Recommendation Q.45 | fR *bis*

TRANSMISSION CHARACTERISTICS OF AN ANALOGUE INTERNATIONAL EXCHANGE

1 Introduction

1.1 *General*

1.1.1 The concern of this Recommendation is the transmission performance of an analogue international exchange in terms of design objectives [1]. Related commissioning objectives [1] may be based on this Recommendation.

For the purposes of this Recommendation an analogue international exchange is a collection of equipment regarded as an entity by the Administration concerned. In the case of an analogue international transit exchange, it extends from the end of the incoming international line (point A of Figure 1/Q.45 | fIbis) to the beginning of the outgoing international line (point D of Figure 1/Q.45 | fIbis).

Exchange testing uses measuring points at boundaries of the same exchange individually agreed upon.

In contrast to exchange testing, circuit testing [2] is recommended between circuit access points expected to be located at or near by the actual analogue switching points (points B or C of Figure 1/Q.45 | fIbis). For the purpose of circuit line-up and maintenance procedures, automatic international exchanges should be provided with circuit test access points.

Applying this Recommendation due account should be taken to the different constitution of the section of transmisison under test compared to circuit testing [2].

Figure 1/Q.45 | is, p. 1

1.1.2 The essential transmission requirements for an international exchange are:

a) The transmission loss through the exchange should be substantially constant with time and independent of the routing through the exchange.

b) Crosstalk and noise contribution should be negligible compared with other transmission sections in a world-wide connection [3].

c) The distortion introduced should be small. These include attenuation distortion, non-linear distortion and intermodulation products.

d) Impedance and balance with respect to earth at the points in the international exchange to which the lines are connected should be closely controlled.

1.1.3 This Recommendation applies to analogue automatic 4-wire international exchanges. It is desirable that it should also apply to analogue national 4-wire exchanges.

The following requirements are intended to be used only for type tests, acceptance tests, or for special investigations. They do not constitute a complete specification. Generally the recommended tests should be conducted on a sampling basis.

1.2 *Definitions*

1.2.1 **connection through an analogue international exchange**

A connection through an analogue international exchange comprises the 4-wire speechpath between the exchange boundaries denoted by points A and D of Figure 1/Q.45 | fIbis . However with exception of crosstalk all transmission requirements are addressed to the 2-wire path of each direction. The GO direction is indicated by a heavy line in Figure 1/Q.45 | fIbis and referred to as a typical section of transmission in the context of this Recommendation.

1.2.2 *Reference points*

1.2.2.1 **exchange input and output ports**

An exchange input and output port has to be defined for unidirectional measuring access. For the GO direction of transmission indicated by a heavy line in Figure 1/Q.45 | fIbis , the boundary at the point A constitutes the input port and the boundary at the point D constitutes the output port respectively. For the RETURN direction of transmission the constitution is approached vice versa.

The exact location of each of the points A and D, and hence of input and output ports depends on national practice and therefore it is unnecessary for the CCITT to define it. Only the national authority responsible for each international transit exchange can fix the location of these points and thus define the boundaries of the exchange concerned.

1.2.2.2 **virtual analogue switching points (VASP)**

The virtual analogue switching points are theoretical points. They are fixed by convention as points where two circuits are considered to be directly connected without any additional loss or gain [4, 5]. Depending on the transmission loss T of the circuits to be connected the relative levels at the virtual analogue switching point can be different for the incoming and outgoing direction respectively. The relative levels agreed upon by CCITT are shown in a hypothetical arrangement in Figure 2a/Q.45 | fIbis relative levels at actual switching points may differ in values, as for example indicated in Figure 2b/Q.45 | fIbis .

1.2.3 *Relative levels*

1.2.3.1 **nominal relative levels at exchange boundaries**

For the GO direction of transmission indicated by the heavy line in Figure 1/Q.45 | fIbis :

— the nominal relative level at the exchange input port at point A is designated L_i;

— the nominal relative level at the exchange output port at point D is designated L_o.

For the RETURN direction of transmission the input port with its nominal relative level L_i is located at point D and the output port with its nominal relative level L_o is located at point A.

The values of the nominal relative levels L_i and L_o may be different for each 2-wire path of a 4-wire connection through the analogue international exchange.

Figure 2/Q.45 | is, p. 2

1.2.3.2 **nominal relative levels at virtual analogue switching points**

The nominal relative levels at the virtual analogue switching points are defined to assure stability and to assist maintenance procedures [3] [4].

The difference of the nominal relative level at the end of the incoming 2-wire path and the nominal international through-connecting level, which is by convention —3.5 dBr, is the stability loss T assigned to a 2-wire path of a 4-wire circuit. By the value of this loss T the nominal transmission loss of a 2-wire path of a connection through an analogue international exchange is referred to its virtual analogue switching point.

1.2.4 *Measurement conditions*

1.2.4.1 **reference frequency**

The nominal reference frequency, on which relative levels, transmission loss, loss-frequency distortion etc. are based, is 800 Hz or 1000 Hz alternatively [5].

Note — Since 1020 Hz is the recommended nominal frequency for techniques using digital processes this frequency should be preferred to harmonize into the evolving digital network [6].

1.2.4.2 **impedance**

Measurements shall be made under nominally matched conditions, i.e. the exchange boundaries are terminated with their nominal exchange impedance.

1.2.4.3 **test levels at exchange boundaries**

At the nominal reference frequency, test levels are defined in terms of the apparent power relative to 1mW. At frequencies different from the nominal reference frequency, test levels are defined as having the same voltage as the test level at the nominal reference frequency. Measurements are based on the use of a test generator with a frequency-independent e.m.f. and which has an impedance equal to the nominal impedance.

1.2.5 *Transmission loss*

1.2.5.1 **nominal transmission loss**

A connection through an analogue international exchange (see Figure 1/Q.45 | fIbis) is established by connecting an input port located at one exchange boundary to an output port located at another exchange boundary in both directions.

The nominal transmission loss of a 2-wire path of a connection through an exchange is equal to the difference of the relative levels at the input and the corresponding output:

$$NL = (L_i — L_o) \text{ dB}$$

Note — The nominal transmission loss of the exchange may be different in the GO and RETURN direction of transmission.

1.2.6 **loss distortion with frequency**

The loss distortion with frequency is the logarithmic ratio of output voltage at the reference frequency, *U* (Ref), divided by its value at frequency *f* , *U* (*f*):

$$LD = 20 \log \left| \frac{\text{f IU (Ref)}}{f\,I\,U(f)} \right|$$

(See Supplement No. 1 to Volume VI, Fascicle VI.5, CCITT [6].)

2 VF-parameters of a connection through the exchange

2.1 *Impedance*

2.1.1 *Nominal value*

The nominal impedance at the input and output ports located at points A and D of Figure 1/Q.45 | fIbis shall be 600 ohms, balanced.

2.1.2 *Return loss*

The return loss of one port located at point A or D of Figure 1/Q.45 | fIbis has to be measured againts the nominal impedance whilst all other ports of the connection through the exchange are terminated with the nominal impedance.

At any frequency from 300 to 600 Hz the return loss should be not less than 15 dB. The corresponding value from 600 to 3400 Hz should be not less than 20 dB.

2.1.3 *Impedance unbalance about Earth*

The impedance unbalance about Earth is measured as longitudinal conversion loss (LCL) according to Figure 1/O.9 [16] and as longitudinal conversion transfer loss (LCTL) according to Figure 2/O.9 [16] at the interfaces located at points A and D of Figure 1/Q.45 *bis* using Z = 600 ohms and ZL = 150 ohms.

The measured values should not be worse than:

300- 600 Hz: 40 dB

600-3400 Hz: 46 dB

Note — Some Administrations guided by their knowledge of local conditions may feel a need to specify a value of impedance unbalance about Earth for a lower frequency, for instance, 50 Hz.

2.2 *Values of relative levels* L_o

2.2.1 *Basic nominal values*

Basic nominal values for the input level L_i and the output level *L* of a connection through an analogue international exchange are given in Table 1/Q.45 | fIbis . For the purpose of demonstration, these values are valid under the following hypothetical assumptions:

— there is no transmission impairment between the points X and A and the points D and Y of Figure 1/Q.45 | fIbis ;

— the nominal relative levels L_i and L_o

are determined by the corresponding nominal relative levels of the channel translating equipment recommended for two cases in Table 2/G.232 [7] corrected by the nominal per-channel loss of the international circuit, T = 0.5 dB.

H.T. [T1.45]

TABLE 1/Q.45 | fIbis

Basic nominal values of relative levels at the exchange boundaries of a connection through an analogue international exchange

Relative level	Channel translating equipment	
	Case 1	Case 2
L	. +4 dBr	. +7 dBr
L	*—14.5 dBr*	*—16.5 dBr*

Table 1/Q.45 | is [T1.45], p.

Nominal values of relative levels will differ in practice from these basic nominal values by the impact of various equipment being inserted and the necessary cabling to interconnect the channel translating equipment to the exchange boundaries. Due account should be taken of this impact in specifying corresponding nominal relative levels, especially by cable length between points X and A and points D and Y in Figure 1/Q.45 | fIbis .

2.2.2 *Offset of mean actual values*

The actual value of the output relative levels depend on the tolerances of components, i.e. mainly attenuation pads, and on the routing of a connection through an exchange via the switchblock (Points B and | in Figure 1/Q.45 | fIbis).

The offset of the mean value of the distribution of the actual output relative levels L_o should be very close to zero but does not need to be specified.

2.2.3 *Dispersion of actual values*

The dispersion of actual values of the output relative level L_o is mainly due to the diversity of paths in the switchblock. The standard deviation of a representative distribution of the actual output relative levels measured at the nominal reference frequency should be as small as practicable. For purpose of calculation a value of 0.2 dB may be assumed.

In order to confirm this value, it is considered sufficient that for purposes of design and acceptance testing, the difference between the actual relative output levels at the nominal reference frequency of the shortest and longest paths from point B to point C in Figure 1/Q.45 | fIbis in no case exceeds 0.8 dB. For a practical assessment of the average value of the actual relative output level, the influence of the switchblock between points B and C can be achieved using the arithmetically computed mean of the maximum and minimum actual relative output levels.

These values apply for connections routed directly, and once only, through the switchblock. If special re-entrant trunking arrangements are used, requiring the connection to pass through the switchblock twice (this may be a convenient way to extend the availability of the switching network or to introduce additional equipment, e.g. echo suppressors), the distribution of the actual relative output levels will be increased to lower values. In view of this, the re-entrant technique should not be used to such an extent as to decrease significantly the mean value of the actual relative output level distribution.

2.3 *Basic nominal values of transmission loss*

In accordance with the definition in § 1.2.5.1 and the basic nominal values of relative levels quoted in § 2.2.1 the following basic nominal values of transmission loss result for the purpose of demonstration:

case 1: NL = +4 dB — (—14.5) dB = 18.5 dB

case 2: NL = +7 dB — (—16.5) dB = 23.5 dB.

2.4 *Response to frequency and input level*

2.4.1 *Loss distortion with frequency*

The loss distortion with frequency according to the definition in § 1.2.6 measured on any 2-wire path of connection through the exchange between points A and D of Figure 1/Q.45 | fIbis should lie within the following limits:

300- 400 Hz: —0.2 dB to +0.5 dB

400-2400 Hz: —0.2 dB to +0.3 dB

2400-3400 Hz: —0.2 dB to +0.5 dB.

2.4.2 *Variation of output level with input level*

The actual output level measured on any 2-wire path of a connection through the exchange between points A and D of Figure 1/Q.45 | fIbis should follow the input level with a variation not more than 0.2 dB in the range of the input level from —40 dBm0 to +3.5 dBm0, using the reference frequency.

2.4.3 *Group delay distortion with frequency*

According to the definition of group delay [9], the group delay distortion measured on any 2-wire path of a connection through the exchange between points A and D of Figure 1/Q.45 | fIbis over the frequency band 600 to 3000 Hz should not exceed 100 microseconds.

2.4.4 *Intermodulation*

The intermodulation products shall be measured on any 2-wire path of a connection through the exchange between points A and D of Figure 1/Q.45 | fIbis .

The intermodulation products to be taken into account for end-to-end multifrequency signalling and for data transmission are those of the third order, of type ($2f_1$-f_2) and ($2f_2$-f_1) where f_1 and f_2 are two signalling frequencies.

For a measurement of the intermodulation products, the two frequencies applied to an input are f_1 = 900 Hz and f_2 = 1020 Hz (see [8]). With each frequency f_1 and f_2 at a level of —6 dBm0, the difference at the output between the level of either frequency f_1 or f_2 and the level of either of the intermodulation products at $(2f_1-f_2)$ or $(2f_2-f_1)$ should be at least 40 dB.

2.5 *Noise*

For a 4-wire international exchange, noise measurements should be performed on a connection through the exchange between points A and D of Figure 1/Q.45 **|** fIbis during the busy hour [10]. Each port should be terminated with 600 ohms. The noise should be measured at the output port of each 2-wire path and should be referred to a point of zero relative level. Thus in Figure 1/Q.45 **|** fIbis the noise in the 2-wire path of the GO direction is measured at point D and the noise in the 2-wire path of the RETURN direction is

measured at point D and the noise in the 2-wire path of the RETURN direction is measured at point A. A sufficient variety of connections should be chosen to ensure that the measurements are representative of the various possible routes through the exchange.

2.5.1 *Weighted noise*

The mean value of the psophometrically weighted noise over a long period during the busy-hour should not exceed —67 dBm0p (200 pW0p).

2.5.2 *Unweighted noise*

Unweighted noise has to be measured with a device having a uniform response curve throughout the frequency band 31.5 Hz-16 kHz [11].

The mean value of the unweighted noise over a long period during the busy-hour should not exceed —40 dBm0 (100,000 pW0).

2.5.3 *Impulsive noise*

For measurement procedure of impulsive noise see Annex A of this Recommendation.

Noise counts should not exceed 5 counts in 5 minutes at a threshold level of —35 dBm0.

Note — Figure 3/Q.45 **|** fIbis shows the maximum number of impulsive noise counts acceptable in a 5-minute period.

2.6 *Crosstalk*

Crosstalk should be measured in exchanges at a frequency of 1100 Hz in accordance with Recommendation G.134 [12].

2.6.1 *Crosstalk between different connections*

(Inter-connection crosstalk)

In an analogue international 4-wire exchange the signal to crosstalk ratio measured at points A and D of Figure 1/Q.45 **|** fIbis between any 2-wire paths of different 4-wire connections through the exchange should be 70 dB or better.

This limit of 70 dB should normally apply to the most unfavourable case, in which two connections have parallel paths throughtout the exchange. It should be noted that this does not occur in practice, because normal cabling layout in such that when, at one switching stage, two connections use adjacent switches, in the following stage the two connections generally use switches which are not adjacent.

2.6.2 *Go-to-return crosstalk of the same connection*

(Intra-connection crosstalk)

The signal-to-crosstalk ratio between the GO and RETURN 2-wire path of the same 4-wire connection through the exchange should be 60 dB or better.

3 Use of cables specified by the IEC

The cables for telephone exchanges in accordance with IEC (International Electrotechnical Commission) publication 189 [13] will meet the electrical characteristics required by the CCITT (especially as regards crosstalk) for ordinary exchanges, but this may no longer hold good for larger exchanges with considerable lengths of cable.

In accordance with Recommendation G.231 [14], it will be for the Administrations or the contractors to check whether standard cables will be satisfactory in equipping an exchange which requires telephone cables of exceptional lenght.

Figure 3/Q.45 | is, p. 4

ANNEX A

(to Recommendation Q.45 | fIbis , § 2.5.3)

Procedure for impulsive noise measurement

A.1 A test circuit should be formed by setting up a connection across the switching unit and terminating the connection on the exchange input by the nominal impedance and on the exchange output by the impulse measuring device in parallel to the terminating nominal impedance. Those terminated ports should be at points A and D in the diagram of Figure 1/Q.45 | fIbis which includes the switching equipment of the exchange. Where it is the desire of an

Administration, measurements may be made at points X and Y if precautions are taken to ensure that the result apply only to the automatic switching equipment, signalling equipment, echo suppressors, relay sets, pads and cabling of the exchange.

A.2 The measurements should be made using the device specified in Recommendation O.71 [15]. The 600-3000 Hz filter network should be in the circuit.

A.3 The measurements should be made at times when the probability of noise occurring is at its highest, that is normally during the busy-hour.

A.4 The time of observation for each test should be five minutes.

Note — The number of different test circuits set up through the exchange for measuring should take into account the size and complexity of the switching unit and should be representative for all various routes through the exchange. See also the documents cited in [15] and [17].

References

[1] Recommendation *Transmission performance objectives and Recommendations* , Vol. III. Fascicle III.1, Rec. G.102, §§ 3 and 4.

[2] CCITT Recommendation *Circuit testing* , Vol. IV, Fascicle IV.1, Rec. M.110, § 1.

[3] CCITT Recommendation *The transmission plan* , Vol. III, Fascicle III.1, Rec. G.101, §§ 2.1 and 5.4.

[4] CCITT Recommendation *Loudness ratings (LR) in an international connection* , Vol. III, Fascicle III.1, Rec. G.111, § 1.1.

[5] CCITT Recommendation *The transmission plan* , Vol. III, Fascicle III.1, Rec. G.101, § 5.3.5.

[6] CCITT Recommendation *Transmission characteristics of digital exchanges* , Vol. VI, Fascicle VI.5, Recs. Q.551 and Q.553 (including Supplement No.1).

[7] CCITT Recommendation *12-channel terminal equipment* , Vol. III, Fascicle III.2, Rec. G.232, Table 2/G.232.

[8] CCITT Recommendation *Characteristics of compandors for telephony* , Vol. III, Fascicle III.1, Rec. G.162, § 5.2.

[9] CCITT Definitions: *Group delay* , Vol. I, Fascicle I.3 (Terms and definitions)

[10] CCITT Definitions: *Busy-hour* , Vol. I, Fascicle I.3 (Terms and definitions)

[11] CCITT Recommendation *Psophometer for use on telephone-type circuits* , Vol. IV, Fascicle IV.4, Rec. O.41, Figure 1/O.41

[12] CCITT Recommendation *Linear crosstalk* , Vol. III, Fascicle III.1, Rec. G.134.

[13] Publication 189 of the IEC.

[14] CCITT Recommendation *Arrangement of carrier equipment* , Vol. III, Fascicle III.2, Rec. G.231.

[15] CCITT Recommendation *Impulsive noise measuring equipment for telephone-type circuits* , Vol. IV, Fascicle IV.4, Rec. O.71.

[16] CCITT Recommendation *Measurement arrangements to assess the degree of unbalance about Earth* , Vol. IV, Fascicle IV.4, Rec. O.9.

[17] *Measurements of impulsive noise in a 4-wire telephone exchange* , Green Book, Vol. IV-4, Supplement No. 7, ITU, Geneva, 1973.

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SECTION 8

SIGNALLING FOR SATELLITE SYSTEMS

Recommendation Q.48

DEMAND ASSIGNMENT SIGNALLING SYSTEMS

1 The term ‘‘demand assignment’’ (abbreviated as DA) should be taken as meaning that the assignment is on a per-call basis.

Note — Satellite circuits with demand assigned multiple access are those circuits which may be set up by assignment of a satellite link to operate between specified earth stations when the actual demand arises.

The origin, destination, or both of the satellite link can be varied. The link is assigned to set up the required telephone circuit according to the call.

This defines the following concepts:

1) variable destination satellite link;

2) variable origin satellite link;

3) fully variable satellite link (the origin and destination of which may both be varied).

The Recommendation covers, when applicable, fully variable and variable destination types of DA systems.

2 The DA signalling system shall be capable of interworking with all currently standardized CCITT signalling systems and shall have the capacity to carry all the telephony signals currently provided by these CCITT signalling systems and shall in addition provide reserve capacity.

Any currently standardized CCITT signalling system shall be able to be applied to any access link. Different CCITT signalling systems may be applied to the various access links at the same time.

3 Account should be taken of the fact that particular earth stations may have special signalling requirements to suit the CTs using these earth stations (e.g. joint use of an earth station by a number of CTs, long distances between CT and earth station, CTs with access to more than one earth station).

4 The DA signalling system shall be an integrated signalling system used both for:

a) signalling for setting up the DA speech circuit; and

b) transfer of the information flow for telephony.

5 The DA signalling system shall be capable of transmitting address information in both the *en bloc* and the overlap mode of operation. The transmission of address information by the outgoing DA system terminal should be such as to result in minimum delay to these signals in the DA system.

The manner of transmitting signals over the DA signalling system shall be independent of the type of signalling system to be encountered in the access link at the far end.

See also the reference cited in [1].

Accordingly, the interworking arrangements described in Table 1/Q.48 are recommended. (For definitions of ‘‘*en bloc* ’’ and ‘‘*en bloc* overlap’’ see the definitions in Recommendation Q.151 [2].)

Table 1/Q.48 (a traiter comme figure MEP), p.

6 The DA signalling system shall send out address digits from ES_B to CT_B in the correct order, that is, the order of dialling.

7 Means shall be provided for preventing spillover of signals between successive calls, which use the same satellite channel through the DA signalling system.

8 The DA signalling system should be capable, for the sequence *re-answer signal-clear back signal* of correctly extending to CT_A from ES_A, the last state representing the final position of the called party's switch hook.

9 The message structure of the demand assignment signalling system should be such that one message will contain all the information necessary for one event (e.g. answer signal for one particular circuit). Single unit and multi-unit messages should be catered for. Each signal unit should contain both information and check bits.

10 All time-outs for both normal and abnormal conditions in the DA signalling system should be designed according to the recommendations concerning the relevant CCITT signalling systems.

11 Signal transfer time through the DA signalling system should be fast. While no firm time requirements in regard to the various components of signal transfer time have been established, design objectives in terms of

average and 95% level values for the signal transfer time (T_d) for answer signals, other one-unit messages and the initial address message are given. These figures are to be viewed as reasonable objectives and not as firm requirements.

11.1 *Signal transfer time in the DA signalling system*

A signal transfer time in the DA signalling system is specified. This signal transfer time is called T'_d in the diagram of Figure 1/Q.48.

Figure 1/Q.48, p.

The value $T_d = T'_d - T_p$ should be used as the design objective for the DA signalling system. The values of T_d calculated for the design of the system are shown in Table 2/Q.48.

Note — These figures have to be interpreted as reasonable estimates and not as firm requirements.

H.T. [T1.48]

TABLE 2/Q.48

Values of signal transfer times for design of a DA signalling system

Design objectives for *T*

{ *T* = *T'* — *T* }				
T in ms	*Type of message* *AV* *95% level*	*Answer* *52* *85*	*Other one-unit message* *85* *175*	*IAM of 5 SU* *145* *235*

Table 2/Q.48 [T1.48], p.

For calculation use the following relations:

$$T_d = 2T_h + T_s + T_r = T_c + T_h \quad (11\text{-}1)$$

$$T_{d\,av} = T_{c\,av} + T_{h\,av} \quad (11\text{-}2)$$

$$T_{d\,95\%} = T_{d\,av} + \sqrt{(\Delta T_c f R)^2 + (\Delta T_h f R)^2} \quad (11\text{-}3)$$

where $\Delta T_c = T_{c\,95\%} - T_{c\,av}$ (11-4)

$\Delta T_h = T_{h\,95\%} - T_{h\,av}$ (11-5)

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For basis of calculation see [4].

12 Dependability requirements

The requirements specified for System No. 6 (see [5]) are recommended as the objectives for the DA signalling system.

12.1 *Signal transfer dependability* | (see [6])

‘‘*b)* Signal units of any type which give rise to wrongly accepted signals due to undetected errors and causing false operation (e.g. false clear-back signal):

not more than one error in 10^8 of all signal units transmitted, and

c) As in item *b)* but causing serious false operation (e.g., false metering or false clearing of a connection):

not more than one error in 10^{10} of all signal units transmitted.’’

12.2 *Error correction by retransmission* | (see [7])

Although the bit error rate in the DA signalling system has not been determined, the design of the system should be made such that a design objective ‘‘not more than one in 10^4 signal units carrying telephone

information is allowed to be delayed as a consequence of error correction by retransmission.’’

12.3 *Interruption of the signalling service* | (see [8])

System No. 6 requirements are:

— interruption of duration between 2 seconds and 2 minutes: not more than once a year;

— interruption of duration exceeding 2 minutes: not more than once in 10 years.

Since the speech circuits and the signalling channel in the DA system normally will be interrupted simultaneously, it is understood that the above figures are related to the signalling equipment and not to the transmission media common to both the signalling channel and the speech circuits.

References

[1] *Signalling for demand assignment satellite systems* , Green Book, Vol. VI-4, Supplement No. 8, ITU, Geneva, 1973.

[2] CCITT Recommendation *Signal code for register signalling* , Vol. VI, Rec. Q.151.

[3] CCITT Recommendation *Signal transfer time definitions* , Vol. VI, Rec. Q.252.

[4] CCITT Recommendation *Signal transfer time requirements* , Vol. VI, Rec. Q.287, Annex A.

[5] CCITT Recommendation *Service dependability* , Vol. VI, Rec. Q.276, § 6.6.1.

[6] *Ibid.* , § 6.6.1, b) and c).

[7] *Ibid.* , § 6.6.1, a).

[8] *Ibid.* , § 6.6.1, d).

SECTION 9

AUTOMATIC TESTING EQUIPMENT

Recommendation Q.49

SPECIFICATION FOR THE CCITT AUTOMATIC TRANSMISSION MEASURING AND SIGNALLING TESTING EQUIPMENT ATME No. 2

(The specification for ATME No. 2 appears in Recommendation O.22, Fascicle IV.4.)

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SECTION 10

SIGNALLING FOR CIRCUIT MULTIPLICATION EQUIPMENT

Recommendation Q.50

SIGNALLING BETWEEN CIRCUIT MULTIPLICATION | EQUIPMENTS (CME)

AND INTERNATIONAL SWITCHING CENTRES (ISC)

1 Introduction

This Recommendation contains principles and examples of signalling between ISC (exchanges) 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.

2. Definitions relating to CME

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

2.1 *Digital circuit multiplication equipment (DCME) and CME*

DCME and CME 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 *CME gain*

The trunk channel to transmission channel multiplication ratio, which is achieved through application of CME, including LRE and/or speech interpolation (DSI).

Figure 1/Q.50, p.

2.6 *Trunk*

A bidirectional connection consisting of a forward channel and a backward channel between the ISC and CME 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 CME.

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.

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 Figures 2a/Q.50 and 2b/Q.50)

Using Figure 2a/Q.50 for reference, the transmit side CME concentrates N trunks into N/G transmission channels, where G is the CME gain.

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

The example in Figure 2b/Q.50 also shows a point-to-point mode. From the switching point of view there could be a difference between the configurations in Figures 2a/Q.50 and 2b/Q.50.

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

Figure 2/Q.50, p.

2.11.2 *Multi-clique mode* (see Figure 3/Q.50)

In this mode the pool of transmission channels is subdivided 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.

Figure 3/Q.50, p.

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/Q.50 shows a unidirectional system block diagram for a multi-destination mode with two transmit and two receive DCME units.

Figure 4/Q.50, p.

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. CME 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 CMEs into the telephone 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 CME, the possible outcomes are more complex.

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

a) Transmission capacity — The circuit multiplication characteristics of a CME result in a lower total transmission capacity for the CME 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 CME but no available transmission channels between two CMEs. 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 CME has available capacity to complete a new call.

b) Call set-up/release — Depending on the bearer service type of the call to be set-up, and on whether or not the CME is able by itself to establish the inter-CME connections, the seizing/releasing actions in the exchange may need to be extended to the CME by means of out-of-band information transfer. For example, in DSI systems, speech connections are made dynamically on detection of channel activity performed by built-in speech detectors. For 64 kbitB/Fs unrestricted on-demand connections (and for 3.1 kHz audio, if

appropriate) through DSI systems (i.e., not through internal pre-assignment), the establishment and disestablishment of connections between the CMEs have to be initiated from the outgoing exchange.

In general, these two aspects are strictly independent from each other as each serves a different purpose. However, depending on the design criteria in the CME and the call set-up procedures in the exchange and the CME associated with one aspect may be related to that of the other.

3.3 *Factors for signalling functions determination*

The functional requirements for signalling between CMEs and exchanges are determined by the type of CME with its capabilities and limitations, and by the types of bearer services it supports.

The remote control of echo control devices and A/μ-law converters, if they are integrated into the CME, is accomplished either by the terminal or test equipment or directly from the ISC (based on call set-up information/signalling information).

Requirements and actions for control of ECD are described in Recommendation Q.115.

3.3.1 *Circuit multiplication equipment and physical location*

There are different types of CME which are being used or will most likely be used in the international telephone network, each with its own capabilities and limitations:

a) 32 kbit/s low rate encoding (LRE);

b) analogue speech interpolation equipment;

c) digital speech interpolation (DSI) with 64 kbit/s PCM;

d) combined 32 kbit/s LRE and DSI

e) 16 kbit/s LRE.

The location of certain types of CME relative to the exchange determines the choice of signalling interface. These CMEs can be located at the ISC or remote from the ISC (e.g., at an earth station). Certain types of signalling interfaces may be more practical when these CMEs are co-located with the ISC, and others may be more practical when they are remote from the ISC. Therefore, the location of the CME needs to be considered when choosing the signalling between ISC and CME.

When the CME is remote from the ISC, the link between the ISC and CME could be composed of digital or analogue transmission path. Both conditions have different equipment configurations and different signalling requirements (see § 7).

3.3.2 *Bearer services supported on CME links*

Up to four basic bearer service types are supported or will likely be supported by CMEs in the international network:

— speech bearer service (full duplex, analogue or digital);

— 3.1 kHz audio bearer service (full duplex);

— 64 kbitB/Fs unrestricted bearer service (full duplex);

— alternate speech/64 kbit/s unrestricted bearer service (full duplex) (in-call modification is for further study).

Each CME type supports one or more bearer services depending on special facilities or functional options built in the equipment.

Different LRE algorithms will also have different levels of performance, for instance, in terms of voiceband data. Since certain speech optimized algorithms have limited transparency to voice band data, the CME 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 CME transmission problems from the ISC switching functions as much as possible to allow independent developments.

4 Bearer services and CME techniques in the context of signalling

Table 1/Q.50 gives the relationship between CME techniques and the four bearer services identified in § 3.3.2 with regard to their supportability and the need for CME-exchange message transfer.

The signalling function requirements are categorized on the basis of bearer services supported by the different CME techniques. For speech bearer services, transmission resource management (TRM) information alone is adequate especially for CMEs 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) exchange is needed for bearer services involving on-demand 64 kbit/s unrestricted service in contemporary digital circuit multiplication equipment (32 kbit/s LRE and DSI).

H.T. [T1.50]

TABLE 1/Q.50

Bearer services supported in CMEs in relation to CME-exchange signalling

<table>
<tr><th></th><th colspan="5">{
Circuit multiplication equipment
}</th></tr>
<tr><th>Bearer service</th><th>Analogue TASI</th><th>LRE 32 kbit/s</th><th>DSI 64 kbit/s PCM</th><th>DCME DSI+32 kbit/s/LRE</th><th>CDR 16 kbit/s</th></tr>
<tr><td>1. Speech
{
2.
3.1 kHz audio (up to 9.6 kbit/s VBD)</td><td>TRM | u1)</td><td>NX | ub)</td><td>TRM | ua)</td><td>TRM</td><td>NX | ub)</td></tr>
<tr><td>}
3. 64 kbit/s unrestricted
NX | ub), c)</td><td>NX
NS</td><td>NS
{</td><td>NX</td><td>TRM + CSM | ud)</td><td>FS</td></tr>
<tr><td>}
{
4.
Alternate speech 64 kbit/s</td><td>NX | ub)</td><td>TRM+CSM</td><td>FS</td><td></td><td></td></tr>
<tr><td>}
FS
}</td><td>NS</td><td>NX | ub)</td><td>NX | ub)</td><td>TRM+CSM</td><td>{</td></tr>
</table>

TRM Transmission resource management

CSM Call set-up messages between CME and ISC

NS Bearer service not supported

NX Bearer service supported without message exchange

FS Further study

a) Message exchange 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 CME special handling facilities.

Table 1/Q.50 [T1.50], p.

5 Division of functionality between the ISC and the CME

5.1 *CME dynamic load control process*

Transmission resource management (TRM) information is based on traffic load measurements at the local and distant CMEs. Therefore in the multi-destination and multi-clique mode of operation, TRM information is provided for each destination/clique separately.

A universal arrangement is used for handling TRM information between CME and an ISC. The TRM information is dynamically presented to the exchange in one of two states for each bearer service. The states are called ‘‘available’’ and ’’not available’’. Logic within the CME is used to determine which of the two states should be indicated to the exchange regardless of any condition at the exchange.

When a CME encounters a ‘‘not available’’ state for a bearer service (either locally or remotely), it presents this indication to the exchange so it will stop routing new calls to the CME for that bearer service even if there are free, unseized circuits available. The exchange will continue to prohibit calls to the CME until it receives an ‘‘available’’ indication for the bearer service when in both, local and remote CMEs, there is no overload.

This dynamic load control information is therefore directly influencing the circuit selection process in the exchange during call set-up for each bearer service separately. The circuit selection in the exchange is a check whether or not a free unseized circuit is suitable for a certain bearer service type, for which a new call is to be accommodated. For example, the exchange would select a free circuit for a speech call if ‘‘speech capacity available’’ is indicated, irrespective of the indications for other bearer service types. If the DCME link is unable to accommodate additional new 64 kbit/s calls, all free unseized circuits within the exchange will be marked accordingly. Even though the generation of bearer service related TRM information with DCMEs may be in part mutually dependent (i.e., no capacity for speech implies no capacity for any other bearer service types but not necessarily vice versa), separate signalling and processing for each bearer service type are necessary to allow different future CMEs to develop independently.

5.2 *Call set-up process*

According to Table 1/Q.50, the contemporary digital circuit multiplication equipment, having the capability to support on-demand all four identified bearer services, in addition to providing TRM to the exchange, requires call set-up messages (CSM) (from the exchange) for selecting bearer services.

For the 64 kbit/s unrestricted bearer service, a circuit is selected if ‘‘unrestricted capacity available’’ is indicated, and a CSM in the form of seizure/select request is forwarded to the DCME. An acknowledgement (positive or negative) is sent upon recognition of a 64 kbit/s request even if capacity is available.

The positive acknowledgement can be used by the ISC to initiate the interexchange signalling to the next ISC (e.g. transmission of the IAM of Signalling System No. 7). A failure to establish a 64 kbit/s circuit between CMEs must be reported to the ISC as soon as the condition has been identified by the CME by using an out-of-service message.

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

The released 64 kbit/s message from the ISC will be positively acknowledged after proper completion of the DCME circuit disestablishment process. Failure to complete this process shall be notified to the ISC 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 ISC.

Under a 64 kbit/s unrestricted dual seizure situation, the non-controlling ISC will initiate a release of the DCME connection using procedures defined in the appropriate inter ISC signalling system protocol. If the DCME is unable to re-establish a remotely released 64 kbit/s duplex connection, it shall indicate this abnormal situation to the appropriate ISC by an out-of-service message.

The information elements and procedures necessary to support the alternate 64 kbit/s speech bearer services are for further study.

Figure 5/Q.50, p.

5.3 *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 inter-dependency between TRM and CSM as described above.

6 Control information elements between ISC and CME

The amount of control information elements utilized between the ISC and the CME depends on the capabilities of the CME and the ISC. Two categories of CME signalling capabilities are recognized. The first category of CME (Type 1) is capable of only transmitting signals from the CME to the ISC (e.g. Dynamic Load Control, see § 6.1). The second category of CME (Type 2) is able to transmit and receive signals to/from the ISC. Tables 2/Q.50, 3/Q.50 and 4/Q.50 give a set of information elements and their flow on the control link between the ISC and the CME for the second category of CME.

6.1 *Information elements for Type 1 CME*

Type 1 CME only should use the following types of information elements. The ‘‘m’’ indicates mandatory use, the ‘‘o’’ optional use.

1. No capacity for speech available (m)
2. Channel(s) available for speech (m) (speech includes 3.1 kHz audio)
3. Out-of-service (o)
4. Back-in-service (o).

6.2 *Information elements for Type 2 CME*

H.T. [T2.50]

TABLE 2/Q.50

Information elements for transmission resource management (load control) CME/ISC (Type 2)

{ Type of information element | ua) } Direction of the information element }	Notes	{	
1.1 (m) No capacity for speech available } No bearer capacity for additional trunk(s) available }	{ { CMEISC		
1.2 (m) This information element is sent to notify the end of the ‘‘No capacity for speech available’’ }	Trunk(s) available for speech CMEISC	{	
1.3 (o) No trunk(s) available for 3.1 kHz audio (Note 1) } No bearer capacity for additional 3.1 kHz audio trunk(s) available }	{ { CMEISC		
1.4 (o) Trunk(s) available for 3.1 kHz (Note 1) } This information element is sent to notify the end of ‘‘No trunk available for 3.1 kHz audio’’ condition }	{ { CMEISC		
1.5 (m) No 64 kbit/s capacity available (Note 2) } No bearer capacity for additional 64 kbit/s trunk(s) available }	{ { CMEISC		
1.6 (o) Acknowledgement of ‘‘No 64 kbit/s capacity available’’ }	{	ISCCME	
1.7 (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 }	{ { CMEISC		
1.8 (o) Acknowledgement of trunk(s) available for 64 kbit/s }	{	ISCCME	

m Mandatory for this type of CME o Optional for this type of CME

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

Note 1 — This information may be implicit in information element 1.1 (e.g., because 3.1 kHz audio data and speech may be supported by the same LRE algorithm or 3.1 kHz audio data is detected by the CME using in-band signals (2100 Hz) from the data terminal).

Note 2 — 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 or 64 kbit/s), a special load control information is needed for each of these call types.

Tableau 2/Q.50 [T2.50], p. 14

H.T. [T3.50]

TABLE 3/Q.50

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

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

(Note 4) } Sent if speech request can be satisfied }	{ CMEISC		
2.13 (o) Speech negative acknowledgement (Note 4) } Sent if speech request cannot be satisfied }	{ { CMEISC		
2.14 (o) Sent to indicate that the speech circuit is not required any longer }	Release speech (Note 4) ISCCME	{	

m Mandatory for this type of CME o Optional for this type of CME

Note 1 — Preassigned digital non-interpolated (DNI) 64 kbit/s channels do not need this information element. A 64 kbit/s select/seizure information element between CME and ISC is mandatory for type 2 CME equipment, if 64 bit/s channels are used on a demand basis.

Note 2 — Depending on the realization of the CME there could be a longer or shorter delay for 64 kbit/s channel acknowledgement.

Note 3 — ‘‘Mandatory’’ refers to the presence of these information elements at the signalling interface between ISC and CME. The use of these elements is optional; however, these elements are preferred to provide safeguards for proper operation.

Note 4 — The request for speech service 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.

H.T. [T4.50]

TABLE 4/Q.50			
{ **Information elements for maintenance (CME/ISC) (Type 2)** } Type of information element Direction of the information element }	Notes	{	
3.1 (o) Maintenance release signal (Note) } Sent for manual control, *planned* | removal from service }	{ { CMEISC		
3.2 (o) Maintenance release acknowledgement (Note) } Sent to acknowledge reception of Maintenance Release, ISC is waiting for the release of the trunk }	{ { ISCCME		
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) }	{ { ISCCME		
3.4 (m) General CME trunk unavailable signal used on a per circuit basis }	Out-of-service CMEISC	{	
3.5 (o) Out-of-service acknowledgement } Sent to acknowledge ''out-of-service signal'' used on a per circuit basis }	{ { ISCCME		
3.6 (m) Sent after the removal from service is no longer necessary — used on a per circuit or per CME basis }	Back-in-service (Note) CMEISC	{	
3.7 (o) Acknowledgement of ''back-in-service'' }	{ Used on a per circuit basis	ISCCME	

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.

Tableau 3/Q.50 [T3.50], p. 15

H.T. [T4.50]
TABLE 4/Q.50
Information elements for maintenance (CME/ISC) (Type 2)

Type of information element Direction of the information element }	Notes	{	
3.1 (o) Maintenance release signal (Note) } Sent for manual control, *planned* | removal from service }	{ { CMEISC		
3.2 (o) Maintenance release acknowledgement (Note) } Sent to acknowledge reception of Maintenance Release, ISC is waiting for the release of the trunk }	{ { ISCCME		
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) }	{ { ISCCME		
3.4 (m) General CME trunk unavailable signal used on a per circuit basis }	Out-of-service CMEISC	{	
3.5 (o) Out-of-service acknowledgement } Sent to acknowledge ‘‘out-of-service signal’’ used on a per circuit basis }	{ { ISCCME		
3.6 (m) Sent after the removal from service is no longer necessary — used on a per circuit or per CME basis }	Back-in-service (Note) CMEISC	{	
3.7 (o) Acknowledgement of ‘‘back-in-service’’ }	{ Used on a per circuit basis	ISCCME	

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.

Tableau 4/Q.50 [T4.50], p. 16

7 Transmission techniques for ISC-CME signalling

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

— location of the CME and the ISC(s);

— type of facility between the CME and the ISC (e.g. analogue, digital);

— performance of the signalling link;

— electrical interface with the ISC;

— software capabilities of the ISC;

— 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 signalling*

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 CME;

— one dedicated common channel signalling link for exchange of information elements between ISC and CME.

8 Recommendation for signalling system

For further study.

9 Example systems

Two example systems can be found in Annexes A and B to this Recommendation.

ANNEX A

(to Recommendation Q.50)

Controlled DCME interface utilizing time-slot 16

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).

A.3 In order to allow TS16 to carry other 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 bearer service 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, bearer service selection, and maintenance signals, from each TS16 of a 2 Mbit/s system. For example, the DCME will transmit a number of simultaneous ‘‘No capacity for speech’’ signals to the ISCs. Bearer service selection signals are exclusive to the channels within each 2 Mbit/s system.

Signal descriptions

Transmission Resource Management

A.7 *No capacity for speech:* (DCME > > > ISC). No bearer capacity is available to set up new calls. BUSY or CAMP-ON BUSY conditions are applied to the appropriate circuits by the ISC.

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.’’

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 *All DCME circuits idle:* (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:

H.T. [T5.50]

DCME > > > switching centre	Bits 5 7 8
Maintenance release request	**Bits** 1 1 0
No capacity for speech	**Bits** 1 1 1
{ No channel(s) available for 3.1 kHz }	**Bits** 0 1 1
{ No 64 kbit/s capacity available }	**Bits** 1 0 1
DCME normal	**Bits** 1 0 0

Note — * indicates that this signal is optional.

Table [T5.50], p.

H.T. [T6.50]

Switching centre > > > DCME	Bits 5 7 8
{ Maintenance release request acknowledgement }	**Bits** 1 1 0
DCME circuits idle	**Bits** 1 1 1
Switching centre normal	**Bits** 1 0 1

Table [T6.50], p.

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 identity 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.

A.20 *Normal service:* (ISC > > > DCME). This is transmitted when the ISC requires only speech facilities.

A.21 *Channel out of service/unavailable:* (DSCE > > > 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 similar to CCITT Recommendation Q.33.

A.22 *Normal service available:* (DCME > > > ISC). Indicates that the channel will only carry speech.

A.22 *Special service acknowledgement:* (DCME > > > ISC). This signal is sent as an acknowledgement to either:

i) 3.1 kHz data request,

ii) 64 kbit/s request,

to confirm that the DCME resources have been allocated to meet the requirements of the requested service.

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

H.T. [T7.50]

Switching centre > > > DCME	Bits A(C) B(D)
64 kbit/s request **Bits** 1**(C)** | }	{
3.1 kHz*** request **Bits** 1**(C)** | }	{
Normal service available	**Bits** 0**(C)** |

Note — *** indicates that the signal is optional.

Table [T7.50], p.

H.T. [T8.50]

DCME > > > switching centre	Bits A(C) B(D)
{ Channel out of service/unavailable } **Bits** 1**(C)** | }	{
{ Special service acknowledgement } **Bits** 1**(C)** | }	{
Normal service available **Bits** 0**(C)** | }	{

Table [T8.50], p.

ANNEX B
(to Recommendation Q.50)

Example of a signalling system between DCME and ISC

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 Recommendation G.704, § 3.3.3.2.2. (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/Q.50 are applied for transmission of the necessary signals.

H.T. [T9.50]

TABLE B-1/Q.50

Signalling modes

{

Signal No. | Type of signal | Direction ISC-DCME

Forward a f b f | Backward a b b b

1 2 3 {
Circuit available for 64 kbit/s
Circuit available for 3.1 kHz data, speech
Circuit not available
}
1 0 1 0 1 0
1 0 0 1 0 0
Load control

{
4
5
.
.
6
7
.
.
8
9
}
{
64 kbit/s seizure
3.1 kHz/speech seizure
.
.
64 kbit/s positive acknowledgement
3.1 kHz/speech positive acknowledgement
.
.
Release 64 kbit/s
Release 3.1 kHz/speech
}
{
(
1
1
(
0
1
(0
1
.
(
1
1
(
0
1
(0
1
.
(
1
0
(
1
0
(1
0
}
{
1
0

0
1
1
0)
(Note)
0
1
1
0
0
1)
(Note)
0
1
1
0
0
1)
(Note)
} Seizure release

{
10
.
11
.
12
13
14
.
.
.
15
16
} {
Maintenance release signal (after
3.1 kHz, speech seizure)
Maintenance release signal (after 64 kbit/s seizure)
Maintenance release acknowledgement
CME clear of traffic
Out of service
a
b
c
d
Out of service acknowledgement
Back in service
} {
0
1
.
1
0
.
0
0
1
0
0
0
0
1
1

0 1 1 0 0 0 0 } 0 0 . 0 0 . 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 1 }	{ Maintenance				

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.

Table B-1/Q.50 [T9.50], p.

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.

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-SCME 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 CCITT System No. 5 and later, after its introduction, also S.S. No. 7);

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

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