions:

1. The Transaction Portion identifies the ”type” of Remote Operations conversation (or Transaction) and supplies the identifiers that correlate successive messages within the conversation with each other. ANSI TCAP supports seven Package Types:
    a. *Unidirectional.* A message with this Package Type sends information in one direction only with no reply expected. No TCAP Transaction is established.
    b. *Query With Permission.* A message with this Package Type initiates a TCAP transaction and informs the destination node (i.e., the node that receives the message) that it may end the TCAP transaction.
    c. *Query Without Permission.* A message with this Package Type initiates a TCAP transaction and informs the destination node that it may not end the TCAP transaction.
    d. *Response.* A message with this Package Type ends the TCAP transaction.
    e. *Conversation With Permission.* A message with this Package Type is the continuation of a TCAP transaction and informs the destination node that it may end the TCAP transaction.
    f. *Conversation Without Permission.* A message with this Package Type is the continuation of a TCAP transaction and informs the destination node that it may not end the TCAP transaction.

g. *Abort.* A message with this Package Type informs the destination node that the sending node has terminated an established TCAP transaction without sending any pending components that may be expected due to a prior message.

Note that, in practice, either side of the Transaction may terminate the Transaction at any time. The concept of “With Permission” and “Without Permission” is purely advisory and application processing of a Query or Conversation “With Permission” is the same as processing of the same message “Without Permission.”

2. The optional Dialogue Portion may include information that:

   a. Identifies the version of SS7 being used.

   b. Provides an Application Context in which the Component Portion may be interpreted.

   c. Contains User Information – e.g., to refine the Application Context.

   d. Provides a Security Context in which the Confidentiality Information that follows may be interpreted.

   e. Contains Confidentiality Information that identifies the confidentiality algorithm to be used and provides any additional required information related to the algorithm.

3. The Component Portion carries the Remote Operation(s) Operation Protocol Data Units (Components) that reflect application activities. ANSI TCAP supports six Component Types:

   a. *Invoke (Last).* This is used to invoke an operation (such as requesting a database to perform digit translation). When the Invoke Component contains a Correlation ID, "Last" indicates no further responding Components. When the Invoke Component does not contain a Correlation ID, it is always coded "Last".

   b. *Return Result (Last).* This is used to return the results of an invoked operation. "Last" indicates that no further responding Components are expected.

   c. *Return Error.* This reports the unsuccessful completion of an invoked operation.

   d. *Reject.* This reports the receipt and rejection of an incorrect Package or Component other than another Reject Component.

   e. *Invoke (Not Last).* This is similar to the Invoke described in Item (1), except that further responding Components are expected.

   f. *Return Result (Not Last).* This is similar to the Return Result described in Item (2), except that further responding Components are expected.

An example of the exchange of multiple Components within one TCAP Transaction is shown in Figure 2.

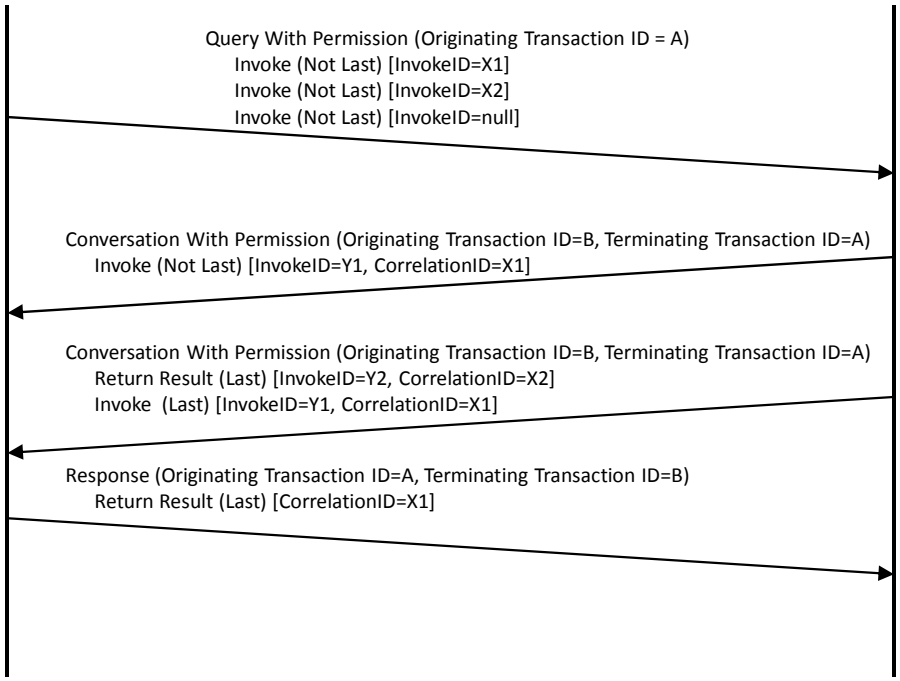

Figure 2 - Example of the Exchange of Multiple Components Within One TCAP Transaction

1. Side A sends a single TCAP message (identified at Side A by the Transaction Identifier A) invoking three operations at Side B:
    a. The operations with the Component identifiers X1 and X2 anticipate responses from Side B. The operation with no Component identifier (InvokeID=null) does not anticipate a response from Side B.
2. Side B completes the operation with no Component identifier. No indication is returned to Side A. Side B completes a portion of the operation X1 and returns a partial reply (therefore, using an Invoke, Not Last), adding its identifier (Y1) to the Component so that any reply from Side A may be correlated appropriately at Side B. This message flow does not include such a reply.
3. Side B completes operation X2 and sends the full reply in a Return Result (Last). Side B closes its state machine for operation X2 and therefore does not include a Component Identifier from its perspective.

    At the same time, application processing at Side B of operation X1 calls for involves invoking an additional action from Side A. Therefore, the message from Side B includes an Invoke (Last) (to indicate completion of operation X1) with Component Identifier X1 (which Side A will use to idle the state machine for the operation X1) and Component Identifier Y1 (which Side A will use to start a new state machine for this operation.)
4. Side A completes operation Y1 and sends the reply in a Return Result (Last).

Through this process, the Transaction Portion Identifiers (A from the perspective of Side A, and B from the perspective of Side B) correlate all of these messages with each other.

5.1 SS7 TCAP to IP Interworking Considerations

SS7 TCAP may be effectively ”encapsulated” and sent to an IP destination using SUA [RFC 3868][3]. In this case, the Common Header is encoded as follows:

- The SUA Protocol Version will be 1 (SUA version 1.0).
- The Message Class will be 7 (Connectionless Messages).
- The Message Type will be1 [Connectionless Data Transfer (CLDT)] .

The parameters of a CLDT message are encoded following the guidance in [Technical Requirements for SS7 and IP Transport Network Signaling Interworking Technical Report]. The Data of the CLDT message is encoded with the complete SS7 TCAP message, comprised of the Component Portion, Dialogue Portion (if received), and Transaction Portion.

Routing Context	Derived from SCCP
Protocol Class	Derived from SCCP
Source Address	Derived from SCCP
Destination Address	Derived from SCCP
Sequence Control	Derived from SCCP
SS7 Hop Count	Not used
Importance	Not used
Message Priority	Derived from MTP and SCCP
Correlation ID	Not used (Note 1)
Segmentation	Not used (Note 2)
Data	Complete SS7 TCAP message, comprised of the Component Portion, Dialogue Portion (if received), and Transaction Portion

NOTE 1: This assumes the Gateway is not maintaining the Transaction state. If the Gateway does maintain a Transaction state, this could be populated and the Data Portion could be comprised of the Component Portion only.

If an SS7 TCAP Conversation or Response message includes a Component with an operation of Automatic Code Gap (ACG) Indicators, the Component will be passed to the destination application in the IP-based Next Generation Network (NGN). Since the ACG is an endpoint-to-endpoint control, this results in the expected congestion mitigation activity in both networks. Since the destination application will act on the ACG (limiting its rate of sending messages toward the sender of the ACG), it is desirable that the Gateway not apply its own code gap procedures, even if the Gateway is maintaining the Transaction state.

An exception to this rule would apply if the Gateway were to also maintain the status of individual congested SS7 signaling end points, applying the code gap procedures to IP-based messages destined for a congested SS7 signaling end point, and not mapping received SS7 ACG operations into IP-based signaling. That is, the code gap procedure should be applied only at the Gateway and further congestion controls should not be invoked in the NGN.

[33] Various mappings of SS7 TCAP messages to IP messages (e.g., SIP INVITE and related response headers) may be envisioned. Such mechanisms are simplified if it is known that each TCAP Transaction consists of: a) a single Unidirectional message; or b) a single Query with only one Invoke component, where the invoked operation generates a single Response with one Return Result component. Without such simplifications, the SS7-IP mapping may require maintenance of Transaction and Component level state machines at the Gateway.

NOTE 2: Segmentation is not used, based on the assumption that the Gateway will reassemble a segmented TCAP message that is received and will provide the complete TCAP message in the Data of the CLDT message. Therefore, the Gateway must also support the capability of sending a segmented TCAP message into the SS7 network if the received CLDT contains a long TCAP message in its Data.

5.2 IP to SS7 TCAP Interworking Considerations

As noted in section 5.1, SS7 TCAP may be effectively encapsulated [4]. In this case, the Data portion of the CLDT message may be extracted and forwarded to the appropriate SS7 destination. If the encapsulated SS7 TCAP Conversation or Response message includes a Component with an operation of Automatic Code Gap (ACG) Indicators, the Component will be passed to the SS7 destination application. Since the ACG is an endpoint-to-endpoint control, this results in the expected congestion mitigation activity in both networks. The Gateway should not apply its own code gap control, even if it is maintaining the Transaction state.

If:

a) The Gateway is maintaining the Transaction state, and

b) The IP side is not including ACG Indicators operations in its messaging, or the Gateway is removing received ACG Indicators operations from the received Data portion,

…then it may be desirable for the Gateway to incorporate a Component with an ACG Indicators operation into SS7 TCAP messages from an IP-based node experiencing congestion. The mechanism by which the Gateway would determine that a particular IP-based node is experiencing congestion and the mechanism by which the Gateway would set the fields of the ACG parameter and maintain the congestion status of the IP-based node would be implementation-dependent.

[4] If a network elects to provide a specific mapping of SS7 TCAP messages to IP messages (e.g., SIP INVITE and related response headers), it is recommended that the reverse mapping (IP to SS7) be unambiguous. Such mechanisms are simplified if it is known that each TCAP Transaction consists of: a) a single Unidirectional message; or b) a single Query with only one Invoke component, where the invoked operation generates a single Response with one Return Result component. Without such simplifications, the SS7-IP mapping may require maintenance of Transaction and Component level state machines at the Border Element.