MESSAGE TRANSFER PART SIGNALLING PERFORMANCE

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MESSAGE TRANSFER PART SIGNALLING PERFORMANCE

The Message Transfer Part of Signalling System No.7 is designed as a joint transport system for the messages of different users. The requirements of the different users have to be met by the Message Transfer Part. These requirements are not necessarily the same and may differ in importance and stringency.

In order to satisfy the individual requirements of each user, the Message Transfer Part of Signalling System No. 7 is designed in such a way that it meets the most stringent service requirements envisioned at the time of specification. To this end, the requirements of the telephone service, the data transmission service and the signalling network management, in particular, were investigated. It is assumed that a signalling performance that satisfies the requirements mentioned above will also meet those of future users.

In light of the above, signalling system performance is understood to be the capability of the Message Transfer Part to transfer messages of variable length, for different users, in a defined manner. In order to achieve proper signalling performance, three groups of parameters must be taken into account.

— The first group covers the objectives derived from the requirements of the different users. The aims are limitation of message delay, protection against all kinds of failures, and guarantee of availability.

— The second group covers the features of the signalling traffic; such as the loading potential and the signalling traffic structure.

— The third group covers the given environmental influences; such as the characteristics (e.g., error rate and proneness to burst) of the transmission media.

The three groups of parameters are considered in the specification of the procedures to enable the Message Transfer Part to transfer the messages in such a way that the signalling requirements of all users are met and that uniform and satisfactory overall signalling system performance is achieved.

1. BASIC PARAMETERS RELATED TO MESSAGE TRANSFER PART

Signalling performance is defined by a great number of different parameters. In order to ensure proper signalling performance for all users to be served by the common Message Transfer Part, the following design objectives are established for the Message Transfer Part.

1.1 Unavailability of a Signalling Route Set

The unavailability of a signalling route set is determined by the unavailability of the individual components of the signalling network (signalling links and the signalling points) and by the structure of a signalling network.

The unavailability of a signalling route set should not exceed a total of 10 minutes per year.

The unavailability of a signalling route set within a signalling network may be improved by replication of signalling links, signalling paths and signalling routes.

An asterisk '*' indicates a change from the CCITT Red Book, Vol. VI, that is specific to U.S. Networks
A bar '|' indicates a change from Issue 1 of Bell Communications Research Specification of Signalling System Number 7, Vol. 1 and 2.

1.2 Unavoidable Message Transfer Part Malfunction

The Message Transfer Part of Signalling System No. 7 is designed to transport messages in a correct sequence. In addition, the messages are protected against transmission errors. However, protection against transmission errors cannot be absolute. Furthermore, mis-sequencing and loss of messages in the Message Transfer Part cannot be excluded in extreme cases.

For all users, the following conditions are guaranteed by the Message Transfer Part: *

a) *Undetected errors*

On a signalling link employing a signalling data link that has the error rate characteristic as described in Recommendation Q.702, not more than one in 10^9 of all signal unit errors will be undetected by the Message Transfer Part.

b) *Loss of messages*

Not more than one in 10^7 messages will be lost due to failure in the Message Transfer Part. *

c) *Messages out-of-sequence*

Not more than one in 10^{10} messages will be delivered out-of-sequence to the users due to failure in the Message Transfer Part. This value also includes duplication of messages.

1.3 Message Transfer Times

This parameter includes:

— handling times at the signalling points (see Section 4.3);

— queueing delays including retransmission delays (see Section 4.2); and

— signalling data link propagation times.

1.3.1 Signalling Traffic Throughput Capability

Needs further study (see Section 2.2).

2. SIGNALLING TRAFFIC CHARACTERISTICS

2.1 Labeling Potential

The design of Signalling System No. 7 provides the potential for labels to identify 16,777,216 signalling points (24 bits). For each of the upper layer entities identified by the 4 bit service indicator, or other means for distribution, a number of user transactions may be identified; e.g. in the case of the ISDN capability, up to 16,384 speech circuits. *

2.2 Loading Potential

Considering that the load per signalling channel will vary according to the traffic characteristics of the service, to the user transactions served and to the number of signals in use, it is not practicable to specify a general maximum limit of user transactions that a signalling channel can handle. The maximum number of user transactions to be served must be determined for each situation, taking into account the traffic characteristics applied so that the total signalling load is held to a level that is acceptable from different points of view.

When determining the normal load of the signalling channel, account must be taken of the need to ensure a sufficient margin for peak traffic loads.

The loading of a signalling channel is restricted by several factors that are itemized below.

2.2.1 Queueing Delay

The queueing delay, in absence of disturbances, is considerably influenced by the distribution of the message length and the signalling traffic load (see Section 4.2).

2.2.2 Security Requirements

The most important security arrangement is redundancy in conjunction with changeover. As load sharing may be applied in normal operation, the load on the individual signalling channels has to be restricted so that, in the case of changeover, the queueing delays do not exceed a reasonable limit. This requirement has to be met not only in the case of changeover to one predetermined link, but also in the case of load distribution to the remaining links. *

2.2.3 Capacity of Sequence Numbering

The use of 7 bits for sequence numbering finally limits the number of signal units sent, but not yet acknowledged, to the value of 127.

In practice this will not impose a limitation on the loading potential.

2.2.4 Signalling Channels Using Lower Bit Rates *

A loading value for a signalling channel using bit rates of less than 56/64 kbit/s will result in greater queueing delays than the same loading value for a 56/64 kbit/s signalling channel. The performance requirements of this Recommendation assume the use of 56/64 kbit/s signalling links. Use of lower bit rates is not preferred. *

2.3 Structure of Signalling Traffic

The Message Transfer Part of Signalling System No. 7 serves different users as a joint transport system for messages. As a result, the structure of the signalling traffic largely depends on the types of users served. It can be assumed that at least in the near future the telephone service will represent the main part of the signalling traffic also in integrated networks. *

It cannot yet be foreseen how the signalling traffic is influenced by the integration of existing and future services. The traffic models given in Section 4.2.4 have been introduced in order to consider, as far as possible, the characteristics and features of different services within an integrated network. If new or more stringent requirements are imposed on signalling (e.g., shorter delays) as a consequence of future services, they should be met by appropriate dimensioning of the load or by improving the structure of the signalling network.

3. PARAMETERS RELATED TO TRANSMISSION CHARACTERISTICS

No special transmission requirements are envisioned for the signalling links of Signalling System No. 7. Therefore, System No. 7 provides appropriate means in order to cope with the given transmission characteristics of ordinary links. The following items indicate the actual characteristics to be expected - as determined by the responsible CCITT Study Groups - and their consequences on the specifications of the Signalling System No. 7 Message Transfer Part.

3.1 Application of Signalling System No. 7 to 56/64kbit/s Links *

MESSAGE TRANSFER PART SIGNALLING PERFORMANCE

The Message Transfer Part is designed to satisfactorily operate with the following transmission characteristics:

a) a long-term bit error rate of the signalling data link of less than 10^{-6}[1];

b) a medium-term bit error rate of less than 10^{-4};

c) random errors and error bursts including long bursts that might occur in the digital link due to, for instance, loss of frame alignment or octet slips in the digital link. The maximum tolerable interruption period is specified for the signal unit error rate monitor (see Recommendation Q.703, Section 10.2).

3.2 Application of Signalling System No. 7 to Links Using Lower Bit Rates

(Not planned for BOC networks.)

4. PARAMETERS OF INFLUENCE ON SIGNALLING PERFORMANCE

4.1 Signalling Network

Signalling System No. 7 is designed for both associated and nonassociated applications. The reference section in such applications is the signalling route set, irrespective of whether it is served in the associated or quasi-associated mode of operation.

For every signalling route set in a signalling network, the unavailability limit indicated in Section1.1 has to be observed irrespective of the number of signalling links in tandem of which it is composed.

4.1.1 International Signalling Network

(Needs further study.)

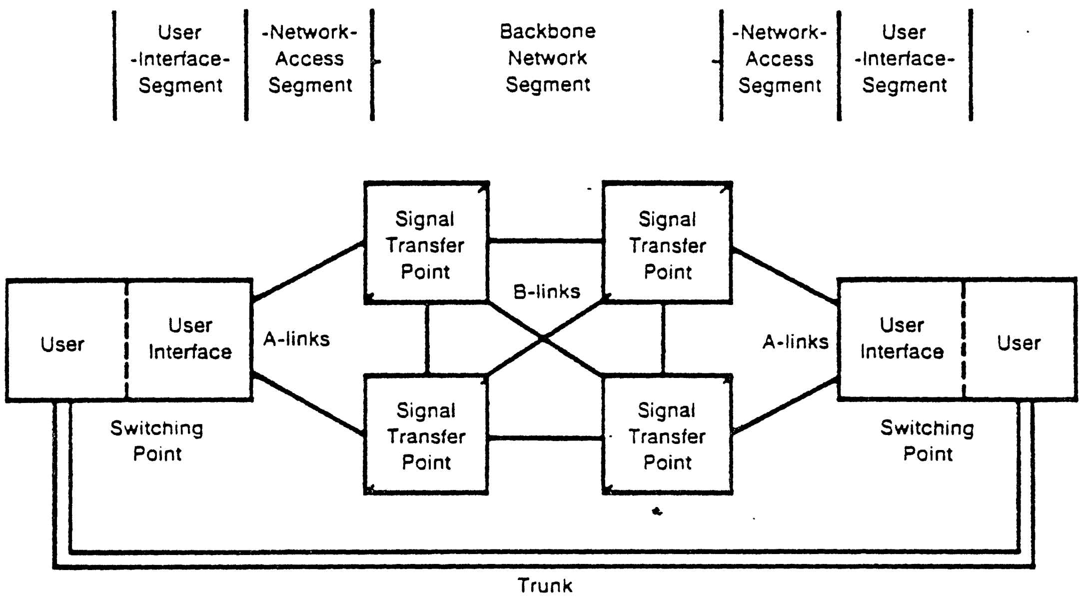
4.1.2 National Signalling Network

The national signalling network can be partitioned into three types of segments (refer to Figure 0A/Q.706.): the backbone network segment, the network access segment, and the user interface segment. With this partitioning, the down times per year of each segment can be added to approximate signalling network down time per year. Nominal requirements for each of these network segments have been assigned as follows.

Each User Interface Segment should be down no more than 3 minutes per year.

Each Network Access Segment should be down no more than 2 minutes per year.

The Backbone Network Segment should be down a negligible amount of time.



NOTE: The backbone network segment may consist of a number of networks in tandem to provide a signalling path.

Figure 0A/Q.706 - National signalling network

4.2 Queueing Delays

The Message Transfer Part handles messages from different users on a time-shared basis. With time-sharing, signalling delay occurs when it is necessary to process more than one message in a given time interval. When this occurs, a queue is built from which messages are transmitted in the order of their arrival times.

There are two different types of queueing delays: queueing delay in the absence of disturbances and total queueing delay.

The examples of queueing delays in Figures 2/Q.706 to 6/Q.706 are based on 56 kbits/s channels.

4.2.1 Assumptions for Derivation of the Formulas

The queueing delay formulas are basically derived from the M/G/1 queue with priority assignment. The assumptions for the derivation of the formulas, in the absence of disturbances, are as follows:

a) the interarrival time distribution is exponential (M);

b) the service time distribution is general (G);

c) the number of server is one (1);

d) the service priority refers to the transmission priority within level 2 (see Recommendation Q.703, Section 11.2), however, the link status signal unit and the independent flag are not considered;

e) the signalling link loop propagation time is constant, including the process time in signalling terminals; and

f) the forced retransmission case of the preventive cyclic retransmission method is not considered.

In addition, for the formulas in the presence of disturbances, the assumptions are as follows:

g) the transmission error of the message signal unit is random;

h) the errors are statistically independent of each other;

i) the additional delay caused by the retransmission of the erroneous signal unit is considered as a part of the waiting time of the concerned signal unit; and

j) in the case of the preventive cycle retransmission method, after the error occurs, the retransmitted signal units of second priority are accepted at the receiving end until the sequence number of the last sent new signal unit is caught by that of the last retransmsitted signal unit (for further study).

Furthermore, the formula for the proportion of messages delayed more than a given time is derived from the assumption that the probability density function of the queueing delay distribution may be exponentially decreasing where the delay time is relatively large.

4.2.2 Factors and Parameters

a) The notations and factors required for calculation of the queueing delays are as follows.

Q_a mean queueing delay in the absence of disturbances

σ^2_a	variance of queueing delay in the absence of disturbances
Q_t	mean total queueing delay
σ^2_t	variance of total queueing delay
P(T)	proportion of messages delayed more than T
a	traffic loading by message signal units (MSU) (excluding retransmission)
T_m	mean emission time of message signal units
T_f	emission time of fill-in signal units
T_L	signalling loop propagation time including processing time in signalling terminal
P_u	error probability of message signal units

$$k_1 = \frac{\text{2nd moment of message signal units emission time}}{T^2_m}$$

$$k_2 = \frac{\text{3rd moment of message signal units emission time}}{T^3_m}$$

$$k_3 = \frac{\text{4th moment of message signal units emission time}}{T^4_m}$$

Note: As a consequence of zero insertion at level 2 (see Recommendation Q.703, Section 3.2), the length of the emitted signal unit will be increased by approximately 1.6 percent on average. However, this increase has negligible effect on the calculation.

b) The parameters used in the formulas are as follows:

$$t_f = T_f/T_m$$

$$t_L = T_L/T_m$$

for the basic method,

$$E_1 = 1 + P_u t_L$$

$$E_2 = k_1 + P_u t_L (t_L + 2)$$

$$E_3 = k_2 + P_u t_L (t_L^2 + 3t_L + 3k_1)$$

for the preventive cyclic retransmission (PCR) method, $a_3 = \exp(-at_L)$: traffic loading caused by fill-in signal units

$a_z = 1 - a - a_3$

$H_1 = at_L$

$H_2 = at_L (k_1 + at_L)$

$H_3 = at_L \left(k_2 + 3at_Lk_1 + a^2t^2_L\right)$

$F_1 = \frac{at_L}{2}$

$F_2 = at_L \left(\frac{k_1}{2} + \frac{at_L}{3}\right)$

$F_3 = at_L \left(\frac{k_2}{2} + at_Lk_1 + \frac{a^2t^2_L}{4}\right)$

$q_a = \frac{k_1 (a + a_z) + a_3t}{2 (1 - a)}$

$s_a = \frac{ak_1}{1 - a} q_a + \frac{k_2 (a + a_z) + a_3t_f^2}{3 (1 - a)}$

$t_a = \frac{3ak_1 5a + 2ak_2q_a}{2 (1 - a)} + \frac{(a + a_z) k_3 + a_3t^3_f}{4 (1 - a)}$

$Z_1 = 2 + P_u (1 + H_1)$

$Z_2 = 4k_1 + P_u (5k_1 + 3H_1 + H_2)$

$Z_3 = 8k_2 + P_u (19k_2 + 27k_1H_1 + 9H_2 + H_3)$

$Y_2 = s_a + 4k_1 + F_2 + 2 \{q_a (2 + F_1) + 2F_1\}$

$Y_3 = t_a + 8k_2 + F_3 + 3 \{s_a (2 + F_1) + q_a(4k_1 + F_2) + 2F_2 + 4k_1F_1\} + 12q_aF_1$

$a = \frac{1 - a \{2 + P_u (1 + at_L)\}}{2 + q_a + \frac{at_L}{2}}$

$$q_d = \frac{aZ_2 + aY_2}{2\,(1 - aZ_1)}$$

$$s_d = \frac{aZ_2}{1 - aZ_1} \quad q_d + \frac{aZ_3 + \alpha Y_3}{3\,(1 - aZ_1)}$$

$$q_b = \frac{q_a + 1 + F_1}{1 - a}$$

$$s_b = \frac{s_a + k_1 + f_2}{(1 - a)^3} + 2\,\frac{\{q_a(1 + F_1) + F_1\}}{(1 - a)^2}$$

$$q_c = \frac{q_d + 1 + P_u\,(1 + H_1)}{(1 - a)}$$

$$s_c = \frac{s_d + k_1 + P_u + (3K'\,H_2)}{(1 - a)^3} + 2\,\frac{\{q_d + P_u\{q_d(1 + H_1) + 2H_1\}}{(1 - a)^2}$$

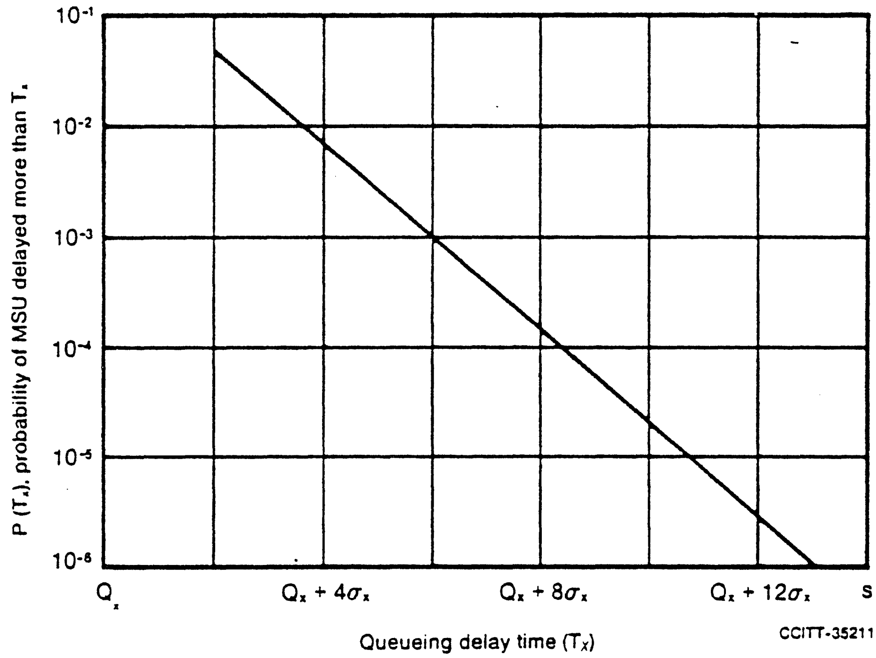
$$P_v = P_u a \frac{\left(q_a + Z + \frac{at_L}{2}\right)}{1 - 2a} \left(1 + P_u \frac{a + a_2 t_L}{1 - 2a}\right)$$

4.2.3 Formulas

The formulas for the mean and the variance of the queueing delays are described in Table1 / Q.706. The proportion of messages delayed more than a given time T_x is:

$$P(T)_2 = \exp\left(-\frac{T_x - Q_2 + \sigma_x}{\sigma_x}\right)$$

where Q_x and σ_x denote the mean and the standard deviation of queueing delay, respectively. This approximation is better suited in the absence of disturbances. In the presence of disturbances, the actual distribution may be further deviated. The relation between $P(T_x)$ and T_x is shown in Figure 1 / Q.706.



Q_x Mean queueing delay (see Figure 2/Q.706)
σ_x Standard deviation (see Figure 3/Q.706)

Figure 1/Q.706 - Probability of message signal unit delayed more than T_x

Error correction method	Disturbance	Mean Q	Variance σ^2
Basic	Absence	$\frac{Q_a}{T_\mu} = \frac{t_f}{2} + \frac{a k_1}{2(1 - a)}$	$\frac{\sigma_a^2}{T_\mu^2} = \frac{t_f^2}{12} + \frac{a[4k_2 - (4k_2 - 3k_1^2)a]}{12(1 - aE_1)^2}$
	Presence	$\frac{Q_t}{T_\mu} = \frac{t_f}{2} + \frac{aE_2}{2(1 - aE_1)} + E_1 - 1$	$\frac{\sigma_t^2}{T_\mu^2} = \frac{t_f^2}{12} + \frac{a[4E_3 - (4E_1E_3 - 3E_2^2)a]}{12(1 - aE_1)^2} + P_u(1 - P_u)t_L^2$
Preventive cyclic retransmission	Absence	$\frac{Q_a}{T_\mu} = q_a$	$\frac{\sigma_t^2}{T_u^2} = s_a^2 - q_a^2$
	Presence	$\frac{Q_t}{T_\mu} = (1 - P_u - P_v)\, q_a + P_\mu q_b + P_v q_c$	$\frac{\sigma_t^2}{T_\mu^2} = (1 - P_u - P_v)\, s_a + P_u s_b + P_v s_c - \frac{Q_t^2}{T_\mu^2}$

TABLE 1/Q.706 - Queueing delay formula

4.2.4 Examples

Assuming the traffic models given in Table 2 Q.706, examples of queueing delays are calculated as listed in Table 3 Q.706.

Model	A	B	
Message length (bits)	120	104	304
Percent	100	92	8
Mean message length (bits)	120	120	
k_1	1.0	1.2	
k_2	1.0	1.9	
k_3	1.0	3.8	

TABLE 2/Q.706 - Traffic model

Figure	Error control	Queueing delay	Disturbance	Model
2/Q.706	Basic/PCR	Mean	Absence	A and B
3/Q.706	Basic/PCR	Standard deviation	Absence	A and B
4/Q.706	Basic	Mean	Presence	A
5/Q.706	Basic	Standard deviation	Presence	A
6/Q.706	PCR	Mean	Presence	A
7/Q.706	PCR	Standard deviation	Presence	A

TABLE 3/Q.706 - List of examples

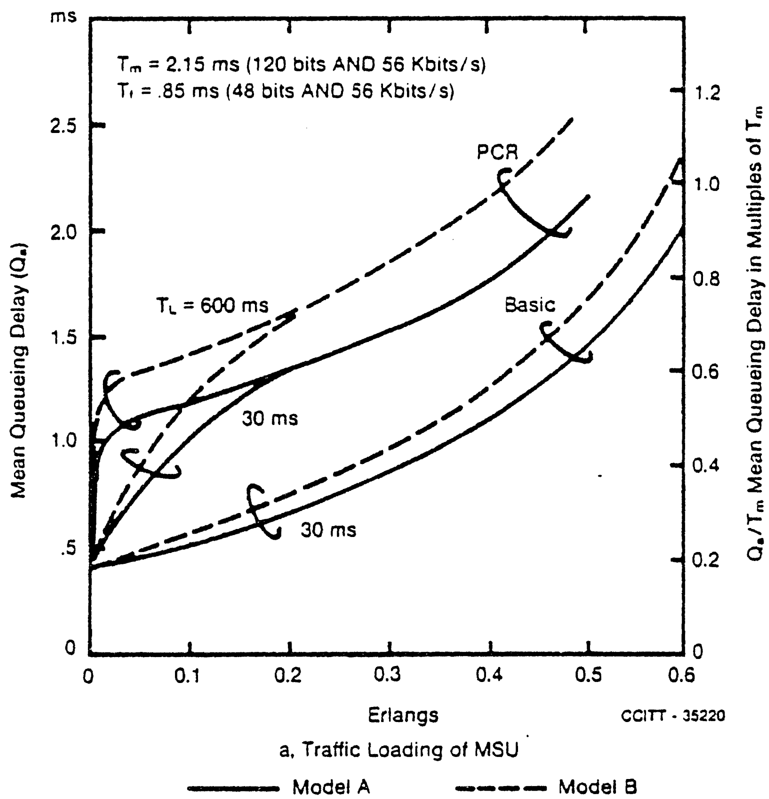


Figure 2/Q.706 - Mean queueing delay of each channel of traffic in absence of disturbance

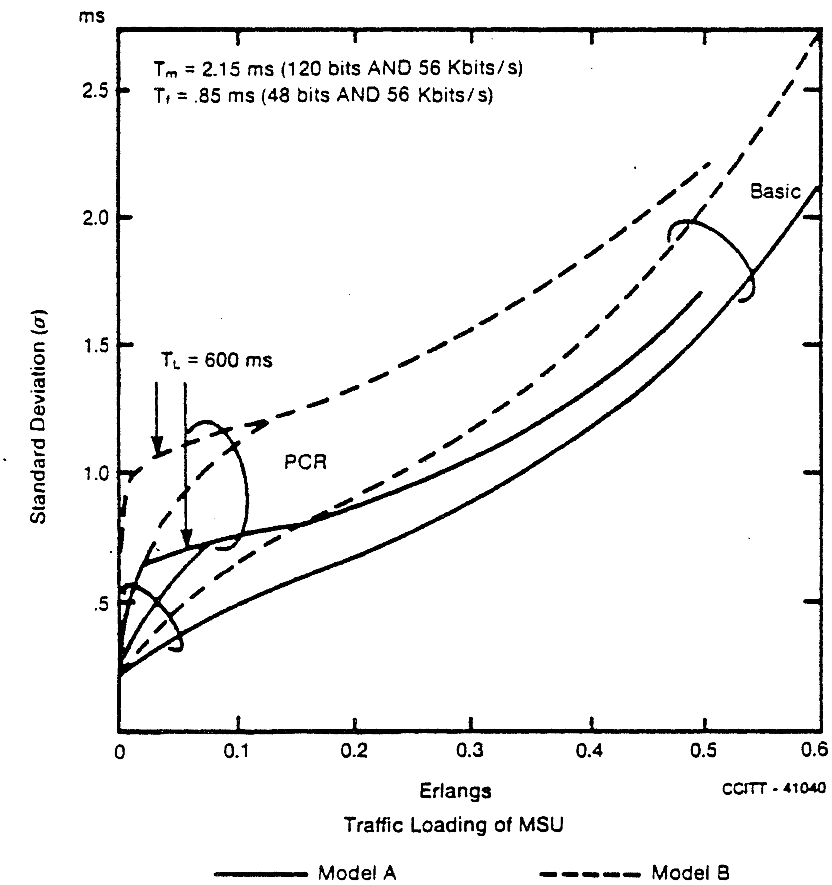
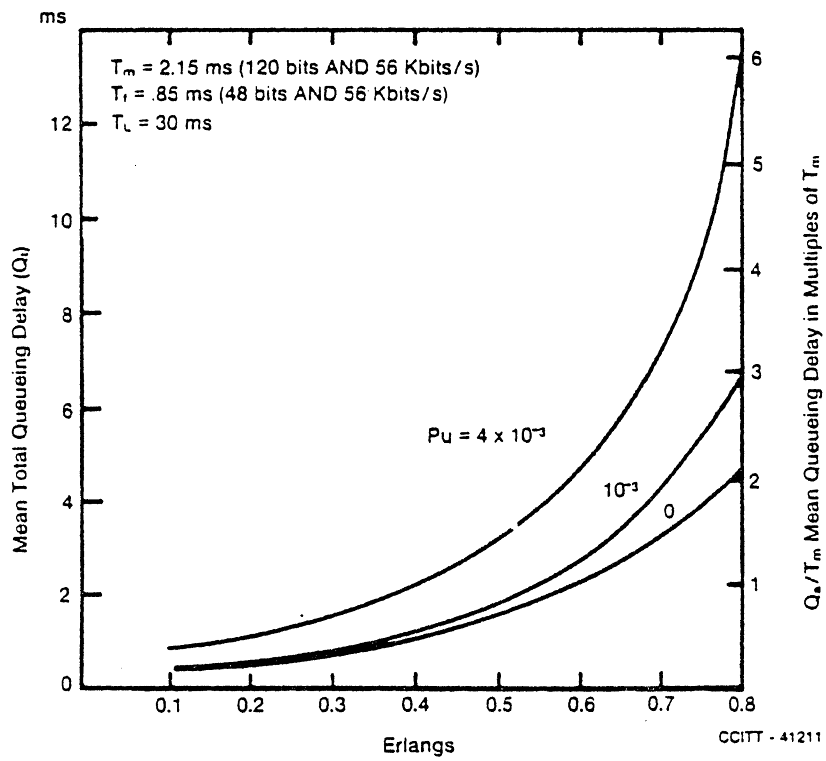


Figure 3/Q.706 - Standard deviation of queueing delay of each channel of traffic in absence of disturbance



a. Traffic Loading of MSU

Figure 4/Q.706 - Mean total queueing delay of each channel of traffic; basic error correction method

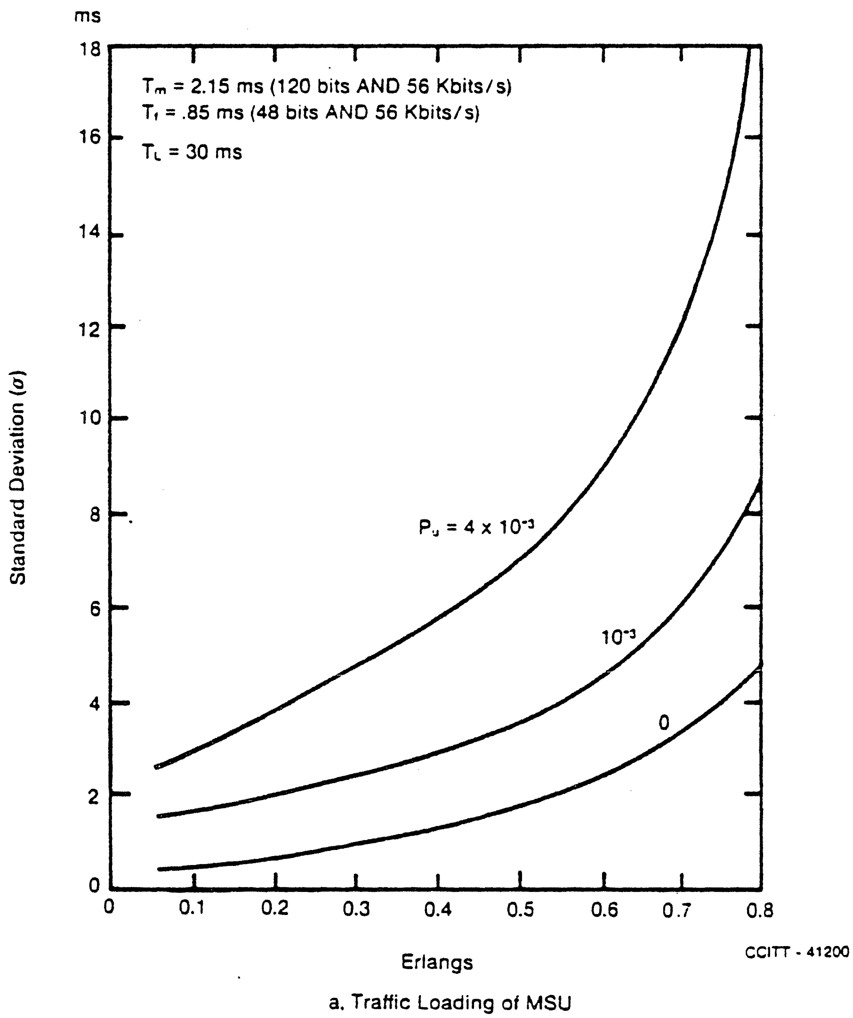


Figure 5/Q.706 - Standard deviation of queueing delay of each channel of traffic; basic error correction method *

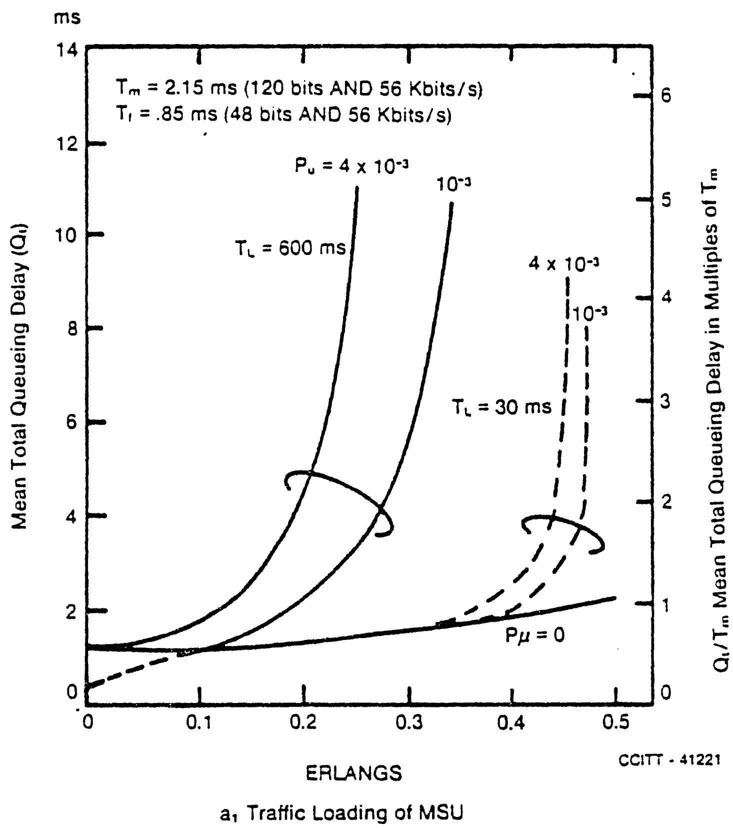


Figure 6/Q.706 -
Mean queueing delay of each channel of traffic; preventive cyclic retransmission error correction method

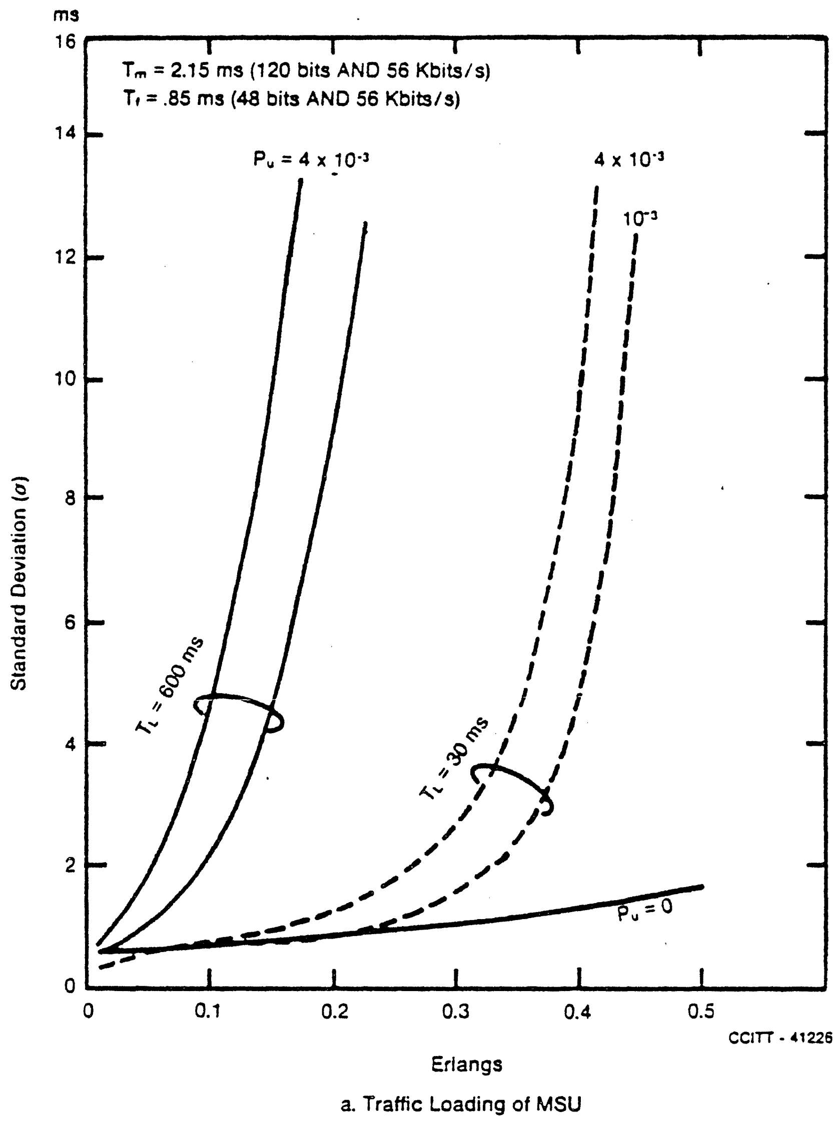


Figure 7/Q.706 -
Standard deviation of queueing delay of each channel of traffic: preventive cyclic retransmission error correction method *

4.3 Message Transfer Times

Within a signalling relation, the Message Transfer Part transports messages from the originating application to the destination application, using several signalling paths. The overall message transfer time needed depends on the message transfer time components (a) to (e) involved in each signalling path.

4.3.1 Message Transfer Time Components and Functional Reference Points

A signalling path may include the following functional signalling network components and transfer time components.

a) Message Transfer Part sending function at the point of origin (see Figure 8/Q.706).

b) Signalling transfer point function (see Figure 9/Q.706).

c) Message Transfer Part receiving function at the point of destination (see Figure 10/Q.706).

d) Signalling data link propagation time (see Figure 11/Q.706).

e) Queueing delay.

An additional increase in overall message transfer time is caused by the queueing delays. These are described in Section 4.2.

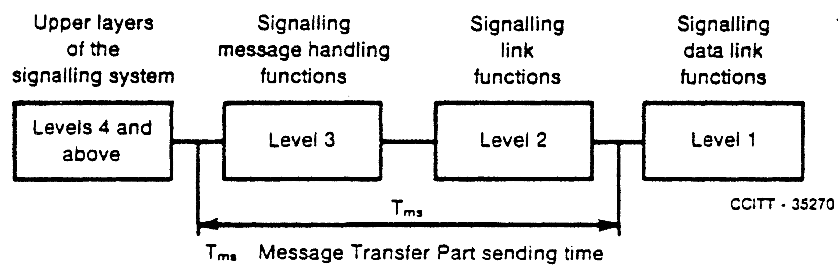


Figure 8/Q.706 - Functional diagram of the Message Transfer Part sending time *

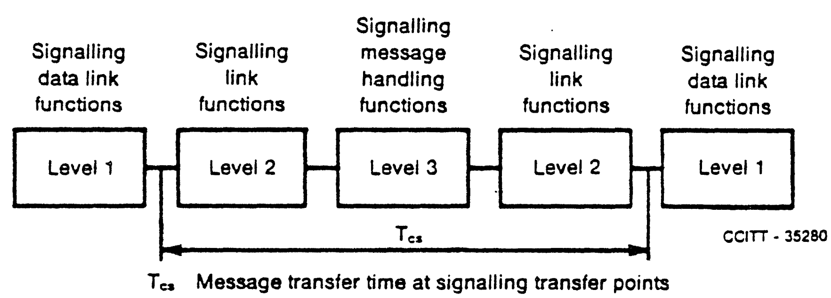


Figure 9/Q.706 - Functional diagram of the message transfer time at signalling transfer points *

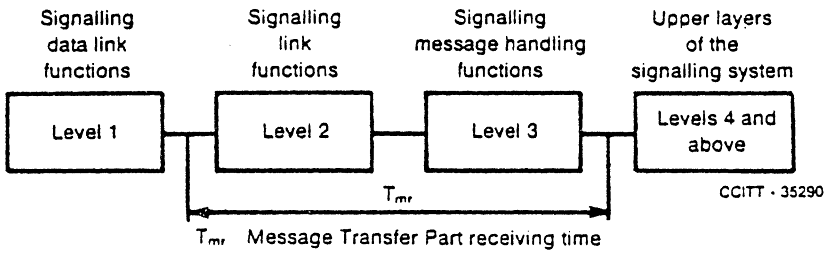


Figure 10/Q.706 - Functional diagram of the Message Transfer Part receiving time

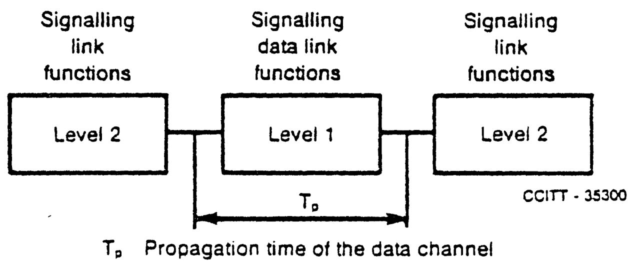


Figure 11/Q.706 -Functional diagram for the propagation time

4.3.2 Definitions[1]

4.3.2.1 Message Transfer Part Sending Time T_{ms}

T_{ms} is the period that starts when the last bit of the message has left level 4 and ends when the last bit of the signal unit enters the signalling data link for the first time. It includes the queueing delay in the absence of disturbances, the transfer time from level 4 to level 3, the handling time at level 3, the transfer time from level 3 to level 2, and the handling time in level 2.

4.3.2.2 Message Transfer Time at Signalling Transfer Points T_{cs}

T_{cs} is the period that starts when the last bit of the signal unit leaves the incoming signalling data link and ends when the last bit of the signal unit enters the outgoing signalling data link for the first time. It also includes the queueing delay in the absence of disturbances, but not the additional queueing delay caused by retransmission.

[1] French and Spanish titles from the CCITT Red Book, Volume VI, have been deleted.

4.3.2.3 Message Transfer Part Receiving Time T_{mr}

T_{mr} is the period that starts when the last bit of the signal unit leaves the signalling data link and ends when the last bit of the message has entered level 4. It includes the handling time in level 2, the transfer time from level 2 to level 3, the handling time in level 3 and the transfer time from level 3 to level 4.

4.3.2.4 Data Channel Propagation Time T_p

T_p is the period that starts when the last bit of the signal unit has entered the data channel at the sending side and ends when the last bit of the signal unit leaves the data channel at the receiving end, irrespective of whether or not the signal unit is disturbed.

4.3.3 Overall Message Transfer Times

The overall message transfer time T_o is referred to the signalling relation. T_o starts when the message has left level 4 at the point of origin and ends when the message has entered level 4 at the point of destination.

The definition of the overall message transfer time and the definitions of the individual message transfer time components give rise to the following relationships.

a) In the absence of disturbances

$$T_{oa} = T_{ms} + \sum_{i=1}^{n+1} T_{pi} + \sum_{i=1}^{n} T_{csi} + T_{mr}$$

b) In the presence of disturbances

$$T_o = T_{oa} + \Sigma(Q_t - Q_a)$$

Here

T_{oa} overall message transfer time in the absence of disturbances

T_{ms} Message Transfer Part sending time

T_{mr} Message Transfer Part receiving time

T_{cs} Message transfer time at signalling transfer points

n Number of STPs involved

T_p data channel propagation time

T_o overall message transfer time in the presence of disturbances

Q_t total queueing delay (see 1.4.2)

Q_a Queueing delay in the absence of disturbances (see Section 4.2)

Note: For $\Sigma (Q_t - Q_a)$, all signalling points in the signalling relation must be taken into account.

4.3.4 Estimates for Message Transfer Times

The estimates must take account of:

— the length of the signal unit,

— the signalling traffic load, and

— the signalling bit rate.

The estimates for T_{mr}, T_{ms} and T_{cs} will be presented in the form of

— mean values, and

— 95 percent level values.

The estimates for T_{cs} for a signalling transfer point are given in Table 4/Q.706.

STP signalling traffic load	Message transfer time (MTP only) at an STP (T_{cs}) in ms	
	Mean	95%
Normal	45	80
2x Normal	55	90 (a)

(a) Preliminary values

TABLE 4/Q.706 - STP estimates *

These figures are related to 56 kbits/s signalling bit rate. The normal signalling traffic load is that load for which the Signal Transfer Point is engineered during the busy hour. The message length distribution is as given in Table 2/Q.706. * *

4.4 Error Control

During transmission, the signal units are subject to disturbances that lead to a falsification of the signalling information. The error control reduces the effects of these disturbances to an acceptable value.

Error control is based on error detection by redundant coding and on error correction by retransmission. Redundant coding is performed by generation of 16 check bits per signal unit based on the polynomial described in Recommendation Q.703, Section 4.2. Moreover, the error control does no introduce loss, duplication or missequencing of messages on an individual signalling link.

However, abnormal situations may occur in a signalling relation, that are caused by failures, so that the error control for the signalling link involved cannot ensure the correct message sequence.

4.5 Security Arrangements

The security arrangements have an essential influence on the observance of the availability requirements listed in Section 1.1 for a signalling relation.

In the case of Signalling System No. 7, the security arrangements are mainly formed by redundancy in conjunction with changeover.

4.5.1 Types of Security Arrangements

In general, a distinction has to be made between security arrangements for the individual components of the signalling network and security arrangements for the signalling relation. Within a signalling network, any security arrangement may be used, but it must be ensured that the availability requirements are met.

4.5.1.1 Security Arrangements for the Components of the Signalling Network

Network components, which form a signalling path when being interconnected, have either constructional security arrangements that exist from the very beginning (e.g., replication of the controls at the exchanges and signalling transfer points), or can be replicated if necessary (e.g., signalling data links). For security reasons, however, replication of signalling data links is effected only if the replicated links are independent of one another (e.g., multipath routing). In the case of availability calculations for a signalling path set, special care must be taken that the individual signalling links are mutually independent.

4.5.1.2 Security Arrangements for Signalling Relations

In quasi-associated signalling networks, where several signalling links in tandem serve one signalling relation, the security arrangements for the network components, as a rule, do not ensure sufficient availability of the signalling relation. Appropriate security arrangements must, therefore, be made for the signalling relations by the provision of redundant signalling path sets that must, likewise, be mutually independent.

4.5.2 Security Requirements

In the case of 56/64 kbit/s signalling links, a signalling network has to be provided with sufficient redundancy so that the quality of the signalling traffic handled is still satisfactory. (Application of the above to signalling links using lower bit rates needs further study.) *

4.5.2.1 Time to Initiate Changeover

If individual signalling data links fail, changeover is initiated by signal unit error monitoring (see Recommendation Q.703, Section 10). With signal unit error monitoring, the time between the occurrence of the failure and the initiation of changeover is dependent on the message error rate: a complete interruption will result in an error rate equal to 1.

Changeover leads to substantial additional queueing delays. To keep the latter as short as possible, the signalling traffic affected by an outage is reduced to a minimum by the use of load sharing on all existing signalling links.

4.6 Failures

4.6.1 Link Failure

During transmission, the messages may be subject to disturbances. A measure of the quality of the signalling data link is its signal unit error rate.

Signal unit error monitoring initiates the changeover at a signal unit error rate of about 4 times 10^{-3}.

The error rate, with which Signalling System No. 7 has to cope, represents a parameter of decisive influence on its efficiency.

As a result of error correction by retransmission, a high error rate causes frequent retransmission of the message signal units and, thus, long queueing delays.

4.6.2 Failures in Signalling Points

(Needs further study.)

4.7 Priorities

Transmission priorities resulting from the meaning of the individual signals are not envisioned. Basically, the "first-in-first-out" principle applies.

Although the service indicator offers the possibility of determining different priorities on a user basis, such user priorities are not yet foreseen.

(Clarification): Transmission priority is not to be confused with congestion priority; see Q.704, Section 3.5A.

Transmission priorities are determined by Message Transfer Part functions. They are solely dependent on the present state of the Message Transfer Part and completely independent of the meaning of the signals (see Recommendation Q.703, Section 11.2).

5. PERFORMANCE UNDER ADVERSE CONDITIONS

5.1 Adverse Conditions

(Needs further study.)

5.2 Influence of Adverse Conditions

(Needs further study.)

REFERENCE

CCITT Recommendation, *Error performance on an international digital connection forming part of an integrated services digital network,* Vol. III, Fascicle III.3, Rec. G.821.