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# Technical Performance Objectives

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## PREFATORY NOTE

ETSI has constituted stable and consistent documents which give specifications for the implementation of the European Cellular Telecommunications System. Historically, these documents have been identified as "GSM recommendations".

Some of these recommendations may subsequently become Interim European Telecommunications Standards (I-ETSs) or European Telecommunications Standards (ETSs), whilst some continue with the status of ETSI-GSM Technical Specifications. These ETSI-GSM Technical Specifications are for editorial reasons still referred to as GSM recommendations in some current GSM documents.

The numbering and version control system is the same for ETSI-GSM Technical Specifications as for "GSM recommendations".

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# 1. SCOPE

This Recommendation contains technical performance objectives that should be met for the fixed infrastructure of GSM PLMNs. Concerning transmission delay for the PLMN in section 4, the requirements should also be met by GSM Mobile Stations.

These performance design objectives are applicable to all implementations at all points in the growth cycle up to the maximum size. These reference loads and performance objectives may be used by manufacturers in designing GSM PLMNs and by Administrations or RPOAs in evaluating a specific design or for comparing different designs for potential use in the Administration's or RPOA's intended implementation.

# 2. GENERAL

For terminology and architecture for GSM PLMNs see Recommendation GSM 03.02.

Interfaces, interface characteristics, connections through an MSC and ancillary functions of the MSC are defined in Recommendation GSM 11.30.

The functions supported by HLRs and VLRs are given in Recommendations GSM 11.31 and 11.32.

Each MSC will be responsible for synchronisation, if required, with the fixed network to which it is connected. The requirements of CCITT Recommendation Q.541 should be observed.

Timing and synchronisation of the radio subsystem is specified in the Recommendation GSM 05.10.

# 3. PERFORMANCE DESIGN OBJECTIVES

## 3.1 General

Part of the text is taken from CCITT Recommendation Q.543 and part from CEPT Recommendation T/S 64-30.

### 3.2 MSCs

#### 3.2.1 Reference loads

The reference loads are traffic load conditions under which the performance design objectives stated below are to be met. The following reference loads are defined.

a) Reference load for incoming inter-exchange circuits

b) Reference load for MS originating calls (including all Dm channel activities)

Reference load A is intended to represent the normal upper mean level of activity which Administrations or RPOA's would wish to provide for MSs, BS-MSC circuits and inter-exchange circuits. Reference load B is intended to represent an increased level beyond normal planned activity levels.

##### 3.2.1.1 Reference load on incoming interexchange circuits

a) Reference load A

- 0.7 Erlang average occupancy on all incoming circuits with 20 call attempts/hour/incoming circuit.

This figure assumes 25% ineffective call attempts.

b) Reference load B

- 0.85 Erlang average occupancy on all incoming circuits with 25 call attempts/hour/incoming circuit.

##### 3.2.1.2 Reference load for MS originating calls

a) Reference load A

TABLE 1/*Traffic model for MS originating calls*

| MS type | Average traffic intensity (Erl/sbscr) | Average BHCA | Average layer 3 signalling messages per second per subscriber |
|---|---|---|---|
| W | 0.03 | 1.2 | 0.02 (Note) |
| X | 0.06 | 2.4 | " |
| Y | 0.1 | 4 | " |

Note: Provisional value. This value doesn't include sending of traffic measurement data.

b) Reference load B

Reference load B is defined as a traffic increase over reference load A of:

+ 25% in Erlangs.
with + 35% in BHCA.

Reference load B levels for Dm channel activity are for further study.

#### 3.2.1.3 Impact of supplementary services

If the reference model MSC assumes that significant use is made of supplementary services, the performance of the MSC can be strongly affected, especially in designs where processor capacity can become a limiting item. The performance delays recommended can be significantly lengthened at a given call load under such circumstances. The Administration or Operating Agency defining the reference model should estimate the fractions of calls which use various supplementary services so that an average processor impact relative to a basic telephone call can be calculated.

### 3.2.2 Inadequately handled call attempts

#### 3.2.2.1 Definition

Inadequately handled call attempts are attempts which are blocked (as defined in CCITT E.600 series of Recommendations) or are excessively delayed within the exchange. "Excessive delays" are those that are greater than three times the "0.95 probability of not exceeding" values recommended in the tables.

For originating and transit calls, this inadequately handled call attempt parameter applies only when there is at least one appropriate outlet available.

#### 3.2.2.2 Probability of inadequately handled call attempts occuring

The values in Table 2 are recommended.

TABLE 2

| Type of connection | Reference Load A | Reference load B |
|---|---|---|
| Internal | $\leq 10^{-2}$ | $\leq 4 \times 10^{-2}$ |
| Originating | $\leq 5 \times 10^{-3}$ | $\leq 3 \times 10^{-2}$ |
| Terminating | $\leq 2 \times 10^{-3}$ | $\leq 2 \times 10^{-2}$ |
| Transit | $\leq 10^{-3}$ | $\leq 10^{-2}$ |

### 3.2.3 Delay probability

The following notes apply to the delay parameters included in this section:

1. The term "mean value" is understood as the expected value in the probabilistic sense.

2. The terms "received from" and "passed to" the signalling system are meant to be that instant at which the information is exchanged between the signalling data link (layer 1) and the signalling link functions (layer 2) in CCITT Signalling System No. 7. For Dm channel signalling it is designated as that instant when the information is exchanged between the data link layer (layer 2) and the network layer (layer 3) by means of primitives. Consequently, the specified time intervals exclude the layer 1 and layer 2 times. However, they do include queuing delay in the absence of disturbances, but not additional queuing caused by retransmission of signalling messages.

#### 3.2.3.1 User signalling acknowledgement delay

User signalling acknowledgement delay is the interval from the instant a user signalling message has been received from Dm channel until a message acknowledging the receipt of that message is passed back from the MSC to Dm channel. Examples of such messages are SETUP ACKNOWLEDGEMENT to SETUP CONNECT ACKNOWLEDGEMENT to CONNECT and RELEASE ACKNOWLEDGEMENT to RELEASE.

The values in Table 3 are recommended

TABLE 3

| | Reference load A | Reference load B |
|---|---|---|
| Mean value | ≤400 ms | ≤800 ms |
| 0.95 probability of not exceeding | 600 ms | 1000 ms |

#### 3.2.3.2 Signalling transfer delay

The MSC signalling transfer delay is the time taken for the MSC to transfer a message from one signalling system to another with minimal or no other exchange actions required. The interval is measured from the instant that a message is received from a signalling system until the moment the corresponding message is passed to another signalling system. Examples of messages are ALERT to ADDRESS COMPLETE, ADDRESS COMPLETE to ADDRESS COMPLETE, CONNECT to ANSWER, RELEASE to DISCONNECT etc. The values in Table 4 are recommended for originating and terminating connections.

TABLE 4

| Reference load A | Reference load B | |
|---|---|---|
| Mean value | ≤200 ms | ≤350 ms |
| 0.95 probability of not exceeding | 400 ms | 700 ms |

### 3.2.3.3 Through connection delay

a) For originating outgoing traffic through connection delay is defined as the interval from the instant that the signalling information required for setting up a connection through the MSC is received from the incoming signalling system to the instant that the transmission path is available for carrying traffic between the incoming and out going terminations on the MSC.

Usually, both directions of transmission will be switched through at the same time. However, at an originating exchange, on certain calls, there may be a requirement to effect switch through in two stages, one direction at a time. In this case, different signalling messages will initiate the two stages of switch through and the recommended delay applies to each stage of switch through.

The values in Table 5 are recommended:

TABLE 5

| | Reference load A | | Reference load B | |
|---|---|---|---|---|
| | Without ancillary function | With ancillary function | Without ancillary function | With ancillary function |
| Mean value | ≤250 ms | ≤350 ms | ≤400 ms | ≤500 ms |
| 0.95 probability of not exceeding | 300 ms | 500 ms | 600 ms | 600 ms |

b) for internal and terminating traffic the through connection delay is defined as the interval from the instant that the CONNECT message is received from the Dm channel until the through connection is established and available for carrying traffic and the ANSWER and CONNECT ACKNOWLEDGEMENT messages have been passed to the appropriate signalling systems.

The values in Table 6 are recommended.

TABLE 6

| | Reference load A | Reference load B |
|---|---|---|
| Mean value | ≤250 ms | ≤400 ms |
| 0.95 probability of not exceeding | 300 ms | 600 ms |

### 3.2.3.4 Incoming call indication sending delay - (for terminating and internal traffic connections)

The incoming call indication sending delay is defined as the interval from the instant at which the necessary signalling information is received from the signalling system to the instant at which the SETUP message is passed to the signalling system of the called subscriber.

In the case of overlap sending in the incoming signalling system, the values in Table 7 are recommended.

TABLE 7

| | Reference load A | Reference load B |
|---|---|---|
| Mean value | ≤400 ms | ≤600 ms |
| 0.95 probability of not exceeding | 600 ms | 1000 ms |

In the case of en-bloc sending in the incoming signalling system, the values in Table 8 are recommended.

TABLE 8

| | Reference load A | Reference load B |
|---|---|---|
| Mean value | ≤600 ms | ≤800 ms |
| 0.95 probability of not exceeding | 800 ms | 1200 ms |

### 3.2.3.5 Connection release delay

Connection release delay is defined as the interval from the instant when DISCONNECT or RELEASE message is received from a signalling system until the instant when the connection is no longer available for use on the call (and is available for use on another call) and a corresponding RELEASE or DISCONNECT message is passed to the other signalling system involved in the connection. The values in Table 9 are recommended.

TABLE 9

| | Reference load A | Reference load B |
|---|---|---|
| Mean value | ≤250 ms | ≤400 ms |
| 0.95 probability of not exceeding | 300 ms | 700 ms |

#### 3.2.3.6 Call clearing delay

Disconnect and call clearing will usually be performed at the same time. However, on certain calls it may be necessary for an exchange to retain call references after disconnect has occurred, until a clearing message is received. The exchange may then discard the call reference information. The corresponding RELEASE message must be passed on to other involved signalling systems in the interval allowed for signalling transfer delay.

#### 3.2.3.7 Timing for start of charging (circuit switched calls)

When required, timing for charging at the MSC where this function is performed, shall begin after receipt of an ANSWER indication from a connecting exchange or the called user. The start of timing for charging should occur within the intervals recommended in Table 10:

TABLE 10

| | Reference load A | Reference load B |
|---|---|---|
| Mean value | ≤100 ms | ≤175 ms |
| 0.95 probability of not exceeding | 200 ms | 350 ms |

#### 3.2.3.8 Call set-up delay

Definition and objective for MS originating and terminating calls for further study (two objectives: a) all parameters are in the VLR, b) parameters must be retrieved from HLR). Authentication delay, objectives are also to be included).

#### 3.2.3.9 Handover delay

Two cases are to be defined

a) between BSs of the same MSC

b) between BSs of different MSCs

objectives are for further study and should include:

i) interruption of communication path

ii) probability of success where initiation was successful

#### 3.2.3.10 Off-air-call-set-up (OACSU) delay

OACSU delay is the extra delay in swithcing the speech path from A- to B-subscriber because of seizing the radio path after the B-subscriber has hooked-off. It is defined as the interval that the answer indication is received from the B-subscriber until the instant when the radio path has been succesfully seized.

The values in table 11 are recommended.

TABLE 11

| | Reference load A |
|---|---|
| Mean value | ≤1000 ms |
| 0.95 probability of not exceeding | 5000 ms |

#### 3.2.3.11 Discontinuous reception mode delay

For further study.

### 3.2.4 Call processing performance objectives

#### 3.2.4.1 Premature release

The probability that an MSC malfunctin will result in the premature release of an established connection in any one minute interval should be:

$$P \leq 2 \times 10^{-5}$$

#### 3.2.4.2 Release failure

The probability that an MSC malfunction will prevent the required release of a connection should be:

$$P \leq 2 \times 10^{-5}$$

#### 3.2.4.3 Incorrect charging or accounting

The probability of a call attempt receiving incorrect charging treatment due to an MSC malfunction should be:

$$P \leq 10^{-4}$$

### 3.2.4.4 Misrouting

The probability of a call being misrouted following receipt by the MSC of a valid address should be:

$$P \leq 10^{-4}$$

### 3.2.4.5 No tone

The probability of a call attempt encountring no tone following receipt of a valid address by the MSC should be:

$$P \leq 10^{-4}$$

### 3.2.4.6 Other failures

The probability of the MSC causing a call failure for any other reason not identified specifically above should be:

$$P \leq 10^{-4}$$

### 3.2.4.7 Transmission performance

The probability of a connection being established with an unacceptable transmission quality across the exchange should be:

$$P \text{ (unacceptable transmission)} \leq 10^{-5}$$

The transmission quality across the exchange is said to be unacceptable when the bit error ratio is above alarm condition.

Note: The alarm condition has yet to defined.

### 3.2.4.8 Slip rate

The slip rate under normal conditions is covered in CCITT Recommendation Q.541. 3.2.5 MSC performance during overload conditions

The requirements stated in CCITT Recommendation Q.543 should be met.

## 3.3 Performance design objectives for HLRs

### 3.3.1 Reference loads

a) Reference load for call handling: 0,4 transactions per subscriber per hour

b) Reference load for mobility management: 1,8 transactions per subscriber per hour.

### 3.3.2 Objectives

The following objectives for delay times are independent of the size of the HLR and are 95% values.

a) The probability of loosing messages should be according to the CCITT Recommendation Q.706:

$$P\ (\text{loosing messages}) \leq 10^{-7}$$

b) The delay for retrieval of information from the HLR (retrieval on a per call basis, retrieval of the authentication etc.) should be less than 1000 ms

c) The delay for location reqistration in the HLR should be less than 2000 ms.

## 3.4 Performance design objectives for VLRs

### 3.4.1 Reference loads

a) Reference load for call handling: 1,5 transactions per subscriber per hour

b) Reference load for mobility management: 8,5 transactions per subscriber per hour.

### 3.4.2 Objectives

The same objectives as for HLRs apply (see section 3.3.2).

# 4. Transmission characteristics

## 4.1 General

### 4.1.1 BS-MSC path

The performance objectives of BS-MSC path are dependent on lenght of the link and therefore they will be decided on national basis. However, they should be fixed taken into account CCITT Rec. G.921.

### 4.1.2 MSC

The MSC should meet the transmission objectives of digital exchanges as specified in CCITT Recommendation Q.551 and Q.554.

## 4.2 System Delay distribution

Recommendation GSM 03.50 specifies an overall transmission delay objective throughout the PLMN for speech channels for reasons of subjective speech quality. Since this transmission delay objective includes several physical network elements, this section specifies transmission delay values allocated to each of them. Due to in-band protocols implemented in the GSM PLMN with timers running across several network entities, also the transmission delay for data channels must be limited and allocated to the physical network elements.

### 4.2.1 Speech Channel Delay

The main problem arising from an excessive delay occurs in a speech channel because of subjective effects of echo and simultaneous speech in both directions. To minimise these effects a both way speech delay of 180 ms between the Mouth Reference Point (MRP)/ Ear Reference Point (ERP) in the MS and the Point Of Interconnection (POI) with the PSTN/ISDN has been specified in recommendation GSM 03.50 as an objective for the GSM PLMN operator when constructing his network.

This delay for the full rate speech channel has been loosely allocated to the various system entities as follows and illustrated in fig 4/1 and fig 4/2. The detailed delay figures internal to a system entity are only indicative. The total delay allowance allocated to any of the system entities should, however, not be exceeded. The propagation delay through the PLMN is not included. It should be noted that even if the sum of allocated delay values may exceed 180 ms in some cases, the long-term objective is still to keep the overall PLMN transmission roundtrip delay below 180 ms.

The allocated delay allowances are indicated as either system dependent or implementation dependent. By system dependent it is meant that the delay values are worst-case delay values given by system-given units of time, and cannot be changed. By implementation dependent it is meant that the values depend on the technology used, and that the values allocated have been fixed as upper bounds by realistic judgement.

Note: The various figures allocated to the various network entities given in these delay budgets are for guidance to network operators for network planning. It is up to the operator to provide other figures, if required.

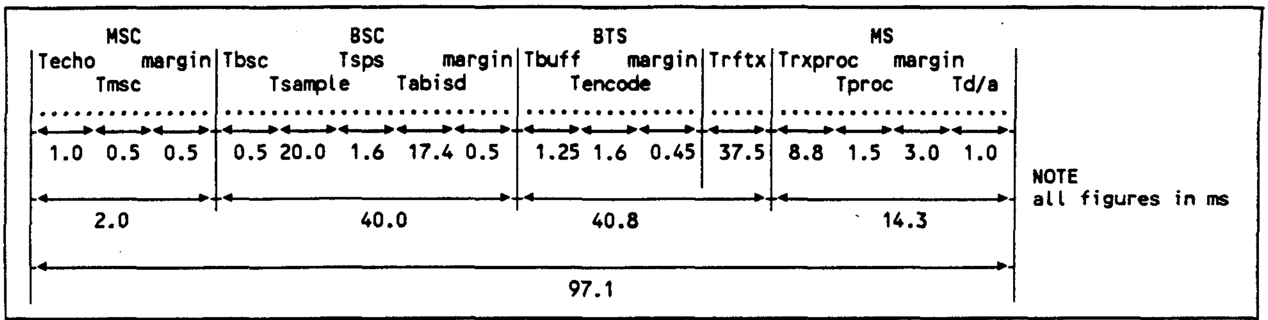


Fig 4/1a
Downlink delay distribution for TCH/FS (16Kbit/s Abis)

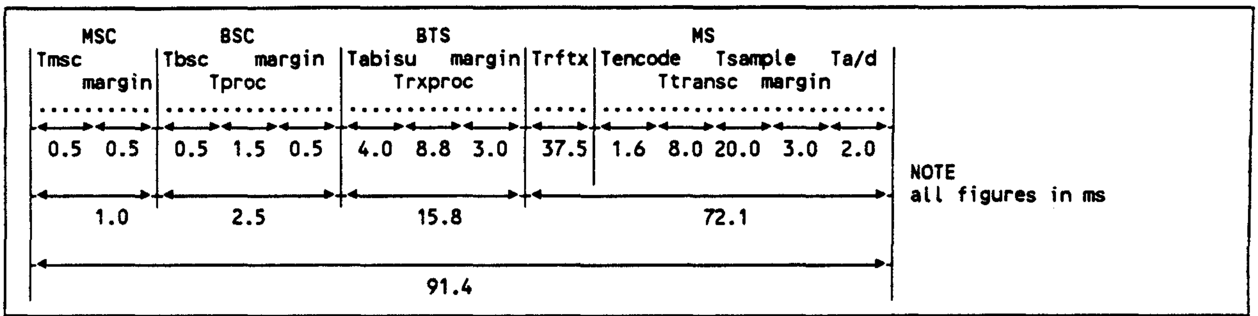


Fig 4/1b
Uplink delay distribution for TCH/FS (16 Kbit/s Abis)

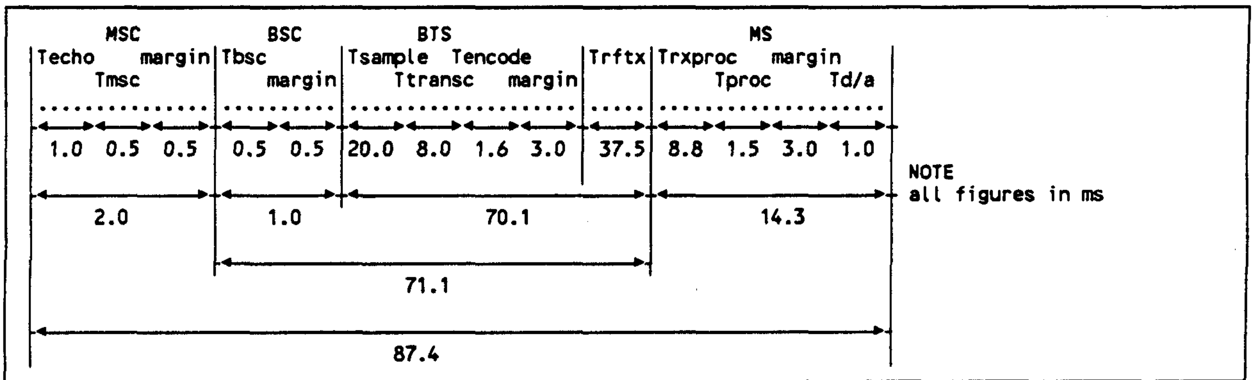


Fig 4/2a
Downlink delay distribution for TCH/FS (64 Kbit/s Abis)

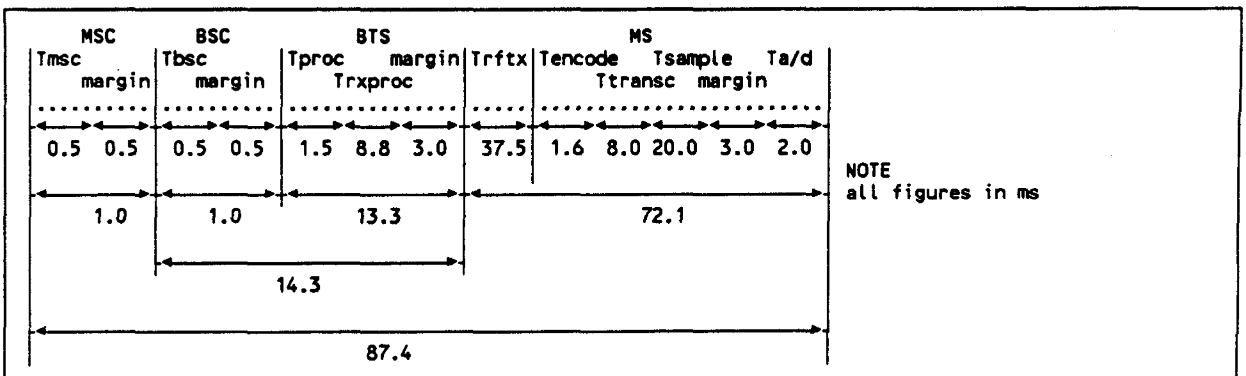


Fig 4/2b
Uplink delay distribution for TCH/FS (64 Kbit/s Abis)

BSS internal delay values (indicative):

Tsample: The duration of the segment of PCM speech operated on by the full-rate speech transcoder (system dependent).

Trftx: The time required for transmission of a TCH radio interface frame over the air interface due to the interleaving and de-interleaving (given in table 4/2) (system dependent).

Tabisu: The time required to transmit the first 56 speech frame data bits (bits C12-C15, D1-D56 and 4 synchronization bits - 64 bits) over the 16 kbit/s A-bis-interface in the uplink direction (system dependent).

Tabisd: The time required to transmit the 260 speech frame data bits (bits D1-D260, C16 and 17 synchronization bits - 278 bits) over the 16 kbit/s A-bis-interface in the downlink direction (system dependent).

Tbuff: Due to the time alignment procedure for inband control of the remote transcoder in case of a 16 kbit/s A-bis-interface in the downlink direction, it is required to have a buffer in the BTS of 1 ms + one 250 us regulation step (system dependent).

Tbsc: Switching delay in the BSC (implementation dependent).

Ttransc: The speech encoder processing time, from input of the last PCM sample to output of the final encoded bit (implementation dependent).

Tsps: Delay of the speech encoder after reception of the last PCM sample until availability of the first encoded bit (implementation dependent).

Tencode: The time required for the channel encoder to perform channel encoding (implementation dependent).

Trxproc: The time required after reception over the radio interface to perform equalization, channel decoding and SID-frame detection (implementation dependent).

Tproc: The time required after reception of the first RPE-sample to process the speech encoded data for the full-rate speech decoder and to produce the first PCM output sample (implementation dependent).

BSS external delay values (indicative):

Techo: Delay due to the echo canceller.

Tmsc: Switching delay in the MSC.

#### 4.2.2 Data Channel Delay

The service requirements on excessive transmission delays for data channels are not as stringent as for speech channels. However, two overall requirements apply:

1. Proper operation of the RLP protocol with the timers T1 and T2 residing in the MSC/IWF and in the MS/TA must be ensured, and thus the roundtrip delay between those network entities must be low enough to avoid time-outs of the RLP retransmission timer T1 (Roundtrip delay < T1 - T2). This applies to non-transparent data only:

2. Proper operation of any end-to-end acknowledged protocols must be ensured in a similar manner. This applies to all data channels.

The transmission delay requirements for data channels have been allocated to the various system entities as follows and as illustrated in figures 4/3 and 4/4, for transparent and non-transparent data separately, and the requirements in the budgets should apply to all full-rate or half-rate channels, whether synchronous or asynchronous. The contributions to the round-trip transmission delay seen by the RLP are also indicated. It should be noted that these concern the transmission delay part only, and that the timer T2 must be added in order to find the limits for T1. The detailed delay figures internal to a system entity are only indicative. The total delay allowance allocated to any of the system entities should, however, not be exceeded. The propagation delay through the PLMN is not included.

The allocated delay allowances are indicated as either system dependent or implementation dependent. By system dependent it is meant that the delay values are worst-case delay values given by system-given units of time, and cannot be changed. By implementation dependent it is meant that the values depend on the technology used, and that the values allocated have been fixed as upper bounds by realistic judgement.

It should be noted that the actual delay distribution for a specific data channel in most cases will have a lower total transmission delay than indicated in the budgets, which show the worst-cases.

It should also be noted that the budgets apply to perfect conditions, i.e. no errors over the radio path (implying no re-transmissions) and no flow control. It should be noted, however, that in a real life situation any errors on the radio path may increase the transmission delay and/or decrease the RLP throughput, and that the flow control buffer limits for XON/XOFF will under continuous flow control have a direct impact on the transmission delay, giving an additional delay contribution directly given by these buffer limits.

The following delay values are specific to data traffic channels:

Transparent data only:

Tchar: The time needed in the IWF and TA to receive a character at the user bit-rate in the transmit direction for bit-to-character conversion (given in table 4/3) (system dependent).

Tra0: The time required for buffering in the IWF and TA in the transmit direction for asynchronous-to-synchronous conversion and overspeed/underspeed detection and correction. This delay corresponds to Tchar above (given in table 4/3) (system dependent).

Tnic: The time needed in the IWF in each direction for buffering for Network Independent Clocking. This time corresponds to one V.110 frame (system dependent).

Non-transparent data only:

Tl2runit: The necessary time in the IWF and TA in the transmit direction to convert the incoming user data bit stream into interpretable data units, e.g. characters (character oriented without framing) or data frames (e.g. bit oriented data like HDLC) (system dependent).

Tl2rbuft: Worst-case delay in the IWF and TA in the transmit direction required for buffering in the L2R in order to assemble one PDU (system dependent).

Tprotpr: Processing time used in the IWF and TA by the L2R and the RLP in the transmit or receive direction (implementation dependent).

Trlpbuft: Worst-case buffering delay in the IWF and TA required by the RLP in the transmit direction in order to synchronize one PDU towards the radio interface transmission (system dependent).

Trlpbufr: Worst-case delay in the IWF in the receive direction required for buffering in the RLP in order to assemble one PDU, before checksum calculation can be carried out (system dependent).

Tl2rbufr: Worst-case buffering delay in the IWF and TA required by the L2R in the receive direction in order to synchronize one PDU with the L2R user (system dependent).

Transparent and non-transparent data:

Tiwfpr: Processing time in the IWF in the downlink or in the uplink direction (implementation dependent).

Tabisf: Worst-case delay over the A-bis-interface due to non-synchronized A-bis-interface transmission. This delay corresponds to one TRAU frame (system dependent).

Tdframe: Additional delay to Tabisf in the downlink direction in order to receive a full radio interface data TCH frame over the A-bis-interface, so that channel encoding can start. The data TCH frame length is given in table 4/1and Tdframe is summarized in table 4/4 (system dependent).

Talignd: The time needed to wait in the downlink in order to align the received data over the A-bis-interface to the radio interface TDMA frame structure. This time corresponds to one TDMA-frame for full-rate channels and two for half-rate channels (system dependent).

Tframe: Delay in the uplink direction in the MS in order to receive a full radio interface data TCH frame over the user interface, so that channel encoding can start. The data TCH frame length is given in table 4/1 (system dependent).

Tdbuff: Additional buffering needed in the TA in the uplink direction with respect to Tframe allowing a total buffering of four V.110 frames. The V.110 frame length is given in table 4/1, and Tdbuff is summarized in table 4/4 (system dependent).

Talignu: The time needed to wait in order to align the received uplink data over the user interface to the radio interface TDMA frame structure. This time corresponds to one TDMA-frame for full-rate channels and two for half-rate channels (system dependent).

Ttaprocd: Processing time required in the TA in the downlink direction for terminal adaptation (implementation dependent).

Ttaprocu: Processing time required in the TA in the uplink direction for terminal adaptation (implementation dependent).

Other delay values indicated in the budgets for data traffic channels are defined as for speech channels. Margins are allocated to each system entity for the total implementation dependent part of the delay contributions, considering the amount of processes in each entity and the amount of data processed. Those operations not included explicitly in the budget are considered only to add minimal delays and are thus considered to be covered by the margins.

The data channel delay budgets for a 64 kbit/s and a 16 kbit/s A-bis-interface are essentially the same, the only difference being a reduction in rate adaptation functions in the 64 kbit/s case and a possible non-synchronized transmission over the 16 kbit/s A-bis-interface (Tabisf). Thus only the 16 kbit/s A-bis-interface is illustrated, and for this option only the worst-cases. The budgets in figures 4/3 and 4/4 apply, hence, also to the case of a 64 kbit/s A-bis-interface. For the case of the integrated BSS the delay budget for the BSS shall contain the sum of the allowances for the BSC and the BTS.

| Traffic channel: | Frame length (ms): | |
|---|---|---|
| | Radio int. (z): | V.110: |
| TCH/FS | 20 | - |
| TCH/HS | [tbd] | - |
| TCH/F9.6 | 20 | 5 |
| TCH/F4.8 | 20 | 10 |
| TCH/H4.8 | 40 | 10 |
| TCH/F2.4 | 20 | 10 |
| TCH/H2.4 | 40 | 10 |

Table 4/1. Radio interface and V.110 frame lengths for traffic channels

| Traffic channel: | Interleaving/deinterleaving (TDMA-frames/timeslots): | delay (y) (ms) |
|---|---|---|
| TCH/FS | 7+1/1 | 37.5 |
| TCH/HS | [tbd] | [tbd] |
| TCH/F9.6 | 18+3+2/1 | 106.8 |
| TCH/F4.8 | 18+3+2/1 | 106.8 |
| TCH/H4.8 | 36+6+4/1 | 212.9 |
| TCH/F2.4 | 7+1/1 | 37.5 |
| TCH/H2.4 | 36+6+4/1 | 212.9 |

Table 4/2. Interleaving/de-interleaving delay for traffic channels

Note: As an example, the TCH/F9.6 has an interleaving depth of 19, resulting in a delay of 18 TDMA-frames and 1 timeslot. Due to the block diagonal interleaving scheme where 4 user data blocks are channel encoded together, it may in the worst-case be necessary to wait for all the 4 subblocks spread over 3 additional TDMA-frames before channel decoding. The channel encoded block will also span a maximum of 2 SACCH frames.

It may be possible, in practice, to reduce the interleaving delay, Trftx, by processing information before the complete data block is received over the air interface. It may also be possible, in practice, to reduce the impact of Tframe by transmitting information over the air interface before the complete data block is encoded. However, due to the less stringent delay requirements on data transmission than on speech transmission, this is considered to unnecessarily constrain the implementation options.

| Ruser: | Tchar (x): |
|---|---|
| 75 bit/s | 146.7 ms |
| 300 bit/s | 36.7 ms |
| 1200 bit/s | 9.2 ms |
| 2400 bit/s | 4.6 ms |
| 4800 bit/s | 2.3 ms |
| 9600 bit/s | 1.2 ms |

Table 4/3. Delays for bit/character conversion (11 bits)

| Traffic channel: | Tdframe (u): | Tdbuff (v): |
|---|---|---|
| TCH/FS | - | - |
| TCH/HS | - | - |
| TCH/F9.6 | 0 ms | 0 ms |
| TCH/F4.8 | 0 ms | 20 ms |
| TCH/H4.8 | 20 ms | 0 ms |
| TCH/F2.4 | 0 ms | 20 ms |
| TCH/H2.4 | 20 ms | 0 ms |

Table 4/4. Tdframe and Tdbuff given for various TCH types

Note: The various figures allocated to the various network entities given in these delay budgets are for guidance to network operators for network planning. It is up to the operator to provide other figures, if required.

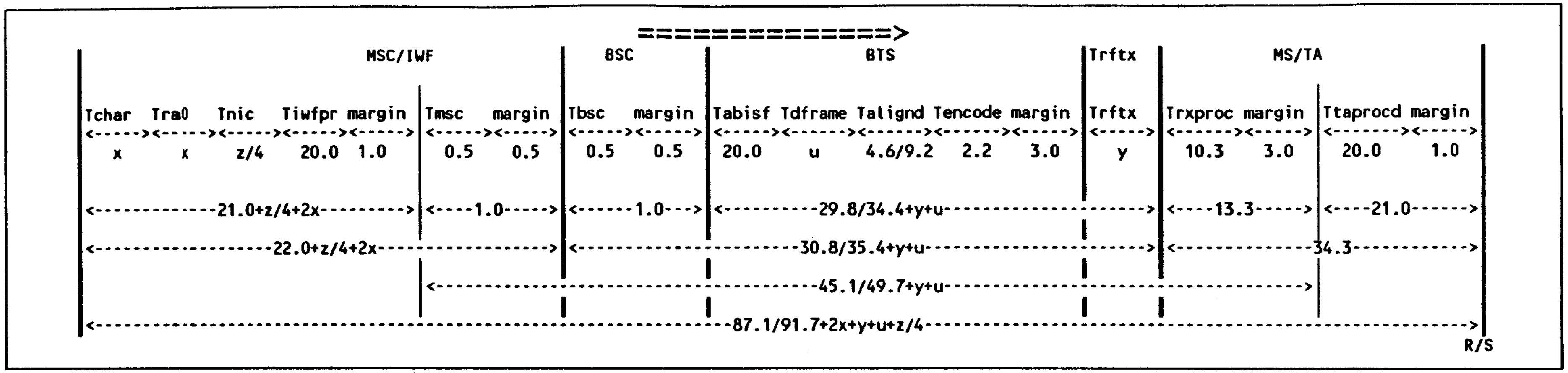


Fig 4/3a. Worst-case downlink delay distribution for data TCH (transparent data)

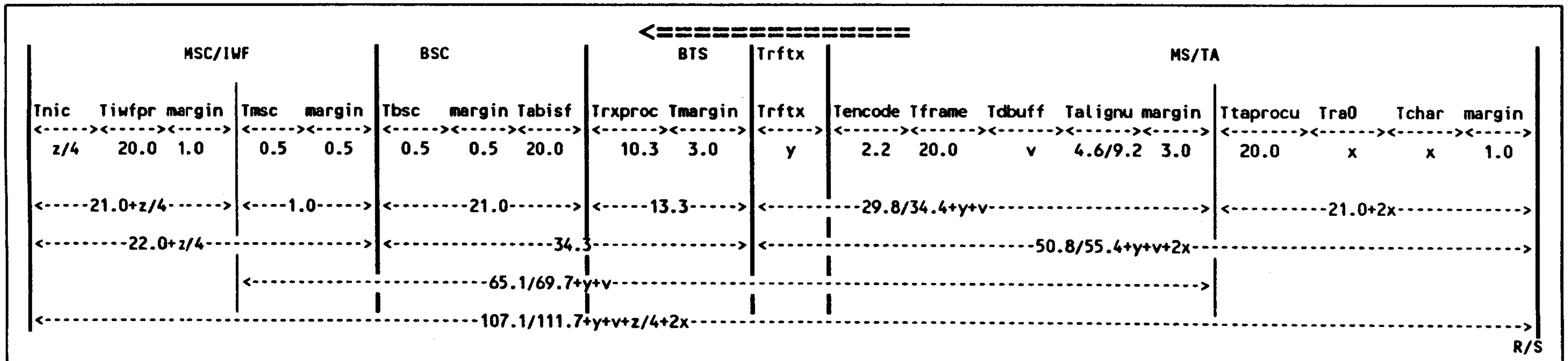


Fig 4/3b. Worst-case uplink delay distribution for data TCH (transparent data)

Note: All figures are in ms. The values of x, y, z, u and v depend on the user bitrate, ranging from 75 - 9600 bit/s, and the data TCH type.

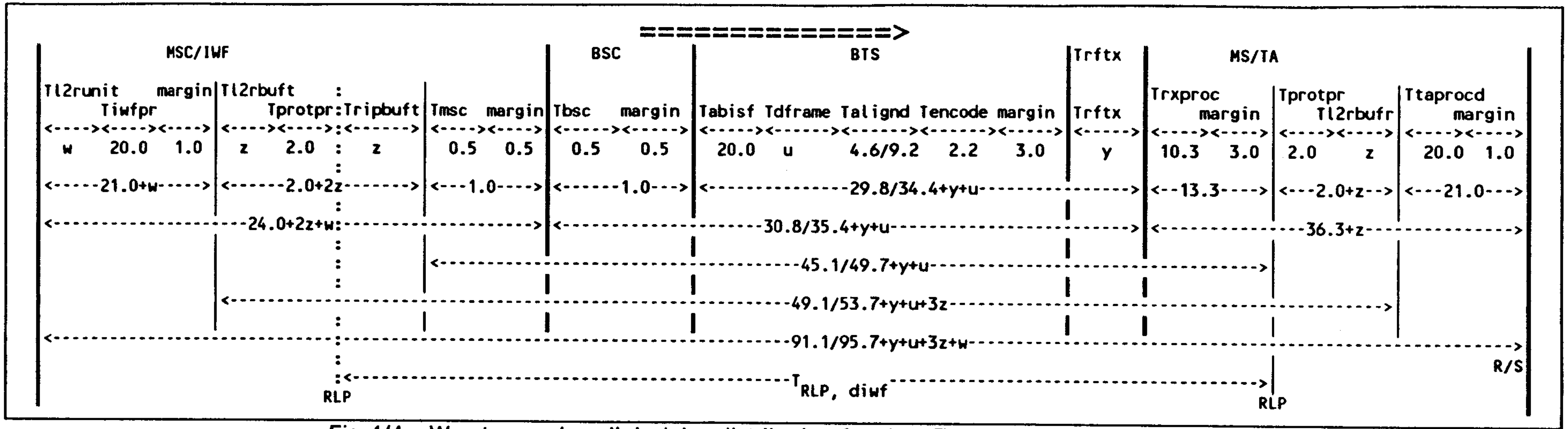


Fig 4/4a. Worst-case downlink delay distribution for data TCH (non-transparent data)

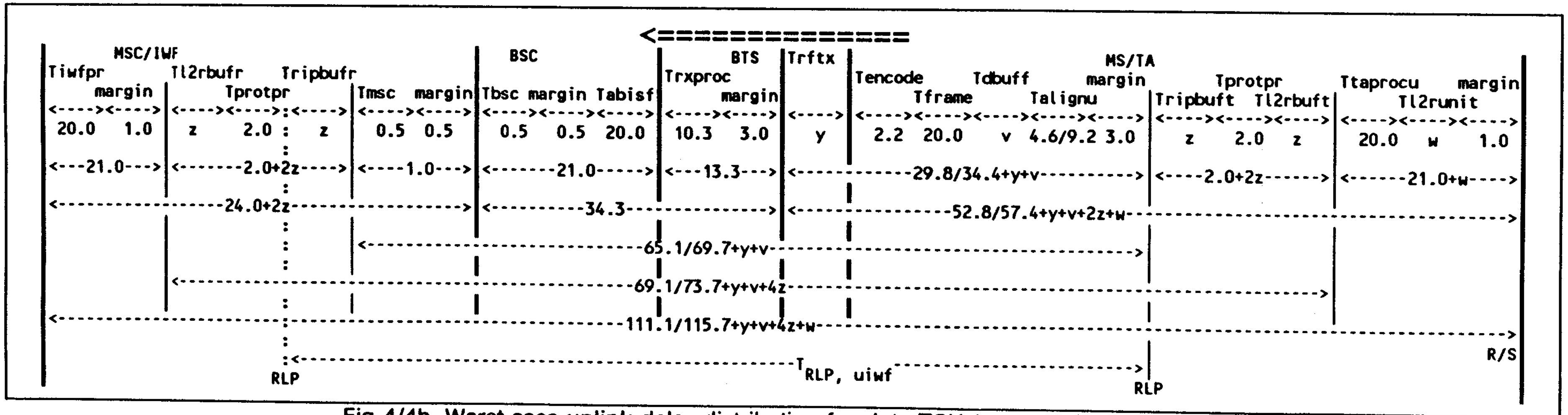


Fig 4/4b. Worst-case uplink delay distribution for data TCH (non-transparent data)

Note: All figures are in ms. The values of y, z, u, v and w depend on the data TCH type and the L2R user protocol. $T_{RLP,diwf}$ and $T_{RLP,uiwf}$ are the transmission delays seen by the RLP in the IWF in the downlink and uplink respectively. It should be noted that the corresponding transmission delays seen by the TA are given by a symmetrical assessment, but are not identical. The sum of the two, however, is the same.