INTERNATIONAL TELECOMMUNICATION UNION

ITU-T Q.50

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(03/93)

GENERAL RECOMMENDATIONS ON TELEPHONE SWITCHING AND SIGNALLING

INTERNATIONAL SEMI-AUTOMATIC AND AUTOMATIC WORKING

SIGNALLING BETWEEN CIRCUIT MULTIPLICATION EQUIPMENTS (CME) AND INTERNATIONAL SWITCHING CENTRES (ISC)

ITU-T Recommendation Q.50

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation Q.50 was revised by the ITU-T Study Group XI (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

© ITU 1994

All rights reserved. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the ITU.

CONTENTS

Page

1 Introduction 1

2 Definitions relating to Circuit Multiplication Equipment 1

2.11 Operating modes 2

3 Requirements for control 4

3.1 Reasons for use of Circuit Multiplication Equipments (CME) 4

3.2 Integration of Circuit Multiplication Equipments into the circuit switched international network 4

3.3 Factors for signalling functions determination 5

4 Connection types and Circuit Multiplication Equipment techniques in the context of signalling 5

5 Division of functionality between the International Switching Centre and the Circuit Multiplication Equipment 6

5.1 Circuit Multiplication Equipment dynamic load control process 6

5.2 Call set-up process 7

5.3 Change of connection of type after call set-up 8

5.4 Inter-dependency between dynamic load control and call set-up process 8

6 Control information elements between International Switching Centre and Circuit Multiplication Equipment 9

6.1 Information elements for Type 1 Circuit Multiplication Equipment 9

6.2 Information elements for Type 2 Circuit Multiplication Equipment 9

7 Transmission techniques for International Switching Centre/Circuit Multiplication Equipment signalling 9

7.1 External data path 9

7.2 Channel associated links 9

7.3 Common channel signalling in the PCM access stream 10

8 Recommendation for signalling system 10

9 Example systems 10

Annex A – Controlled DCME interface utilizing time-slot 16 12

Annex B – Example of a signalling system between DCME and ISC 15

B.1 General 15

B.2 Physical level of interface 15

B.3 Distribution of functions between DCME and ISC 16

B.4 Signalling code 16

B.5 Signalling procedures 16

B.6 DCME load tests 18

SIGNALLING BETWEEN CIRCUIT MULTIPLICATION EQUIPMENTS (CME) AND INTERNATIONAL SWITCHING CENTRES (ISC)

(Melbourne, 1988; modified at Helsinki, 1993)

1 Introduction

This Recommendation contains principles and examples of signalling between the International Switching Centre (ISC) (exchanges) (see Note) and their associated circuit multiplication equipments.

Circuit multiplication equipments may have integral echo control and A/μ law converter functions. The information in this Recommendation is compatible with the control procedures for such devices.

NOTE – As Circuit Multiplication Equipment may also be used in national networks, the signalling described here could not only be used in International Switching Centres but also in national exchanges.

2 Definitions relating to Circuit Multiplication Equipment

For a complete description of additional definitions see Recommendation G.763.

2.1 digital circuit multiplication equipment (DCME) and circuit multiplication equipment (CME): DCME and Circuit Multiplication Equipment constitute a general class of equipment which permits concentration of a number of trunks on a reduced number of transmission channels. DCME in particular permits concentration of a number of 64 kbit/s PCM encoded trunks on a reduced number of digital transmission channels.

2.2 speech interpolation; digital speech interpolation (DSI): A method of profiting from the time instants when a speaker is not active, which is indicated by a speech detector. The channel is then used by another active connection. The signals carried by a transmission channel therefore represent interleaved bursts of speech signals derived from a number of different trunks.

2.3 low rate encoding (LRE): Speech coding methods with bit rates less than 64 kbit/s, e.g. the 32 kbit/s transcoding process defined in G.721 applied to speech coded according to G.711.

2.4 speech activity: The ratio of the time speech and corresponding hangover occupies the trunk to the total measuring time, averaged over the total number of trunks carrying speech.

2.5 circuit multiplication equipment gain: The trunk channel to transmission channel multiplication ratio, which is achieved through application of Circuit Multiplication Equipment, including LRE and/or speech interpolation (DSI) (see Figure 1).

2.6 trunk: A bidirectional connection consisting of a forward channel and a backward channel between the International Switching Centre and Circuit Multiplication Equipment not subject to LRE or DSI operation.

2.7 transmission channel, bearer channel: One channel of the connection between the transmit unit and receive unit of corresponding Circuit Multiplication Equipment.

2.8 freeze-out: The temporary condition when a trunk channel becomes active and cannot immediately be assigned to a transmission channel, due to lack of available transmission capacity.

2.9 freeze-out fraction: The ratio of the sum of the individual channel freeze-outs to the sum of the active signals and their corresponding hangover times and front end delays, for all trunk channels over a fixed interval of time, e.g. one minute.

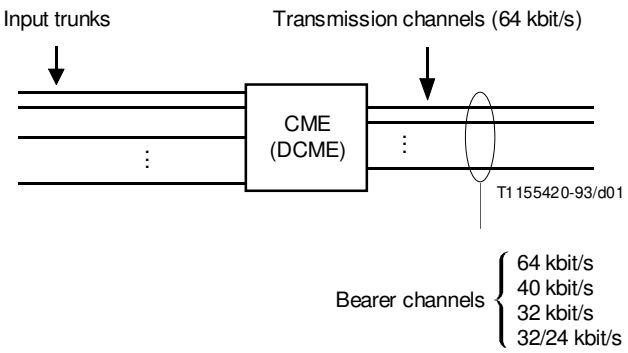


FIGURE 1/Q.50

Circuit Multiplication Equipment gain

2.10 transmission overload: The condition when the freeze-out fraction or average bits per sample goes beyond the value set in accordance with speech quality requirements.

2.11 Operating modes

2.11.1 Point-to-point mode [see diagrams a) and b) of Figure 2]

Using diagram a) of Figure 2 for reference, the transmit side Circuit Multiplication Equipment concentrates N trunks into N/G transmission channels, where G is the Circuit Multiplication Equipment gain.

At the receive side, the receiving Circuit Multiplication Equipment simply reconstitutes the N trunks from the N/G transmission channels.

The example in diagram b) of Figure 2 also shows a point-to-point mode. From the switching point of view there could be a difference between the configurations in diagrams a) and b) of Figure 2.

For transmission of alarms it has also to be considered, that different exchanges may be connected to one Circuit Multiplication Equipment.

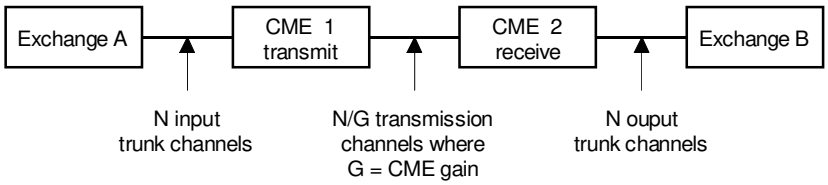
2.11.2 Multi-clique mode (see Figure 3)

In this mode the pool of transmission channels is sub-divided into several independent pools (cliques) of fixed capacity, each destination specific. If a part of the cliques capacity is not used, it cannot be used for another destination (see Figure 3).

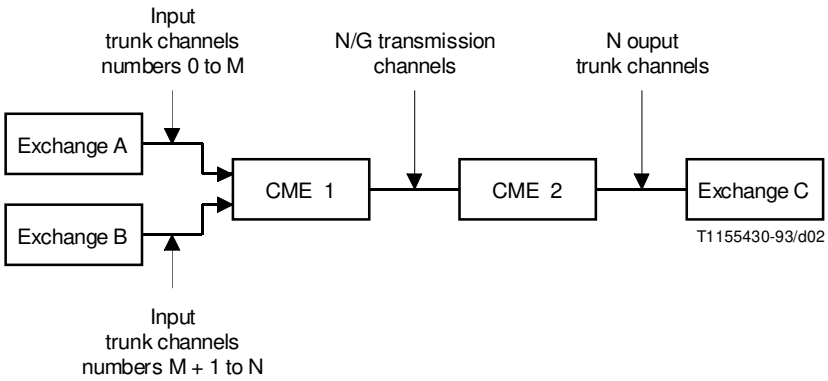
2.11.3 Multi-destination mode

A DCME operational mode where input trunk channel traffic is interpolated over a pool of available transmission channels for all destinations having traffic in the pool. The transmit trunk channels are designated to receive trunk channels at corresponding locations.

Figure 4 shows a unidirectional system block diagram for a multi-destination mode with two transmit and two receive DCME units.



a) Point-to-point unidirectional



b) Point-to-point two origins unidirectional

FIGURE 2/Q.50

Multi-clique for two origins and two destinations unidirectional

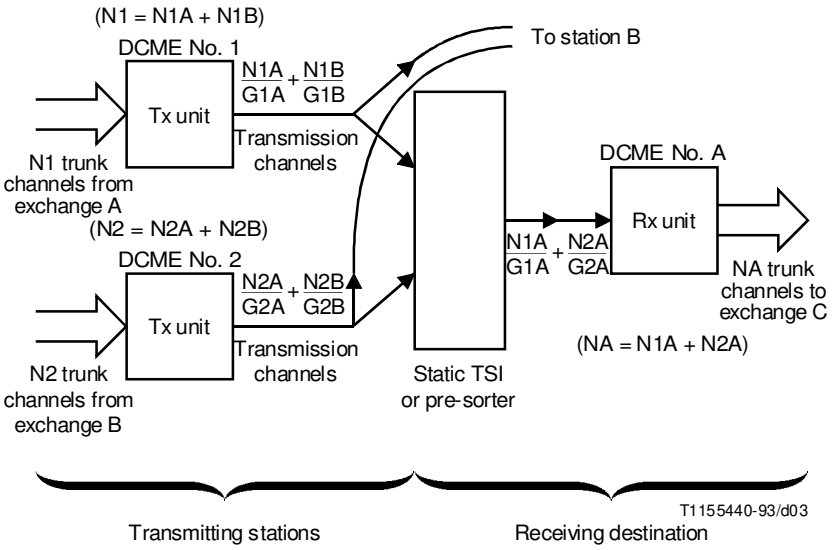


FIGURE 3/Q.50

Multi-clique mode (only one direction shown)

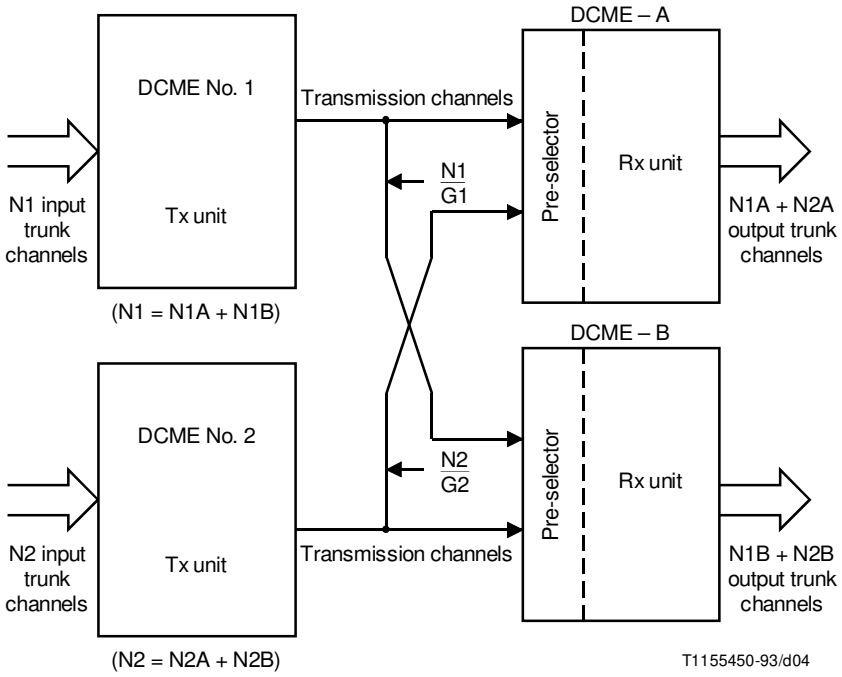


FIGURE 4/Q.50

Multi-destination mode (only one direction shown)

3 Requirements for control

3.1 Reasons for use of Circuit Multiplication Equipments (CME)

Circuit Multiplication Equipments are used in order to reduce the bandwith required for transmission of a given set of calls. This can be achieved by reducing the redundancy which is inherent in speech communications. Circuit Multiplication Equipment gains of up to 5:1 can be achieved using DSI + LRE with subjectively acceptable quality. Thus, the amount of line plant required between switching points and hence the cost of provision can be minimized.

3.2 Integration of Circuit Multiplication Equipments into the circuit switched international network

Normally, when an exchange needs an outgoing circuit, the circuit selection is based on circuit availability. In this example, the call may be blocked if all of the circuits are unavailable due to traffic or maintenance. If the same call encounters a Circuit Multiplication Equipment, the possible outcomes are more complex.

From the point of view of call set-up, two Circuit Multiplication Equipment aspects may necessitate information transfer between the exchange and the Circuit Multiplication Equipment.

a) *Transmission Capacity* – The circuit multiplication characteristics of a Circuit Multiplication Equipment result in a lower total transmission capacity for the Circuit Multiplication Equipment as compared to the transmission capacity of all of the input trunks. A call may find a free (unseized) circuit from the exchange to the Circuit Multiplication Equipment but no available transmission channels between two Circuit Multiplication Equipments. For systems employing speech interpolation, allowing additional calls could lead to unacceptable speech quality degradation due to freeze-out. The probability of freeze-out can be reduced by the creation of overload channels using bit-stealing techniques. Additional quality control is achieved if the exchange knows, through a Transmission Resource Management System, if the Circuit Multiplication Equipment has available capacity to complete a new call.

b) *Call Set-Up/Release* – Depending on the connection type to be supported on a per call basis, and on whether or not the Circuit Multiplication Equipment is able, by itself, to establish the inter-Circuit Multiplication Equipment connections, the seizing/releasing actions in the exchange may need to be extended to the Circuit Multiplication Equipment by means of out-of-band information transfer. For example, in DSI systems, 3.1 kHz audio or speech connections are made dynamically on detection of channel activity performed by built-in speech detectors. For 64 kbit/s unrestricted on-demand connections (the use of "on demand" and "pre-assigned" for DCME is clarified in Recommendation G.763) through DSI systems (i.e. not through internal pre-assignment), the establishment and disestablishment of connections between the Circuit Multiplication Equipments have to be initiated from the outgoing exchange.

3.3 Factors for signalling functions determination

3.3.1 Capabilities and limitations

The functional requirements for signalling between Circuit Multiplication Equipments and exchanges are determined by the type of Circuit Multiplication Equipment with its capabilities and limitations, and by the connection types it supports. (Refer to Table 1.)

Different LRE algorithms will also have different levels of performance, for instance, in terms of voice-band data. Since certain speech optimized algorithms have limited transparency to voice-band data. The Circuit Multiplication Equipment has internal facilities (e.g. data detectors combined with route around mechanisms and/or special algorithms) to overcome its inherent limitations. This approach clearly separates the Circuit Multiplication Equipment transmission problems for the International Switching Centre switching functions as much as possible to allow independent developments.

3.3.2 Connection types supported on Circuit Multiplication Equipment links

With the proper selection of the appropriate Circuit Multiplication Equipment mode a suitable Circuit Multiplication Equipment connection type can be made available thus offering cost effective transmission through a network, two basic connection types are supported or will likely be supported by Circuit Multiplication Equipments in the international network.

Internal exchange functions are common to bearer services associated with ISDN calls, and bearer service call information is generally carried transparently across the network. Connection type/element information is explicitly carried by the inter-exchange signalling to be used for call routing decisions in the network (see Recommendation E.172).

There are basically two Circuit Multiplication Equipment operational modes, each representing a distinct connection type/element with a characteristic information transfer susceptance attribute value. These two Circuit Multiplication Equipment connection types are:

- 3.1 kHz audio or speech connection type;
- 64 kbit/s unrestricted connection type.

4 Connection types and Circuit Multiplication Equipment techniques in the context of signalling

Table 1 gives the relationship between Circuit Multiplication Equipment techniques and the two connection types identified in 3.3.2 with regard to their supportability and the need for Circuit Multiplication Equipment-exchange message transfer.

The signalling function requirements are categorized on the basis of connection types supported by the different Circuit Multiplication Equipment techniques. For 3.1 kHz audio or speech connection types, transmission resource management (TRM) information alone is adequate especially for Circuit Multiplication Equipments employing speech interpolation. The objective of this provision is to maintain the reduction of transmission quality within tolerable limits. In addition to TRM information, external call set-up message (CSM) is needed for the support of connection types involving on-demand 64 kbit/s unrestricted service in contemporary digital Circuit Multiplication Equipment (32 kbit/s LRE and DSI).

TABLE 1/Q.50

Connection types supported in Circuit Multiplication Equipments in relation to Circuit Multiplication Equipment-exchange signalling

Connection type	Circuit multiplication equipement				
	Analogue TASI	LRE 32 kbit/s	DSI 64 kbit/s PCM	DCME DSI + 32 kbit/s LRE	LRE 16 kbit/s FS
1. 3.1 kHz audio or speech	TRM[a], NX	NS NX[b]	TRM[a], NX	TRM + CSM[d]	FS
2. 64 kbit/s unrestricted	NS	NX[b, c]	NX[b]	TRM + CSM	FS

TRM Transmission resource management
CSM Call set-up messages between Circuit Multiplication Equipment and ISC
NS Connection type not supported
NX Connection type supported without TRM or CSM messages
FS Further study
a) Messages not necessarily implemented
b) Supported through pre-assignments (e.g. Recommendation G.761 transcoder DNI)
c) Supported in a limited fashion (e.g. Recommendation G.761)
d) CSM not needed with internal Circuit Multiplication Equipment special handling facilities.

5 Division of functionality between the International Switching Centre and the Circuit Multiplication Equipment

5.1 Circuit Multiplication Equipment dynamic load control process

Transmission resource management is used for handling TRM information between Circuit Multiplication Equipment and an International Switching Centre. TRM Circuit Multiplication Equipment information is based on traffic load measurements at the local and remote Circuit Multiplication Equipments. Therefore in the multi-destination and multi-clique mode of operation, TRM information is provided for each destination/clique separately. The TRM received by an exchange will temporarily stop selection of circuits using the Circuit Multiplication Equipment for specified connection types.

A universal arrangement is used for handling TRM information between Circuit Multiplication Equipment and an International Switching Centre. The TRM information is dynamically presented to the exchange in one of two states for each of the two connection types. The states are called “available” and “not available”. Logic within the Circuit Multiplication Equipment is used to determine which of the two states should be indicated to the exchange regardless of any condition at the exchange.

When a Circuit Multiplication Equipment detects a “not available” state for a connection type (either locally or remotely), it presents this indication to the exchange so it will stop routing new calls to the Circuit Multiplication Equipment for that connection type even if there are free, unseized circuits available. The local and remote exchange shall continue to prohibit calls to the Circuit Multiplication Equipment until they receive an “available” indication for the connection type when in both, local and remote Circuit Multiplication Equipments, there is no overload.

As both ISCs are informed of the load situation, there is no need to send any signal in the signalling system between the two ISCs (see Note).

This dynamic load control information is therefore directly influencing the circuit selection process in the exchange during call set-up for each connection type separately. The circuit selection in the exchange is a check whether or not a free unseized circuit is suitable for a certain connection type, for which a new call is to be accommodated. For example, the exchange would select a free circuit for a speech call if “3.1 kHz audio or speech capacity available” is indicated, irrespective of the indications for the 64 kbit/s connection type. If the DCME link is unable to accommodate additional

new 64 kbit/s calls, all free unseized circuits connected to this DCME within the exchange will be marked accordingly. Even though the generation of connection type related TRM information with DCMEs may be in part mutually dependent (i.e. no capacity for 3.1 kHz audio or speech implies no capacity for any other connection types but not necessarily vice versa), separate signalling and processing for each connection type are necessary to allow different future Circuit Multiplication Equipments to develop independently.

NOTE – It is suggested that the blocking state should not be entered.

5.2 Call set-up process

According to Table 1, the contemporary digital circuit multiplication equipment has the capability to support on-demand the two connection types. In addition to providing TRM to the exchange, the DCME requires call set-up messages (CSM) (from the exchange) for selecting the 64 kbit/s unrestricted Circuit Multiplication Equipment connection type.

The following subclauses describe the signalling procedures for the on demand set-up and release of (duplex) DCME connections of the 64 kbit/s unrestricted type initiated by the calling exchange (see Figure 5).

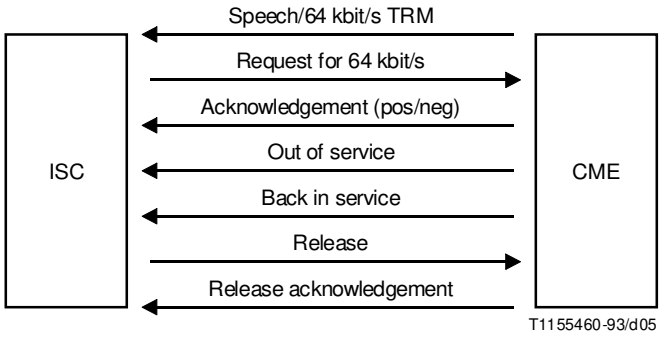


FIGURE 5/Q.50

Typical International Switching Centre/Circuit Multiplication Equipment information flows

5.2.1 Seizure/select

For support of 64 kbit/s unrestricted connection type, an unrestricted circuit is selected if "64 kbit/s unrestricted capacity available" is indicated, and a CSM in the form of Seizure/Select request is forwarded to the DCME. A positive or negative acknowledgement is sent towards the calling International Switching Centre upon recognition of a 64 kbit/s request depending on the current status of unrestricted capacity at the local DCME as well as on other inter-DCME 64 kbit/s circuit handling states (see Recommendation G.763).

There is a need to reduce the probability that the called party is alerted before the DCME 64 kbit/s path is established.

This could be avoided by:

a) performing a continuity check or;

b) not sending IAM before the positive acknowledgement has been received from the DCME.

In the G.763 type of DCME and other proprietary equipment, the set-up and release of an inter-DCME 64 kbit/s transparent connection entail a "hitless" change of the condition of a DCME circuit (i.e. bit manipulating LRE and DSI processes either removed or inserted). Exchange-to-exchange circuit continuity is preserved during the change. For connections subject to digital speech interpolation, "virtual" circuit continuity is provided during detected channel activity.

A failure to establish a 64 kbit/s circuit between Circuit Multiplication Equipments must be reported to the International Switching Centre as soon as the condition has been identified by the Circuit Multiplication Equipment by using an out-of-service message.

The out-of-service message is considered by the International Switching Centre to be equivalent to the alarm signal defined in Recommendation Q.33. The International Switching Centre will take release actions (if appropriate) as specified in 4/Q.33.

5.2.2 Release

The released 64 kbit/s message from the International Switching Centre to the DCME will be positively acknowledged after proper completion of the DCME circuit disestablishment process. Failure to complete this process shall be notified to the International Switching Centre using an out-of-service message and the DCME will put the circuit in a blocked condition. After the failure condition is removed, this circuit will be in idle condition and a back-in-service message shall be sent to the International Switching Centre.

5.2.2.1 Release (ISUP)

An originating International Switching Centre sending an SS No. 7 Release Message also sends a Release 64 Message to DCME for the same circuit. The circuit in the International Switching Centre is not returned to idle until it receives a Release Complete Message of SS No. 7 and a Release Acknowledgement from the DCME.

NOTE – When the destination International Switching Centre initiates the Release sequence in SS No. 7 signalling, it will cause the originating International Switching Centre to send a Release 64 Message to DCME. The originating International Switching Centre will hold the Release Complete Message until it receives a Release Acknowledgement from the DCME.

5.2.2.2 Release (TUP)

An originating International Switching Centre sending an SS No. 7 Clear Forward Message also sends a Release 64 Message to DCME for the same circuit. The circuit in the International Switching Centre is not returned to idle until it receives a Release Guard Message of SS No. 7 and a Release Acknowledgement from the DCME.

5.2.3 Dual seizure

Upon detection of a dual seizure, the non-control exchange take the actions described in 2.10.1.4/Q.764. In addition, the non-control exchange should send a Q.50 64 kbit/s release request message to its associated DCME, if it has previously sent a Q.50 64 kbit/s seizure/select request message for the call to be backed-off.

The DCME will automatically re-establish an inter-DCME 64 kbit/s transparent connection if this has previously been requested by the control exchange for the call which is allowed to mature (see Recommendation G.763).

5.3 Change of connection of type after call set-up

In subclause 5.2, the selection and release of the 64 kbit/s connection type via DCME is described for the case of simultaneous call set-up and release in SS No. 7.

In some cases, e.g. when the Multi-Use Bearer Service is used, a change of the connection type is made after the call is set up.

The procedure to support such changes of the connection types is for further study.

This does not restrict the introduction of SS No. 7 new capabilities.

5.4 Inter-dependency between dynamic load control and call set-up process

To allow a standard method of interworking with inter-exchange signalling systems it is important to adopt the functional interdependency between TRM and CSM as described above.

6 Control information elements between International Switching Centre and Circuit Multiplication Equipment

The amount of control information elements utilized between the International Switching Centre and the Circuit Multiplication Equipment depends on the capabilities of the Circuit Multiplication Equipment and the International Switching Centre. Two categories of Circuit Multiplication Equipment signalling capabilities are recognized. The first category of Circuit Multiplication Equipment (Type 1) is capable of only transmitting signals from the Circuit Multiplication Equipment to the International Switching Centre (e.g. Dynamic Load Control, see 6.1). The second category of Circuit Multiplication Equipment (Type 2) is able to transmit and receive signals to/from the International Switching Centre. Tables 2, 3 and 4 give a set of information elements and their flow on the control link between the International Switching Centre and the Circuit Multiplication Equipment for the second category of Circuit Multiplication Equipment.

6.1 Information elements for Type 1 Circuit Multiplication Equipment

Type 1 Circuit Multiplication Equipment only should use the following types of information elements. The "m" indicates mandatory use, the "o" optional use:

1) no trunk(s) available for 3.1 kHz audio or speech (m);
2) trunk(s) available for 3.1 kHz audio or speech (m);
3) out-of-service (o);
4) back-in-service (o).

6.2 Information elements for Type 2 Circuit Multiplication Equipment

See Tables 2, 3 and 4.

7 Transmission techniques for International Switching Centre/Circuit Multiplication Equipment signalling

The selection of a transmission technique (signalling protocol) for transferring Circuit Multiplication Equipment control information between the Circuit Multiplication Equipment and the International Switching Centre will be determined by each Administration and it will be based on numerous factors. Some of the key factors are:

- location of the Circuit Multiplication Equipment and the International Switching Centre(s);
- type of facility between the Circuit Multiplication Equipment and the International Switching Centre (e.g. analogue, digital);
- performance of the signalling link;
- electrical interface with the International Switching Centre;
- software capabilities of the International Switching Centre; and
- the complexity of the desired signalling.

All these functions need to be considered when selecting a transmission technique.

The choice of a transmission technique is for further study.

7.1 External data path

Examples of separate data paths are:

- V.24 interface;
- copper loop.

7.2 Channel associated links

Examples of channel associated links are:

- TS16 of PCM 2 Mbit/s;
- outband signalling, e.g. 3825 Hz;
- a nominated 64 kbit/s PCM time-slot.

7.3 Common channel signalling in the PCM access stream

Examples of common channel signalling are:

- use of specialized messages integrated into the common channel signalling systems to be interpreted by the Circuit Multiplication Equipment;
- one dedicated common channel signalling link for exchange of information elements between International Switching Centre and Circuit Multiplication Equipment.

8 Recommendation for signalling system

For further study.

9 Example systems

Two example systems can be found in Annexes A and B. Annex B will be the preferred solution when cross-connect systems are used between ISC and DCME.

TABLE 2/Q.50

Information elements for transmission resource management (load control)
Circuit Multiplication Equipment/International Switching Centre (Type 2)

Type of information element[a]		Notes	Direction of the information element
1.1 (o)	No trunk(s) available for 3.1 kHz audio or speech (Note 2)	No bearer capacity for additional 3.1 kHz audio or speech trunk(s) available	CME → ISC
1.2 (o)	Trunk(s) available for 3.1 kHz audio or speech (Note 2)	This information element is sent to notify the end of "No trunk available for 3.1 kHz audio or speech" condition	CME → ISC
1.3 (m)	No 64 kbit/s capacity available (Note 1)	No bearer capacity for additional 64 kbit/s trunk(s) available	CME → ISC
1.4 (o)	Acknowledgement of "No 64 kbit/s capacity available"		ISC → CME
1.5 (m)	Trunk(s) available for 64 kbit/s	This information element is sent to notify the end of "No 64 kbit/s capacity available" overload condition	CME → ISC
1.6 (o)	Acknowledgement of trunk(s) available for 64 kbit/s		ISC → CME

m Mandatory for this type of Circuit Multiplication Equipment

o Optional for this type of Circuit Multiplication Equipment

a) Each information element may be sent as a message or may be implicit by the lack of a signal (e.g. the Circuit Multiplication Equipment may send a signal for no capacity for speech available and remove the same signal to indicate trunks available for speech).

NOTES

1 If a defined portion of the bearer capacity is used for special call types (definition of a minimum and/or maximum number of channels per call type, e.g. for 3.1 kHz audio/speech or 64 kbit/s), as special load control information is needed for each of these call types.

2 For the application of these information elements see also Table 1.

TABLE 3/Q.50

Information elements for seizure/release (CME/ISC) (Type 2)

Type of information elements		Notes	Direction of the information element
2.1 (m)	64 kbit/s select/seizure	Sent when 64 kbit/s circuit is required via the DCME (Note 1)	ISC → CME
2.2 (m)	Trunk identity	Explicit or implicit information to assign an information element to a specific trunk	ISC → CME CME → ISC
2.3 (m)	64 kbit/s positive acknowledgement	Sent if 64 kbit/s request can be satisfied (Notes 2 and 3)	CME → ISC
2.4 (m)	64 kbit/s negative acknowledgement	Sent if 64 kbit/s request cannot be satisfied (Note 3)	CME → ISC
2.5 (m)	Release 64 kbit/s	Sent by the originating ISC to indicate that a 64 kbit/s circuit is not necessary	ISC → CME
2.6 (m)	Release 64 kbit/s positive acknowledgement	Sent to indicate successful completion of release (Note 3)	CME → ISC
2.7 (o)	3.1 kHz service or speech connection type select/seizure (Note 4)	Request to allocate data, 3.1 kHz or speech optimized facilities	ISC → CME
2.8 (o)	3.1 kHz service or speech connection type positive acknowledgement (Note 4)	Sent if 3.1 kHz service or speech request can be satisfied	CME → ISC
2.9 (o)	3.1 kHz service or speech connection type negative acknowledgement (Note 4)	Sent if 3.1 kHz service or speech request cannot be satisfied	CME → ISC
2.10 (o)	Release 3.1 kHz or speech connection type service (Note 4)	Sent to indicate termination of the call	ISC → CME

m Mandatory for this type of Circuit Multiplication Equipment

o Optional for this type of Circuit Multiplication Equipment

NOTES

1 Pre-assigned digital non-interpolated (DNI) 64 kbit/s channels do not need this information element.

A 64 kbit/s select/seizure information element between Circuit Multiplication Equipment and International Switching Centre is mandatory for Type 2 Circuit Multiplication Equipment, if 64 kbit/s channels are used on a demand basis.

2 Depending on the realization of the Circuit Multiplication Equipment there could be a longer or shorter delay for 64 kbit/s channel acknowledgement.

3 "Mandatory" refers to the presence of these information elements at the signalling interface between International Switching Centre and Circuit Multiplication Equipment. The use of these elements is optional; however these elements are preferred to provide safeguards for proper operation.

4 The request for 3.1 kHz or speech connection type may be implicit, that means, that a discrete information flow may be required. For indication of termination (not interruption) of a call, select/seizure and release may be necessary on a per call basis.

TABLE 4/Q.50

Information elements for maintenance (CME/ISC) Type 2

Type of information element		Notes	Direction of the information element
3.1 (o)	Maintenance release signal (Note)	Sent for manual control, planned removal from service	CME → ISC
3.2 (o)	Maintenance release acknowledgement (Note)	Sent to acknowledge reception of maintenance release, ISC is waiting for the release of the trunk	ISC → CME
3.3 (o)	CME clear of traffic signal (released after maintenance release signal) (Note)	Signal sent when all (this) trunk(s) are (is) idle. The ISC prevents new seizures on these (this) trunk(s)	ISC → CME
3.4 (m)	Out-of-service	General CME trunk unavailable signal used on a per circuit basis	CME → ISC
3.5 (o)	Out-of-service acknowledgement	Sent to acknowledge "out-of-service signal" used on a per circuit basis	ISC → CME
3.6 (m)	Back-in-service (Note)	Sent after the removal from service is no longer necessary – used on a per circuit or per CME basis	CME → ISC
3.7 (o)	Acknowledgement of "back-in-service"	Used on a per circuit basis	ISC → CME

m Mandatory for this type of CME

o Optional for this type of CME

NOTE – Information elements 3.1, 3.2, 3.3 and 3.6 are a set of elements that should only be used together. Information element 3.6 could also be used after "out-of-service" information without 3.1, 3.2 and 3.3.

Annex A

Controlled DCME interface utilizing time-slot 16

(This annex forms an integral part of this Recommendation)

A.1 This annex describes a signalling protocol which utilizes time-slot 16 of a CEPT 30 channel 2 Mbit/s system (see Recommendation G.704). Use is made of the standard frame and multi-frame structure of TS16 to convey both transmission resource management information, bearer service selection and maintenance signals between a DCME terminal and its associated switching centre. Spare bits within TS16 are used to provide a comprehensive range of signals.

A.2 TS16 frame 0 has three spare bits (5, 7, and 8). These are used to provide transmission of transmission resource information and maintenance signals when it is possible to carry TS16 frame 0 between the DCME and the International Switching Centre. (Equipment placed between the DCME and the International Switching Centre such as time-slot interchange equipment, may prevent this).

A.3 In order to allow TS16 to carry other channel associated signalling protocols (e.g. R2D), only two of the four available bits are used in TS16 frames 1-15, for DCME signalling; either bits A and B, or C and D. The DCME terminal and the switching centre can select either pair of bits per 2 Mbit link if this option is necessary.

A.4 The signalling system employs a continuous state protocol, utilizing TS16 frame 0 for transmission resource management (TRM) and maintenance signals. TS16 frames 1-15 within the multi-frame are assigned to telephone channels 1-30 according to Recommendation G.704, and provide the DCME connection type requests for individual channels.

A.5 The TS16 signals are passed over each 2 Mbit/s system. This allows one or more ISCs to be served by a single DCME. Independent working of each 2 Mbit/s system ensures that under failure conditions of a 2 Mbit/s transmission link, traffic carried by other 2 Mbit/s systems is unaffected.

A.6 The DCME terminal will transmit and receive transmission resource management, connection type selection, and maintenance signals, from each TS16 of a 2 Mbit/s system. For example, the DCME will transmit a number of simultaneous "No trunk(s) available for 3.1 kHz audio or speech" signals to the ISCs. Connection type selection signals are exclusive to the channels within each 2 Mbit/s system.

Signal descriptions

Transmission Resource Management

A.7 No trunk(s) available for 3.1 kHz audio or speech: (DCME >>> ISC). No bearer capacity is available to set up new calls.

A.8 No channel(s) available for 3.1 kHz data: (DCME >>> ISC). No bearer capacity is available for additional 3.1 kHz calls. This signal is optional, depending upon the facilities and design of the DCME. If it is not required the "No capacity for speech" signal also means "No 3.1 kHz capacity". This signal is retained for backward compatibility only and is not to be used in implementations based on 1992 (or later) Recommendations. The actions to be taken are the same as for the signal in A.6.

A.9 No 64 kbit/s capacity available: (DCME >>> ISC). Receipt of this signal shall cause the switching centre to prevent setting up any calls requiring unrestricted 64 kbit/s capacity, end to end.

A.10 DCME terminal working normally: (DCME >>> ISC). This is transmitted if no other signals are to be sent.

A.11 ISC normal: (ISC >>> DCME). When the ISC has no other signal to send, this signal is transmitted.

Maintenance signals

A.12 Maintenance release request: (DCME >>> ISC). This request is sent when the DCME terminal is to be removed from service for maintenance. The switching centre(s) can refuse the request by withholding its acknowledgement signal. This gives security in the event of erroneous operation at the DCME.

A.13 Maintenance release request acknowledgement: (ISC >>> DCME). If the switching centre accepts the maintenance release request an acknowledgement is sent.

A.14 DCME clear of traffic: (ISC >>> DCME). If the ISC has accepted the maintenance release request signal, this signal informs the DCME when all circuits are idle, enabling maintenance to be performed. The ISC also prevents new calls from being generated.

A.15 Maintenance signals are sent for the duration of maintenance procedures until a change of status is required (e.g. the maintenance release request signal remains until DCME normal is sent).

A.16 The coding for the transmission resource management and maintenance signals in TS16 frame 0 are as follows:

DCME >>> switching centre	Bits 5 7 8
Maintenance release request	1 1 0
No trunk(s) available for 3.1 kHz audio or speech	1 1 1
No channel(s) available for 3.1 kHz (Note)	0 1 1
No 64 kbit/s capacity available	1 0 1
DCME normal	1 0 0
NOTE – This signal is retained for backward compatibility only and is not to be used in implementations based on 1992 (or later) Recommendations.	

Switching centre >>> DCME	Bits 5 7 8
Maintenance release request acknowledgement	1 1 0
DCME clear of traffic	1 1 1
Switching centre normal	1 0 1

Bearer service select signals

A.17 The appropriate signals are sent on an individual circuit basis. Special service signals are sent for the duration of every call attempt, whilst the availability signals are sent continuously. Use of TS16 frames 1-15 removes the need to provide the identify of the requesting circuit on a separate basis.

A.18 64 kbit/s unrestricted request: (ISC >>> DCME). This is a call request for a transparent 64 kbit/s channel, i.e. no DCI or LRE must be applied. This signal is maintained for the duration of the call. Its removal by the ISC indicates to the DCME that the connection can be released.

A.19 3.1 kHz data request: (ISC >>> DCME). This is a call request to allocate a channel suitable for data transmission. This signal is maintained for the duration of the call. Its removal by the ISC indicates to the DCME that the connection can be released. This signal is optional and is not to be used in new implementation.

A.20 Normal service: (ISC >>> DCME). This is transmitted when the ISC requires connection type 3.1 kHz audio or speech.

A.21 Channel out of service/unavailable: (DCME >>> ISC). The DCME transmits this signal when for any reason it is unable to accept traffic. The switching centre shall then apply busy or force release conditions to the related circuit. This signal allows actions to be taken on a per-circuit basis as in Recommendation Q.33.

A.22 Normal service available: (DCME >>> ISC). Indicates that the channel will carry the connection type 3.1 kHz audio or speech.

A.23 Special service acknowledgement: (DCME >>> ISC). This signal is sent as an acknowledgement to a 64 kbit/s request to confirm that the DCME resources have been allocated to meet the requirements of the requested service. In existing implementations it may also be used to acknowledge the request described in A.19.

A.24 The coding of the bearer service signals in TS16 frames 1-15 are as follows:

Switching centre >>> DCME	Bits	A(C)	B(D)
64 kbit/s request		1	1
3.1 kHz (Note) request		1	0
Normal service available		0	1
NOTE – Indicates that this signal is only used in existing implementations.			

Annex B

Example of a signalling system between DCME and ISC

(This annex forms an integral part of this Recommendation)

B.1 General

The interface between ISC and DCME described below is intended to connect Deutsche Bundespost exchanges to the TAT-8 cable from 1988 onward.

Appropriate test equipment has been available since the end of 1986.

The mentioned interface has three basic functions:

- dynamic load control between ISC and DCME;
- conveyance of transmission-related alarms;
- seizure and release of 64 kbit/s unrestricted circuits “on demand”.

B.2 Physical level of interface

For transmission of the signalling signals, the interface operates with 2 bits each for the forward and backward directions during call set-up. In the incoming seizure direction the same bits are used only for the transmission of alarm conditions (see also Recommendation Q.33).

To avoid a special interface at the ISC, DCME/ISC signalling is transmitted in the same PCM system to the DCME as the speech and data circuits.

Since the connected ISC has only 2 Mbit/s interfaces, time slot (TS) 16 of these 2 Mbit/s PCM-systems is used in the manner described in 3.3.3.2.2/G.704. (In principle, any other physical interface with 2 × 2 bits is suitable for the forward and backward directions.)

The use of TS16 offers the possibility of transmitting information for each channel individually (channel associated signalling).

The application of this transmission mode between ISC and DCME has considerable merits (e.g. transmission of alarms per channel, “soft” DLC, flexible use for point-to-point, multiclique, multi-destination modes, flexible size of circuits groups, simple control for selective traffic management (STM), i.e. 64 kbit/s seizures can be limited to a pre-selectable maximum number of simultaneous seizures at different daytimes). This means that TS16 is not available for other applications on the section between ISC and DCME. This restriction, however, concerns only the short section up to the DCME. Due to the time slot interchange (TSI) function, no loss is caused on the LRE/DSI section.

B.3 Distribution of functions between DCME and ISC

B.3.1 DCME functions

The DCME converts the bit rate available on the bearer into ISC-intelligible information on seizable/non-seizable circuits, the seizable ones being distinguished according to 64 kbit/s or speech/3.1 kHz audio seizability. In this process, the DCME takes account of the instantaneous limits for the number of 64 kbit/s circuits (min, max, STM function).

Consequently, three conditions are distinguished for each circuit:

- free for 64 kbit/s seizures;
- free for speech/3.1 kHz audio;
- non-seizable.

A change between these conditions is allowed with a maximum of only 0.1 Hz, whereas a transition to the non-seizable condition is directly possible.

The 3.1 kHz bearer and the speech bearer services are distinguished only in the DCME, using a 2100 Hz tone sent by the terminal. No distinction is made by the ISC. Information on the seizable and non-seizable circuits is sent continuously to the ISC. Moreover, alarm and maintenance information is passed on to the ISC.

B.3.2 ISC functions

The ISC takes over the information sent by the DCME and searches circuits, according to their condition reported by the DCME.

B.4 Signalling code

The codes shown in Table B.1 are applied for transmission of the necessary signals.

B.5 Signalling procedures

B.5.1 Successful call setup

The ISC searches a circuit as requested and sends the corresponding seizure signal for a circuit. The DCME receives the seizure signal and sends

- an immediate positive acknowledgement in the case of a 3.1 kHz/speech seizure (if not opposed by DCME-internal reasons);
- a positive acknowledgement in the case of 64 kbit/s seizure as soon as possible, i.e. as soon as through-connection of the 64 kbit/s circuit has been ensured.

After receipt of the positive acknowledgement the ISC starts the interexchange signalling (e.g. Signalling Systems No. 5 and No. 7). [Basically, the same procedure (sending of the corresponding seizure signal/acknowledgement/continuation of interexchange signalling) allows also a change of the bearer service during the call.]

B.5.2 Unsuccessful call setup

In the event of a missing positive acknowledgement the ISC sends, after 150 ms, a busy signal in the backward direction or another, free circuit is searched.

B.5.3 Call release

As soon as an ISC recognizes that the call is to be released (clear forward, release), it sends a release signal to the DCME. If required, the DCME releases the connection to the other DCME. A renewed seizure of the released circuit must not take place before a time-out of 150 ms in order to enable the DCME to indicate changes in the seizability of this circuit.

TABLE B.1/Q.50

Signalling modes

Signal No.	Type of signal	Direction ISC-DCME	Bits a, b of TS16, call set-up direction				Group of information element
			Forward		Backward		
			a_f	b_f	a_b	b_b	
1	Circuit available for 64 kbit/s		1	0	1	0	Load control
2	Circuit available for 3.1 kHz data, speech		1	0	0	1	
3	Circuit not available		1	0	0	0	
4	64 kbit/s seizure		1	1	1	0	Seizure release
5	3.1 kHz/speech seizure		0	1	0	1	
			(0	1	1	0) (Note)	
6	64 kbit/s positive acknowledgment		1	1	0	1	
7	3.1 kHz/speech positive acknowledgement		0	1	1	0	
			(0	1	0	1) (Note)	
8	Release 64 kbit/s		1	0	0	1	
9	Release 3.1 kHz/speech		1	0	1	0	
			(1	0	0	1) (Note)	
10	Maintenance release signal (after 3.1 kHz, speech seizure)		0	1	0	0	Maintenance
11	Maintenance release signal (after 64 kbit/s seizure)		1	0	0	0	
12	Maintenance release acknowledgement		0	0	0	0	
13	CME clear of traffic		1	0	0	0	
14	Out of service a		0	0	1	1	
	b		0	1	1	1	
	c		1	0	1	1	
	d		1	1	1	1	
15	Out of service acknowledgement		0	0	1	1	
16	Back in service		0	0	0	1	

NOTE – This bit combination is required only if 3.1 kHz/speech seizure is to be permitted for circuits marked available for 64 kbit/s.

B.5.4 Maintenance procedures

The DCME offers the possibility to prevent renewed seizures of circuits after their release. For this purpose the maintenance release signal is sent.

This signal is immediately acknowledged by the ISC.

After the connection has been released, the ISC sends the signal “CME clear of traffic” and prevents a renewed seizure of this circuit. After maintenance work on the release circuits has been terminated, the DCME sends one of the “load control” signals. If the return signal “CME clear of traffic” is not sent

- the maintenance activities can be postponed and the DCME be reactivated via the “back in service” signal; or
- a forced release of the circuits still busy is achieved with the “out of service signal”.

Thereafter operation is resumed also by means of the “back in service” signal.

If the DCME equipment is faulty, it sends an “out of service” signal and, after fault removal, normal operation starts again, using the “back in service” signal.

B.6 DCME load tests

To conduct a test of both the DCME equipment and ISC-DCME signalling under realistic conditions, call simulators have been installed since the end of 1986. These simulators:

1) simulate the ISC-DCME signalling protocol for both interfaces (ISC side/DCME side);

2) simulate the switching-specific part of the call setup via interexchange signalling (first Signalling System No. 5 and later, after its introduction, also SS. No. 7);

3) generate pre-selectable load situations in the DCME by application of pulsed in-band tones.