# 26

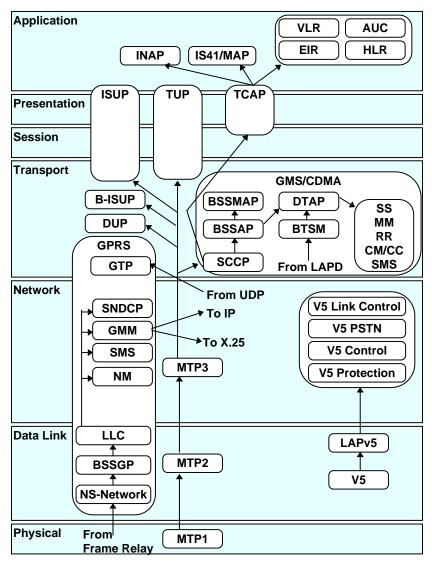
# SS7 Suite

CCITT developed the Signalling System 7 (SS7) specification. SS7 is a common channel signalling system. This means that one channel is used only for sending the signalling information, whether the system has one bearer channel or multiple bearer channels. The hardware and software functions of the SS7 protocol are divided into layers which loosely correspond to the OSI 7 layer model.

This chapter describes the following SS7 protocols:

- MTP-2 Message Transfer Part Level 2.
- MTP-3 Message Transfer Part Level 3.
- SCCP: Signalling Connection Control Part.
- DUP: Data User Part.
- ISUP: ISDN User Part.
- TUP: Telephone User Part.
- TCAP: Transaction Capabilities Application Part.
- MAP: Mobile Application Part.

The following diagram illustrates the SS7 protocol suite in relation to the OSI model:



SS7 in relation to the OSI model

# MTP-3

Q.704 http://www.itu.ch/itudoc/itu-t/rec/q/q500-999/q704\_27792.html

Message Transfer Part - Level 3 (MTP-3) connects Q.SAAL to the users. It transfers messages between the nodes of the signalling network. MTP-3 ensures reliable transfer of the signalling messages, even in the case of the failure of the signalling links and signalling transfer points. The protocol therefore includes the appropriate functions and procedures necessary both to inform the remote parts of the signalling network of the consequences of a fault, and appropriately reconfigure the routing of messages through the signalling network.

The structure of the MTP-3 header is shown in the following illustration:

Service indicator	Subservice field
4 bits	4 bits

MTP-3 header structure

#### Service indicator

Used to perform message distribution and in some cases to perform message routing. The service indicator codes are used in international signalling networks for the following purposes:

- Signalling network management messages.
- Signalling network testing and maintenance messages.
- SCCP.
- Telephone user part.
- ISDN user part.
- Data user part.
- Reserved for MTP testing user part.

#### Sub-service field

The sub-service field contains the network indicator and two spare bits to discriminate between national and international messages.

# MTP-2

Q.703 http://www.itu.int/itudoc/itu-t/rec/q/q500-999/q703\_24110.html ANSI T1.111 199

Message Transfer Part - Level 2 (MTP-2) is a signalling link which together with MTP-3 provides reliable transfer of signalling messages between two directly connected signalling points.

The format of the header is shown in the following illustration:

7	<u>8 b</u> it
Flag	
BSN (7 bits)	BIB
FSN (7 bits)	FIB
LI (6 + 2 bits)	
SIO	
SIF	
Checksum (16 bits)	
Flag	

MTP-2 header structure

#### **BSN**

Backward sequence number. Used to acknowledge message signal units which have been received from the remote end of the signalling link.

#### BIB

Backward indicator bit. The forward and backward indicator bit together with forward and backward sequence number are used in the basic error control method to perform the signal unit sequence control and acknowledgment functions.

#### **FSN**

Forward sequence number.

#### FIB

Forward indicator bit.

# LI

Length indicator. This indicates the number of octets following the length indicator octet.

# SIO

Service information octet.

### **SIF**

Signalling information field.

### Checksum

Every signal unit has 16 check bits for error detection.

# SCCP

Q.713 http://www.itu.int/itudoc/itu-t/rec/q/q500-999/q713\_23786.html ANSI T1.112

The Signalling Connection Control Part (SCCP) offers enhancements to MTP level 3 to provide connectionless and connection-oriented network services, as well as to address translation capabilities. The SCCP enhancements to MTP provide a network service which is equivalent to the OSI Network layer 3.

The format of the header is shown in the following illustration:

	Octets
Routing label	3-4
Message type code	1
Mandatory fixed part	
Mandatory variable part	
Optional part	

SCCP header structure

#### **Routing label**

A standard routing label.

# Message type code

A one octet code which is mandatory for all messages. The message type code uniquely defines the function and format of each SCCP message.

Existing Message Type Codes are:

CR Connection Request. CCConnection Confirm. CREF Connection Refused.

RLSD Released.

RLC Release Complete. DT1 Data Form 1. DT2 Data Form 2.

AK Data Acknowledgment.

UDT Unidata.

UDTS Unidata Service. ED Expedited Data.

EΑ Expedited Data Acknowledgment. RSR Reset Request. RSC Reset Confirm.

ERR Protocol Data Unit Error.

IT Inactivity Test. XUDT Extended Unidata.

XUDTS Extended Unidata Service.

### Mandatory fixed part

The parts that are mandatory and of fixed length for a particular message type will be contained in the mandatory fixed part.

### Mandatory variable part

Mandatory parameters of variable length will be included in the mandatory variable part. The name of each parameter and the order in which the pointers are sent is implicit in the message type.

#### **Optional part**

The optional part consists of parameters that may or may not occur in any particular message type. Both fixed length and variable length parameters may be included. Optional parameters may be transmitted in any order. Each optional parameter will include the parameter name (one octet) and the length indicator (one octet) followed by the parameter contents.

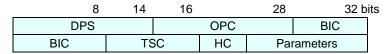
# DUP

TU-T recommendation X.61 (Q.741) http://www.itu.int/itudoc/itu-t/rec/q/q500-999/q741.html

The Data User Part (DUP) defines the necessary call control, facility registration and cancellation related elements, for international common channel signalling, by using SS7 for circuit-switched data transmission services. The data signalling messages are divided into two categories:

- Call and circuit related messages: used to set up and clear a call or control and supervise the circuit state.
- Facility registration and cancellation related messages: used to exchange information between originating and destination exchanges to register and cancel information related to user facilities.

The general format of the header of call and circuit related messages is shown in the following illustration:



DUP call and circuit related message structure

The general format of the header of Facility Registration and Cancellation Messages is shown in the following illustration:

	8	14	16	28	32 b	its
	DPS		OPC		Spare	
HC			Parameter	'S		

DUP facility registration and cancellation message structure

# Routing label

The label contained in a signalling message and used by the relevant user part to identify particulars to which the message refers. This is also used by the message transfer part to route the message towards its destination point. It contains the DPS, OPC, BIC and TSC.

#### **DPS**

Destination Point code.

#### **OPC**

Origination Point Code.

#### **BIC**

Bearer Identification Code.

#### **TSC**

Time Slot Code.

#### HC

Heading code, contains the message type code which is mandatory for all messages. It uniquely defines the function and format of each Data User Part message.

#### **Parameters**

Contains specific fields for each message. Variable length.

### **Spare bits**

Not used, should be set to 0000.



Q.763 http://www.itu.int/itudoc/itu-t/rec/q/q500-999/q763\_23976.html

ISUP is the ISDN User Part of SS7. ISUP defines the protocol and procedures used to setup, manage and release trunk circuits that carry voice and data calls over the public switched telephone network. ISUP is used for both ISDN and non-ISDN calls. Calls that originate and terminate at the same switch do not use ISUP signalling. ISDN User Part messages are carried on the signalling link by means of signal units. The signalling information field of each message signal unit contains an ISDN User Part message consisting of an integral number of octets.

The format of the ISUP packet is shown in the following illustration:

	Octets
Routing label	3-4
Circuit identification code	2
Message type code	1
Mandatory fixed part - (Parameters)	
Mandatory variable part - (Parameters)	
Optional part - (Parameters)	

ISUP packet structure

#### Routing label

The label contained in a signalling message, and used by the relevant user part to identify particulars to which the message refers. It is also used by the Message Transfer Part to route the message towards its destination point.

#### Circuit identification code

The allocation of circuit identification codes to individual circuits is determined by bilateral agreement and/or in accordance with applicable predetermined rules.

# Message type code

The message type code consists of a one octet field and is mandatory for all messages. The message type code uniquely defines the function and format of each ISDN User Part message. Each message consists of a number of parameters. Message types may be:

Address complete.

- Answer.
- Blocking.
- Blocking acknowledgement.
- Call progress.
- Circuit group blocking.
- Circuit group blocking acknowledgement.
- Circuit group query @.
- Circuit group query response @.
- Circuit group reset.
- Circuit group reset acknowledgement.
- Circuit group unblocking.
- Circuit group unblocking acknowledgement.
- Charge information @.
- Confusion.
- Connect.
- Continuity.
- Continuity check request.
- Facility @.
- Facility accepted.
- Facility reject.
- Forward transfer.
- Identification request.
- Identification response.
- Information @.
- Information request @.
- Initial address.
- Loop back acknowledgement.
- Network resource management.
- Overload @.
- Pass-along @.
- Release.
- Release complete.
- · Reset circuit.
- Resume.
- Segmentation.
- Subsequent address.

- Suspend.
- Unblocking.
- Unblocking acknowledgement.
- Unequipped CIC @.
- User Part available.
- User Part test.
- User-to-user information.

#### **Parameters**

Each parameter has a name which is coded as a single octet. The length of a parameter may be fixed or variable, and a length indicator for each parameter may be included.

```
WAN:Capture Buffer Display
                                                                                                                                                                          _ U ×
Filter:
                           All Frames
                                                                                                                                                            M Protocol: ISUP
 |Captured at:
|Length: 108
                                  +00:00.000
                                                                      Status: CD Lost
                                      From:
 | ISUP: Message Type Code: 6 Address complete
| ISUP: Backward Call Indicators | ISUP: Optional Part: | Param: Optional backward call indicators | ISUP: Param: Call reference | ISUP: Call Identity: 0x140002 | ISUP: Param: Cause indicators | ISUP: Param: Cause indicators | ISUP: Param: User-to-user indicators | ISUP: Service 3: 11... Request, Essential | ISUP: Service 2: ...11... Request, Essential | ISUP: Service 1: ...00. No Information | ISUP: Param: User-to-user information | ISUP: Param: User-to-user information | ISUP: Param: Access transport | ISUP: IE: Bearer capability |
  ISUP
                       Backward Call Indicators
                      ISUP:
  ISUP:
  ■ ISHP
  ISUP:
  ISUP
  ISUP
  ■ ISHP :
             Options...
                                                   Search...
                                                                                         Restart
                                                                                                                             Setup...
                                                                                                                                                                     <u>D</u>one
```

ISUP decode

# **TUP**

ITU-T recommendation q.723 http://www.itu.int/itudoc/itu-t/rec/q/q500-999/q763\_23976.html

In Telephone User Part (TUP) Signalling System no.7, Telephone User messages are carried on the signalling data link by means of signal units. The signalling information of each message constitutes the signalling information field of the corresponding signal unit and consists of an integral number of octets. It consists of the label, the heading code and one or more signals and/or indications. Each of these is described here.

The format of the label is shown in the following illustration:

	bits
DPC	14
OPC	14
CIC	12

TUP standard label format

#### **DPC**

Destination point code indicates the signalling point for which the message is intended.

#### **OPC**

Originating point code indicates the signalling point which is the source of the message.

#### CIC

Circuit identification code indicates one speech circuit among those directly interconnecting the destination and the originating points.

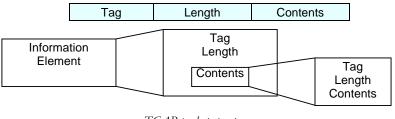
The heading code consists of two parts, heading code H0 and heading code H1. H0 identifies a specific message group, while H1 either contains a signal code or in the case of more complex messages, identifies the format of these messages.

# **TCAP**

ITU recommendation Q.773 http://www.itu.int/itudoc/itu-t/rec/q/q500-999/q773\_24880.html

TCAP (Transaction Capabilities Application Part) enables the deployment of advanced intelligent network services by supporting non-circuit related information exchange between signalling points using the SCCP connectionless service. TCAP messages are contained within the SCCP portion of an MSU. A TCAP message is comprised of a transaction portion and a component portion.

A TCAP message is structured as a single constructor information element consisting of the following: Transaction Portion, which contains information elements used by the Transaction sub-layer; a Component Portion, which contains information elements used by the Component sublayer related to components; and, optionally, the Dialogue Portion, which contains the Application Context and user information, which are not components. Each Component is a constructor information element.



TCAP packet structure

#### Information element

An information element is first interpreted according to its position within the syntax of the message. Each information element within a TCAP message has the same structure. An information element consists of three fields, which always appear in the following order.

# Tag

The Tag distinguishes one information element from another and governs the interpretation of the Contents. It may be one or more octets in length. The Tag is composed of Class, Form and Tag codes.

### Length

Specifies the length of the contents field.

#### **Contents**

Contains the substance of the element, containing the primary information the element is intended to convey.

# **TCAP Packet Types**

TCAP packet types are as follows:

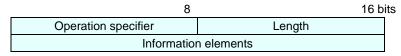
- Unidirectional.
- Query with permission.
- Query without permission.
- Response.
- Conversation with permission.
- Conversation without permission.
- Abort.



#### EIA/TIA-41 http://www.tiaonline.org

Mobile Application Part (MAP) messages sent between mobile switches and databases to support user authentication, equipment identification, and roaming, are carried by TCAP in mobile networks (IS-41 and GSM). When a mobile subscriber roams into a new mobile switching center (MSC) area, the integrated visitor location register requests service profile information from the subscriber's home location register (HLR) using MAP information carried within TCAP messages.

The packet consists of a header followed by up to four information elements. The general format of the header is shown in the following illustration. The operation specifier field, when present and length field are actually part of the TCAP message which is above MAP.



MAP header structure

### Operation specifier

Optional field which specifies the type of packet. The following operations are specified:

- AuthenticationDirective.
- AuthenticationDirectiveForward.
- AuthenticationFailureReport.
- AuthenticationRequest.
- AuthenticationStatusReport.
- BaseStationChallenge.
- Blocking.
- BulkDeregistration.
- CountRequest.
- FacilitiesDirective.
- FacilitiesDirective2.
- FacilitiesRelease.
- FeatureRequest.

- FlashRequest.
- HandoffBack.
- HandoffBack2.
- HandoffMeasurementRequest.
- HandoffMeasurementRequest2.
- HandoffToThird.
- HandoffToThird2.
- InformationDirective.
- InformationForward.
- InterSystemAnswer.
- InterSystemPage.
- InterSystemPage2.
- InterSystemSetup.
- LocationRequest.
- MobileOnChannel.
- MSInactive.
- OriginationRequest.
- QualificationDirective.
- QualificationRequest.
- RandomVariableRequest.
- RedirectionDirective.
- RedirectionRequest.
- RegistrationCancellation.
- RegistrationNotification.
- RemoteUserInteractionDirective.
- ResetCircuit.
- RoutingRequest.
- SMSDeliveryBackward.
- SMSDeliveryForward.
- SMSDeliveryPointToPoint.
- SMSNotification.
- SMSRequest.
- TransferToNumberRequest.
- TrunkTest.
- TrunkTestDisconnect.
- Unblocking.

- UnreliableRoamerDataDirective.
- UnsolicitedResponse.

# Length

The length of the packet.

# **Information elements**

Various information elements which depend on the operation specified.