Message Transfer Part (MTP)

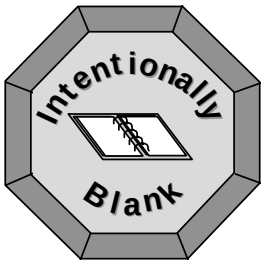
Chapter 8

This chapter is designed to provide the student with an overview of the protocol Message Transfer Part (MTP).

OBJECTIVES:

Upon completion of this chapter the student will be able to:

- describe the format of a Message Signal Unit.
- list the functions of the Message Transfer Part protocol used in a signaling network.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8 Message Transfer Part (MTP)

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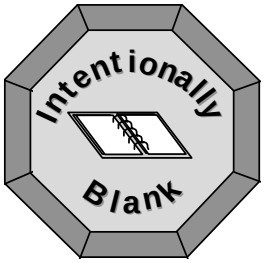
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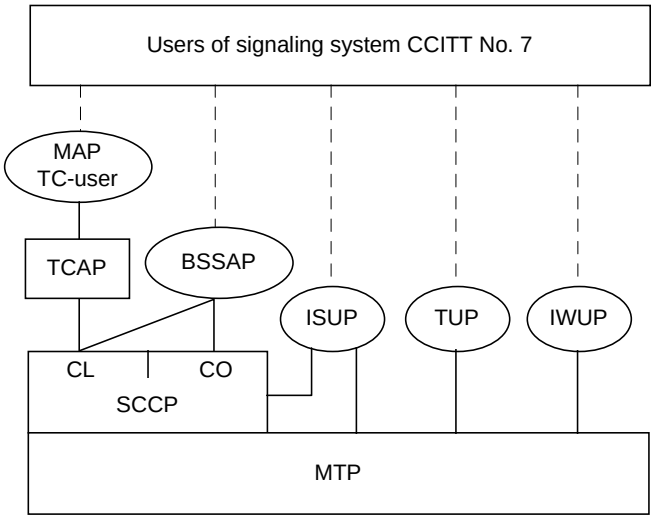
MESSAGE TRANSFER PART (MTP)

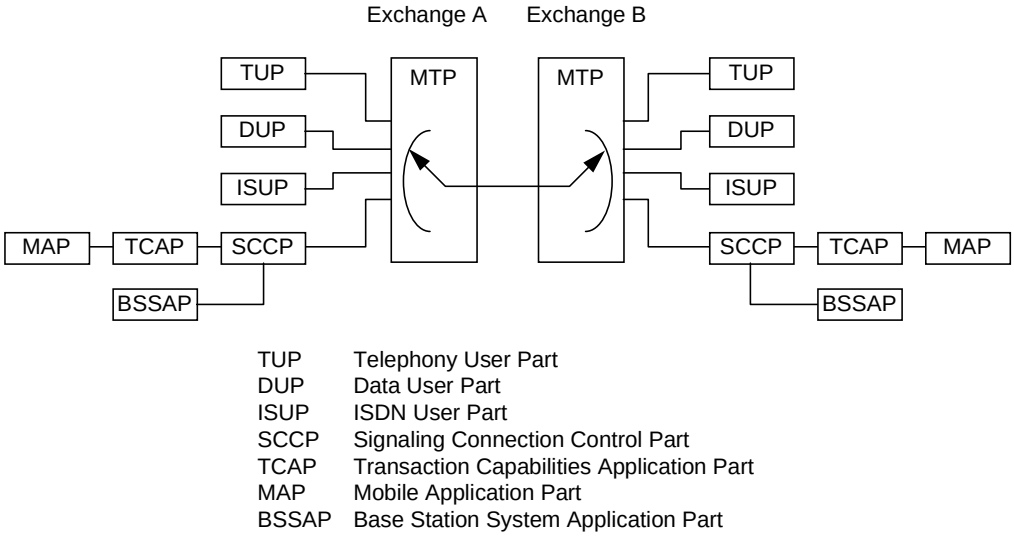
The signaling system chosen for GSM is the common channel signaling system No. 7. This means that the exchanges use a separate network for signaling. Since signaling system No. 7 is used as a means for information transmission between different users, for example, telephony or ISDN, its functions have been divided into a number of User Parts (UP), see Figure 8-1.



BSSAP	Base Station System Application Part
ISUP	ISDN User Part
IWUP	Interworking Function User Part
TUP	Telephony User Part
SCCP	Signaling Connection Control Part
MAP	Mobile Application Part
MTP	Message Transfer Part
TCAP	Transaction Capabilities Application Part
CO	Connection Oriented
CL	Connection Less

Figure 8-1 Architecture of signaling system No. 7.

Only UPs of the same type can communicate with each other. To forward signaling messages between UPs located in different nodes, the MTP is used. The user parts (see Figure 8-2) contain functions dealing with the processing of signal information before and after it is transmitted through the signaling network.



TUP	Telephony User Part
DUP	Data User Part
ISUP	ISDN User Part
SCCP	Signaling Connection Control Part
TCAP	Transaction Capabilities Application Part
MAP	Mobile Application Part
BSSAP	Base Station System Application Part

Figure 8-2 MTP, a common transport medium between users.

The MTP provides the means for reliable transport and delivery of UP information across the SS7 network. It also has the ability to react to system and network failures that affect the information from the UPs and to take the necessary action to ensure that the information is safely conveyed. Examples of MTP user parts are the ISDN User Part (ISUP), the Telephony User Part (TUP), the Signaling Connection Control Part (SCCP), the InterWorking function User Part (IWUP) and the Data User Part (DUP).

MTP is divided into three functional levels (also see Figure 8-3):

- MTP level 1 - the signaling data link functions
- MTP level 2 - the signaling link functions
- MTP level 3 - the signaling network functions

In AXE, these functions are implemented in a number of function blocks.

Level 1 Physical Level
Access the link
64 kb/s bit rate

Level 2 Link Level
Reliable transmission
Alignment
Fault detection
Correction by retransmission

Level 3 Network Level
Message handling
Network management

Figure 8-3 Message Transfer Part (MTP).

LEVEL 1 - SIGNALING DATA LINK FUNCTIONS, PHYSICAL LEVEL

Level 1 defines the physical, electrical and functional characteristics of a signaling data link and the means to access it. The level 1 element provides a bearer for a signaling link.

The signaling data link is a bi-directional transmission path for signaling messages between two signaling points. It is made up of a 64 kbps digital transmission channel and digital switches or their terminating equipment, providing an interface to signaling terminals. The digital signaling data link is shown in Figure 8-4.

The signaling data link is permanently connected through the Group Switch Device (GSD) by an exchange data command. The digital Pulse Code Device (PCD-D) demultiplexes the 2 Mbps or 1.5 Mbps PCM system into 64 kbps channels for the connection of signaling terminals (ST-7). Any channel in the Exchange Terminal Circuit (ETC), except channel 0, can be used as a signaling data link. In GSM 900/GSM 1800, channel 0 is always used for synchronization.

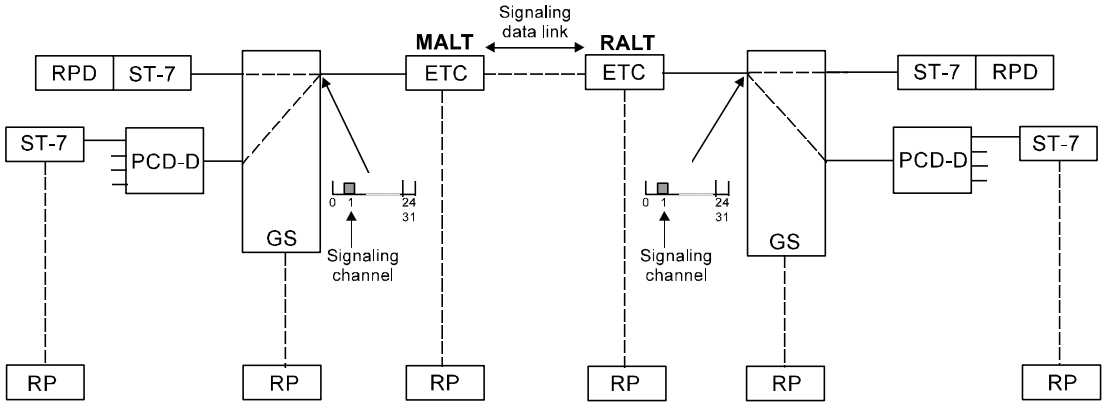


Figure 8-4 MTP connection.

LEVEL 2 - SIGNALING LINK FUNCTIONS

The data received on the data link is converted to appropriate signals and then handed over to MTP layer 2 which, in line with the OSI model, checks the data to detect and correct any faults that may have occurred.

The signaling link consists of the signaling terminals in both SPs and the intermediate PCM circuit through the PCD-D, the GSD and the ETC.

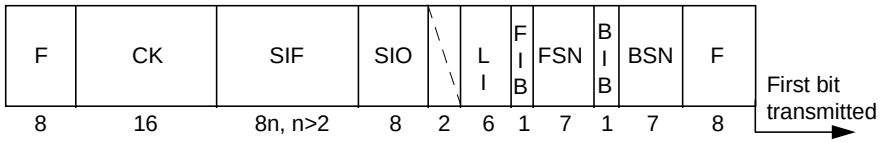
The signaling link functions handle the traffic on the signaling link and are implemented in the SS7 Signaling Terminal (C7ST) block (SS 7 in USA), which consists of hardware (the signaling terminal) as well as regional and central software. The block also serves as an interface between the hardware and the software in the SS7 implementation in AXE. This means that all functions at levels above level 2 are implemented in software only.

Level 2 defines the functions and procedures for and relating to the transfer of signaling messages over one individual signaling data link. Level 2 functions together with a level 1 signaling data link as a bearer and provides a signaling link for reliable transfer of signaling messages between two signaling points.

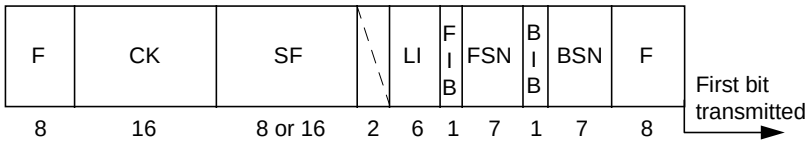
A signaling message, delivered by the higher levels, is transferred over the signaling link by means of variable length signal units. To ensure reliable transfer, the function block C7ST contains functions for signal units delimitation, flag imitation prevention, error detection, error correction and signaling data link supervision.

Signal Unit Formats

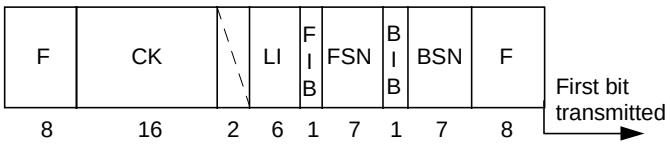
There are three types of signal units. These are differentiated by means of the length indicator. For information generated by UP, the Message Signal Unit (MSU) is used. Link Status Signal Units (LSSU) and Fill In Signal Units (FISU) are used for information aimed for MTP level 2. The different formats are shown in Figure 8-5. MSUs are re-transmitted in error cases, while LSSUs and FISUs are not re-transmitted.



a) Basic format of amessage signal unit (MSU)



b) Format of a link status signal unit (LSSU)



c) Format of a fill-in signal unit (FISU)

BIB	Backward indicator bit	LI	Length indicator
BSN	Backward sequence number	n	Number of octets in the SIF
CK	Check bits	SF	Status Field
F	Flag	SIF	Signaling information field
FIB	Forward indicator bit	SIO	Service information octet
FSN	Forward sequence number		

Figure 8-5 Signal unit formats.

FISU

Fill In Signal Unit (FISU) is used for error supervision of the link and to keep the link running when there are no MSUs to be sent.

LSSU

Link Status Signal Unit (LSSU) is used for starting up a signaling link and when there are errors on the link. A Status Field (SF) containing one or two octets is generated by the signaling terminal.

MSU

The Message Signal Unit (MSU) is used to carry the signal information between user parts. MSU is re-transmitted when an error is detected. There are also MSUs that are used for signaling network management and signaling network testing and maintenance. However, these are not sent to any user part but stay in MTP level 3.

Flag

One flag indicates the beginning of a signal unit and another flag indicates the end. However, consecutive frames are delimited by one flag only. The signaling terminal on the transmitting side generates the flag with the bit pattern 01111110 (7E hex).

A method called bit stuffing eliminates this pattern appearing within the signal unit. Bit stuffing means that the transmission terminal inserts a zero after five consecutive bits in the message, before the delimiting flags are attached and the signal unit is transmitted. At the receiving signaling terminal, after flag detection and removal, each zero which follows directly after a sequence of five consecutive ones is deleted and the length of the received signal unit is checked. A correctly received frame consists of a multiple of 8 bits and at least 6 octets, including the opening flag. If this is not the case, the signal unit is discarded and a negative acknowledgment is sent.

Check Bits

MTP level 2 only passes messages that have been checked for errors to MTP level 3. Every signal unit has 16 check bits for error detection. The check bits are generated by the transmitting signaling terminal by applying a specified algorithm to the bits of the signal unit. The receiving terminal uses the same algorithm to check the correspondence of the check bits and the remaining part of the signal unit. If a complete correspondence is not found, the signal unit is discarded.

Correction (Retransmission)

To handle retransmission in cases where there is a faulty MSU, there is a correction field of two octets which follows the opening flag. The basic error correction method ensures correct transfer of MSUs over the signaling link in sequence and with no double delivery. As a consequence, no re-sequencing or

eliminating of the received information is required within the user parts.

Positive acknowledgments are used to indicate correct transfer of MSUs. Negative acknowledgments are used as explicit requests for retransmission of signal units that are received corrupt. Transmitted but not yet positively acknowledged MSUs remain available for retransmission.

As part of the error correction method, each signal unit carries a:

- Forward Sequence Number (FSN)
- Forward Indicator Bit (FIB)
- Backward Sequence Number (BSN)
- Backward Indicator Bit (BIB)

The FSN and FIB in one direction with the BSN and BIB in the other direction are associated with the signal unit flow in the first direction. The sequence control is performed by means of the forward sequence number while the acknowledgment is performed by means of the backward sequence number.

Length Indicator

A length indicator with a binary value between 0 and 63 is used both to indicate the number of octets following the length indicator field and preceding the check bits, and also to indicate the type of signal unit.

L = 0	FISU
L = 1 or 2	LSSU
L > 2	MSU

However, LI=63 might mean more than 63 octets since LAPD can carry up to 249 octets in a frame. In this case the end of the frame is found using the ending flag.

Service Information Octet

The Service Information Octet (SIO) is present only in the MSU. It is divided into the Service Indicator (SI) and the subservice field. The SI is used by signaling handling functions to distribute the message to the appropriate user as shown in Figure 8-6. The subservice field contains the network indicator and two spare

bits. The network indicator determines if it is a national or international network that is concerned.

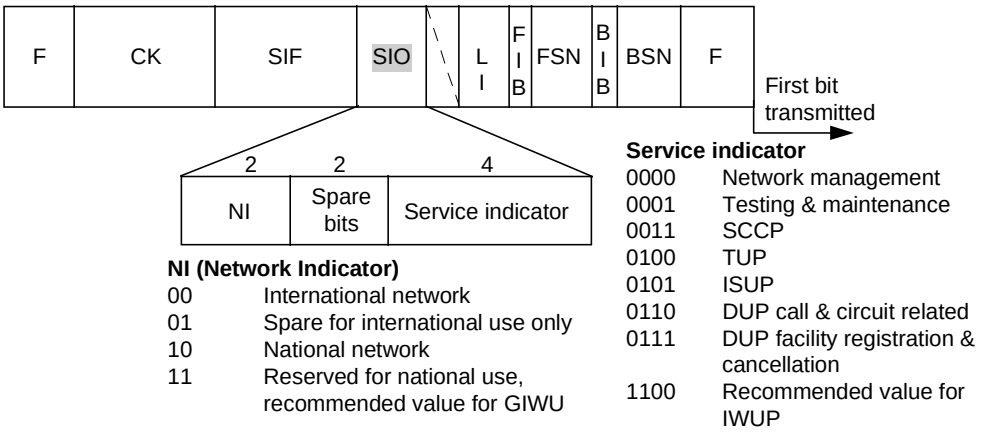


Figure 8-6 SIO divided into subfields.

Signaling Information Field

The Signaling Information Field (SIF) carries the information from the user part. It includes a routing label which provides information enabling the message to be routed by the level 3 functions through a signaling network to its destination and to direct it at the receiving user part to the particular circuit, call management or other transaction to which the message is related. There are different labels depending on the MSU. The labels are shown in Figure 8-7.

In case of a TUP or an ISUP message, the label includes a Circuit Identity Code (CIC) to indicate which speech or data circuit the signaling message belongs to. In case of IWUP messages, the label includes a Circuit Pair Identity Code.

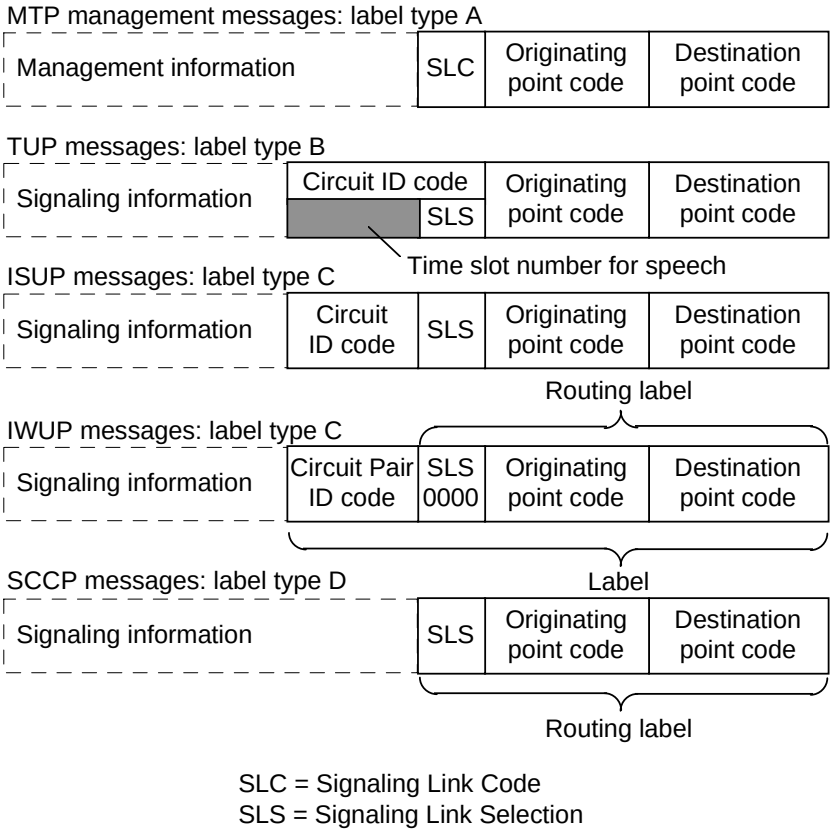


Figure 8-7 SS7 message label types.

Each SP is uniquely defined with a binary code called the Signaling Point Code (SPC). The code for the destination signaling point is called the Destination Point Code (DPC). The DPC is included in the routing label. To define the SP from which the message originates, the Originating Point Code (OPC) is also included in the routing label.

The DPC in an MTP routing label is used to route the message to the appropriate signaling point (inter-node addressing), while the SIO addresses are used to route the call to the appropriate destination within the node (intra-node addressing). The DPC is always determined and inserted in the routing label by the level 4 MTP user. The OPC is normally inserted by level 4, but as the OPC might be constant, it could be inserted by MTP.

As can be seen in Figure 8-7, the contents in the SIF field differ depending on the MTP user.

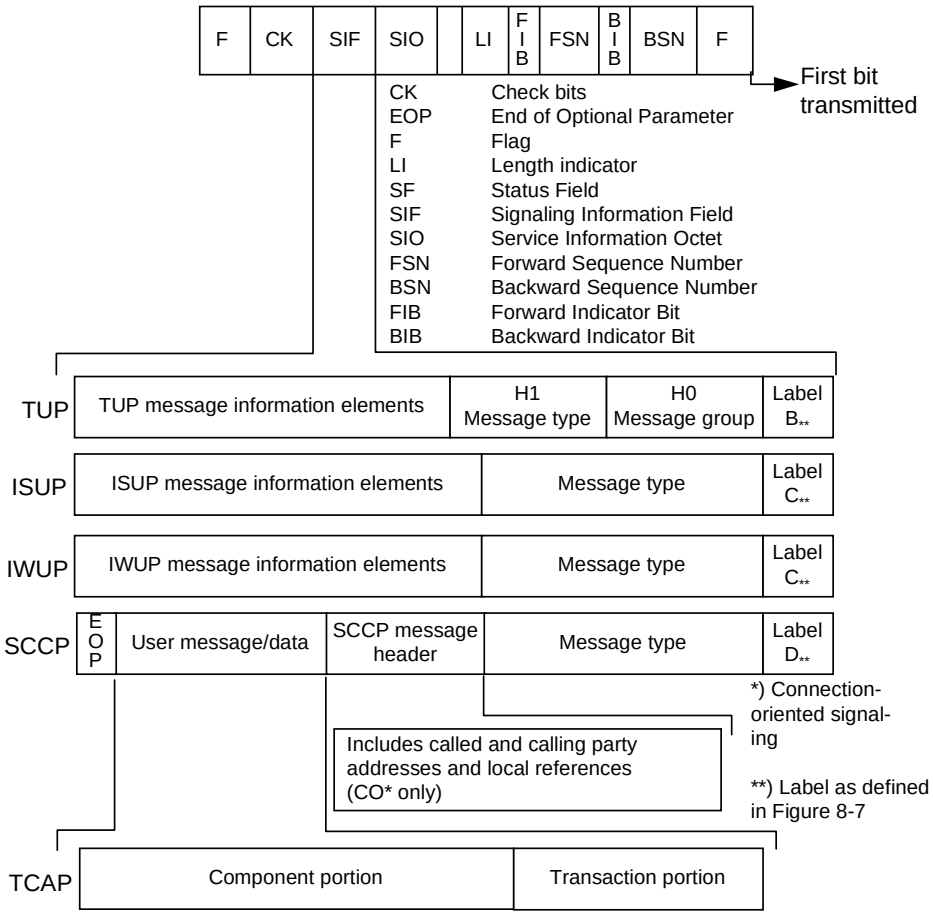


Figure 8-8 SIF structure for TUP, ISUP and SCCP.

LEVEL 3 - SIGNALING NETWORK FUNCTIONS

MTP layer 3 handles signaling network functions. These can be divided into two categories:

- functions for message handling
- functions for signaling network management

Signaling Message Handling

The purpose of the signaling message handling functions is to ensure that the signaling messages originated by a particular user part in one signaling point (the originating point) are delivered to the same user part at the destination point indicated by the sending user part.

Delivery of messages may be made using a signaling link which directly interconnects the originating and destination point. Alternatively, the messages can be sent via one or more

intermediate signaling transfer points. The signaling message functions are based on the routing label.

Message handling comprises routing, discrimination and distribution of messages as shown in Figure 8-9. The message routing function is used at each signaling point to determine the outgoing signaling link to send the message on. The message discrimination function is used at a SP to determine whether a message received at the SP has arrived at the correct location or not. The message distribution function is used at each SP to deliver the received message to the appropriate user part.

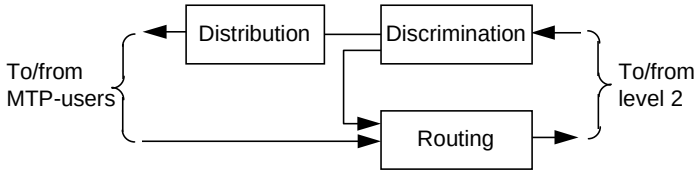


Figure 8-9 Message routing, discrimination and distribution.

Signaling Network Management

Figure 8-10 shows the signaling network functions, which include signaling network management and signaling message handling functions.

Signaling network management functions are divided into signaling traffic management, signaling route management and signaling link management. The purpose of the signaling network management functions is to provide reconfiguration of the signaling network in case of failure. It also includes functions to control the traffic in case of congestion.

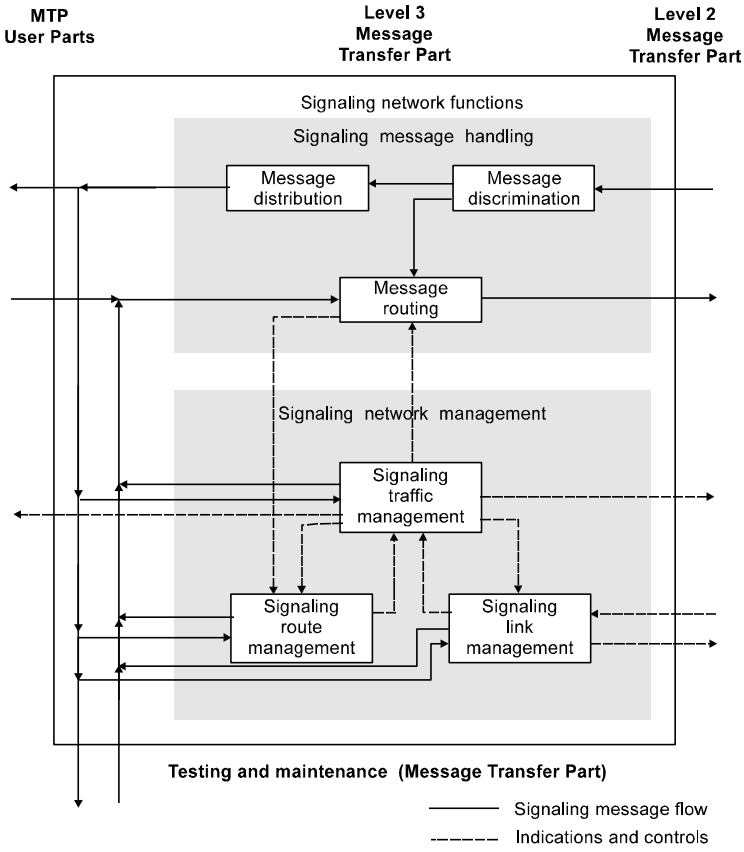


Figure 8-10 Signaling network functions.

Signaling traffic management communicates with other SPs and also with STPs to inform them for example, that a change in the routing of a message has occurred due to a faulty signaling link. Signaling route management controls the message routing. To reroute a message, information concerning which link to use is provided by network management to the message routing function. Signaling link management functions control locally connected link sets and interact with the signaling link functions at level 2.

SUMMARY OF MTP FUNCTIONS

Figure 8-11 shows MTP level 1-3. MTP level 1 receives the message on the data link which is connected via the Group Switch and multiplexed in the PCD-D onto a 2 Mbit PCM line to the ST-7.

The signaling link functions remove stuffed zeroes and perform error detection and correction. Correctly received signal units are passed to the discrimination function in level 3.

The discrimination function looks at the destination point code to determine whether the signal unit is destined for this SP or another SP. If the received message is destined for another exchange, that is the SPC for the exchange is not the same as the DPC in the label; it must be transmitted on an outgoing link according to the routing function. The routing function examines the DPC and reroutes the MSU with help of the signaling route management which knows which outgoing signaling link to use.

Each signaling point has routing information that allows it to determine the signaling link over which a message must be sent on the basis of the destination point and the signaling selection field. Typically the destination point is associated with more than one signaling link that may carry the message. Load sharing between signaling links is performed. The selection of the particular signaling link is made by means of the signaling link selection field.

If the MSU is destined for this exchange, it will be sent to the distribution function.

The distribution function examines the SIO in order to deliver the message to the appropriate UP or MTP layer 3 functions, Signaling Network Management or Signaling Network Testing and maintenance.

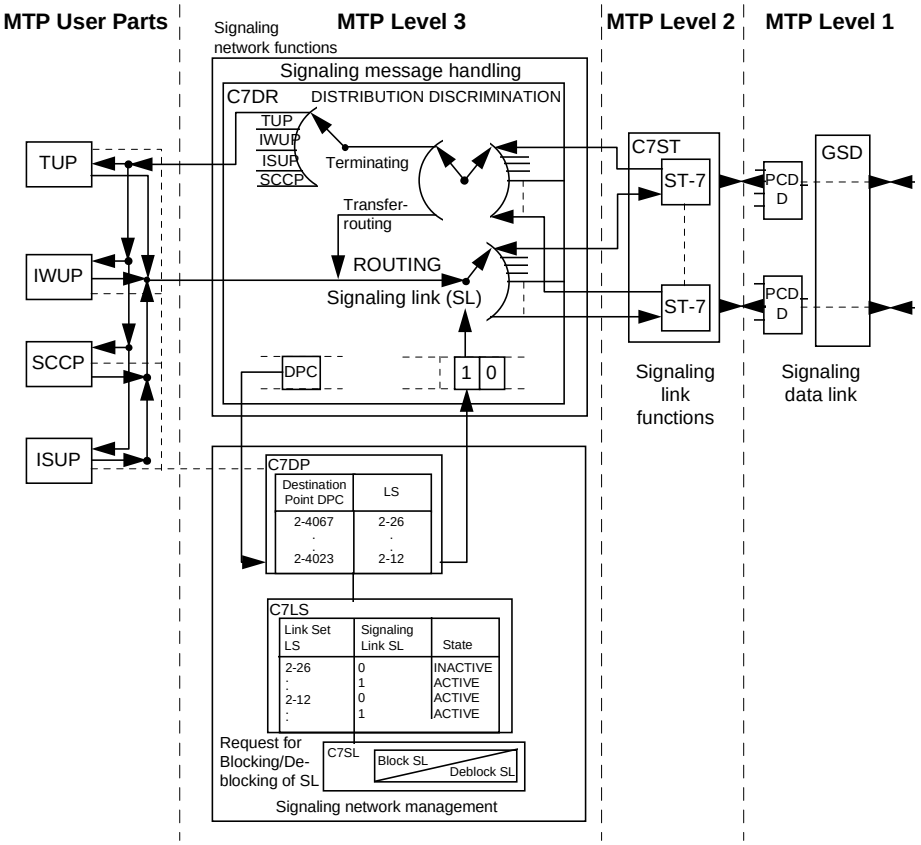


Figure 8-11 Working principle for MTP layer 3.