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TELEPHONE NETWORK AND ISDN

QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING

GRADE OF SERVICE (GOS) MONITORING

ITU-T Recommendation E.493

(Previously "CCITT Recommendation")

FOREWORD

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

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

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation E.493 was prepared by ITU-T Study Group 2 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 19th of February 1996.

NOTE

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

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SUMMARY

This Recommendation provides the methods for monitoring GOS parameters in fixed and mobile telecommunications networks. GOS monitoring is considered for all traffic related GOS parameters defined in ITU-T Recommendations.

The GOS monitoring methodology is based on the principle that the measurements that are available are those that a network operator can obtain on a continuous basis using measurements taken at network elements. All measurements are defined so that a network element can provide the data without requiring coordination or communication with any other network element. An implication of this principle is that for all GOS parameters that involve multiple networks, each network's contribution to the GOS parameter is monitored and the overall GOS parameter is monitored only if it is possible from measurements taken within a single network.

GRADE OF SERVICE (GOS) MONITORING

(Geneva, 1996)

1 Scope

This Recommendation covers the monitoring of traffic related Grade of Service (GOS) parameters in fixed and mobile telecommunications networks. The services considered are circuit-switched services, packet-switched services, Intelligent Network (IN)-based services and Broadband ISDN (B-ISDN)-based services.

Many of the GOS parameters defined are end-to-end in nature and to directly measure the parameter, the measurement equipment would have to be at the customer location (e.g. for post-selection delay and end-to-end blocking), or measurements would have to be taken between two locations [e.g. answer signal delay would be measured between two customer locations, Initial Address Message (IAM) delay would be measured between two local exchange switches]. This Recommendation does not consider measurements of that type. End-to-end or customer-based measurement usually involves temporary installations of monitoring equipment, and is not done on a continuous basis. Quality of Service (QOS) monitoring is frequently done in this way.

The type of GOS monitoring considered in this Recommendation is of a type that a network operator can do on a continuous basis using measurements taken at the network elements. Monitoring with specialized measurement equipment that connects to the network at one or more places is not considered. All measurements are defined so that a network element can collect the data without requiring coordination or communication (for the purpose of taking measurements) with any other network element. That is, each network element acts autonomously with regard to taking measurements.

The implication of this restriction on how measurements are taken is that the defined GOS parameters are not measured directly, but rather, each network's contribution to the defined parameter is measured. In order for network operators to assess how well their networks are meeting objectives, an allocation for each network needs to be made of the target values for the defined GOS parameters. This Recommendation does not cover how to do this allocation. The allocation will depend on how a specific network interconnects with other networks for different services. It is up to the network operators to work out these allocations with their interconnection partners. Recommendation E.721 provides the reference connection models used in determining the target GOS parameter values given there, and those reference connections should be considered in making allocations of target values to separate networks.

2 References

The following CCITT and ITU-T Recommendations provide the definitions and target values for the GOS parameters considered in this Recommendation:

- CCITT Recommendation E.543 (1988), *Grades of service in digital international telephone exchanges.*
- CCITT Recommendation E.721 (1991), *Network grade of service parameters and target values for circuit-switched services in the wolving ISDN.*
- CCITT Recommendation E.723 (1992), *Grade-of-service parameters for Signalling System No. 7 networks.*
- ITU-T Recommendation E.724 (1996), *GOS parameters and target GOS objectives for IN services.*
- ITU-T Recommendation E.771 (1993), *Network grade of service parameters and target values for circuit-switched land mobile services.*
- ITU-T Recommendation E.774[1)], *Network grade of service parameters and target values for maritime and aeronautical mobile services.*

[1)] Presently at the stage of draft.

– ITU-T Recommendation E.776[2] , *Network grade of service parameters and target values for UPT.*

The following CCITT and ITU-T Recommendations contain information related to this Recommendation:

– CCITT Recommendation E.502 (1992), *Traffic measurement requirements for digital telecommunication exchanges.*

– CCITT Recommendation E.505 (1992), *Measurements of the performance of common channel signalling network.*

– CCITT Recommendation E.540 (1988), *Overall grade of service of the international part of an international connection.*

– CCITT Recommendation E.541 (1988), *Overall grade of service for international connections (subscriber-to-subscriber).*

– ITU-T Recommendation E.743 (1995), *Traffic measurements for SS No. 7 dimensioning and planning.*

– ITU-T Recommendation E.770 (1993), *Land mobile and fixed network interconnection traffic grade of service concept.*

– ITU-T Recommendation E.773[2], *Maritime and aeronautical mobile GOS concept.*

– ITU-T Recommendation E.775 (1996), *UPT grade of service concept.*

3 Introduction

Traffic-related GOS parameters are of two general types: delay parameters and probability of mishandling or blocked call parameters. The probability of steady-state blocking or malfunctioning measurements are usually straightforward. The total number of events (e.g. call attempts) are counted and the number of malfunctions (e.g. blocked calls) are counted, and taking the ratio gives the desired measure.

Delay measures can be more difficult. One problem is that many delay parameters measure delays between different points in a network. It is desirable to take direct measurements whenever possible, but sometimes this cannot be done. The SS No. 7 protocol does not provide for time stamping of messages and so a direct measurement of delay using time stamps on the actual message is not possible. One of the basic principles of GOS monitoring that is taken in this Recommendation is that no coordination should be required between network elements to take the measurements. Each network element should work autonomously in taking measurements. This means that each network element needs to take delay measures within itself. The combination of individual network element performances to estimate defined end-to-end GOS parameters can be approximated using reference connections such as those given in clause 3/E.721.

Another difficulty with delay measures is that frequently 95% target values are specified. Since for some GOS parameters the methods used here do not measure the GOS parameter directly, but rather add and subtract different measures to arrive at the GOS parameter, the 95% calculations can be troublesome. To do these calculations accurately, correlations of probability distributions are required, and this can become complicated and require significant data storage. An alternative suggested here is to use the following approximation.

Approximation for computing 95% values

The approximation is to assume that for any random variable considered, say z, its mean, $\bar{z}$ and its 95% value, z^{95}, are related by:

$$z^{95} = \bar{z} + \alpha\sigma_z$$

where σ_z is the standard deviation of z. The important part of the assumption is that α is the same for all random variables considered. One class of random variables satisfying this condition are those having a normal distribution.

[2] Presently at the stage of draft.

Consider independent random variables x_i for which the mean values, $\bar{x}_i$ and 95% values, x_i^{95}, are known. Note that these are easily computed from data and do not require distribution information to be stored. If the x_i are assumed to satisfy the above condition, then if:

$$z = \sum_{i=1}^{N} x_i$$

il s'ensuit que:

$$z^{95} = \sum_{i=1}^{N} \bar{x}_i + \left[\sum_{i=1}^{N} \left(x_i^{95} - \bar{x}_i \right)^2 \right]^{1/2}$$

The above approximation is used in this Recommendation to derive expressions for 95% values of sums of independent random variables. The above expression is derived using the fact that the variance of a sum of independent random variables is the sum of their variances.

4 Monitoring network GOS parameters for circuit-switched services in ISDN

The following network GOS parameters for circuit-switched services in ISDN are defined in clause 2/E.721:

- pre-selection delay (overlap sending);
- post-selection delay (overlap sending);
- post-selection delay (*en bloc* sending);
- answer signal delay;
- call release delay; and
- probability of end-to-end blocking.

The target values for these GOS parameters are given in clause 3/E.721.

An individual circuit-switched network is defined as a collection of interconnected network elements (e.g. switches, service control points, signal transfer points, etc.) that:

- has the capability to establish a connection between a subscriber or network and another subscriber or network; and
- is operated by a single network operator.

Figure 1 illustrates the idea of individual networks and local, toll and international end-to-end connections. Network 1 is a local area network that provides local connections (e.g. between T1 and T2), toll connections (e.g. for a toll call from T1 to T3, network 1 provides a connection between T1 and network 2) and international connections (e.g. for an international call from T1 to T4, network 1 provides a connection between T1 and network 2). Network 2 provides toll connections (e.g. for the call from T1 to T3, it provides a connection between network 1 and network 3) and international connections (e.g. for the call between T1 and T4, it provides the connection between network 1 and network 4).

There are many possibilities for different network configurations and interconnections. The principle used below in monitoring the above GOS parameters is that monitoring should be done by each individual switched network to determine its contribution to the end-to-end GOS parameters. Target values for each individual network's contribution to a GOS parameter must be determined using reference connection models that reflect the role that network plays in different connection types.

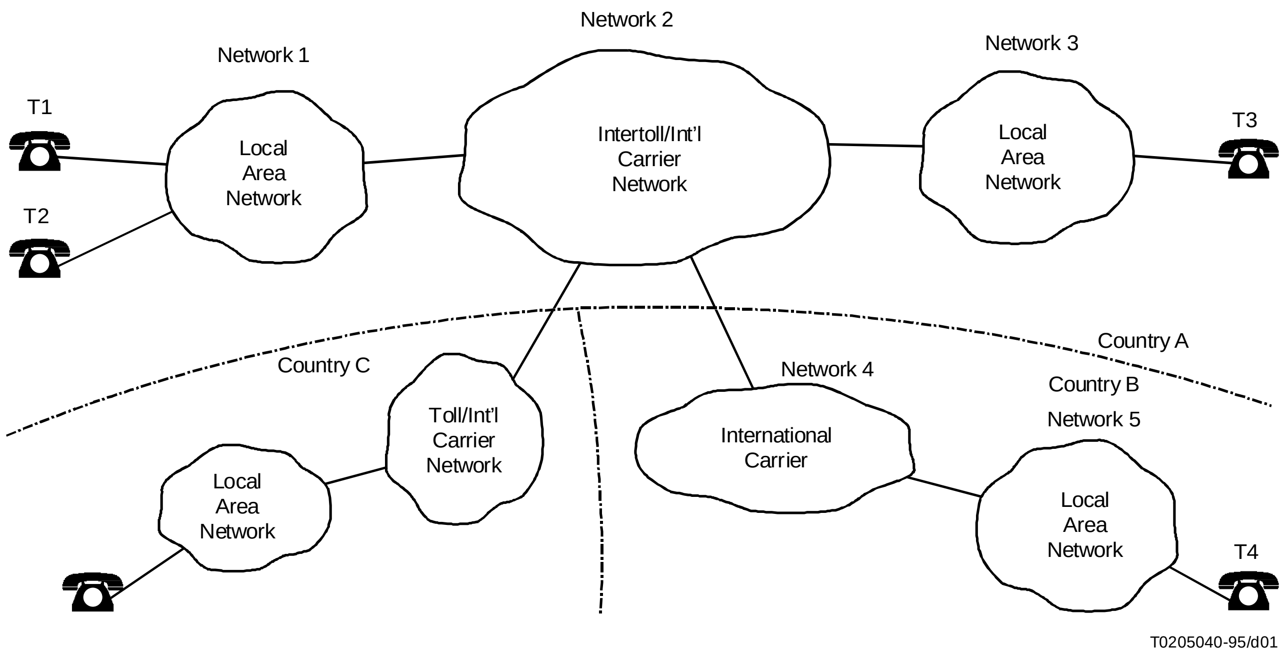

FIGURE 1/E.493

Illustration of networks and end-to-end connections

4.1 Monitoring delay GOS parameters

A signal flow diagram for a circuit-switched connection in ISDN is shown in Figure 2. The four delay parameters identified above are denoted by t_1 to t_4 as follows:

t_1 Pre-selection delay (overlap sending).

t_2 Post-selection delay (overlap or *en bloc* sending).

t_3 Answer signal delay.

t_4 Call release delay.

These four delays, t_1 to t_4 , are identified in Figure 2. It is clear that t_1, t_2 and t_4 are directly measurable only from the calling terminal (A). The answer signal delay is not directly measurable from any single point in the connection. Since the objective of GOS monitoring is for each network operator to be able to take measurements from their network and assess how their network is performing relative to the GOS objectives, a methodology other than direct measurement of the defined GOS parameters is required for monitoring the delay GOS parameters. The following subclauses define the methodology that should be used and the measurements required for each network operator to monitor their contribution to each of the delay GOS parameters t_1 through t_4.

4.1.1 Monitoring pre-selection delay t_1

The components of the pre-selection delay t_1 are the emission time and propagation time for the set-up message from the calling terminal to the local exchange serving the calling terminal, the intra-office delay t_1^A (see Figure 2) at the local exchange, the emission time and propagation time for the set-up ACK message from the local exchange to the calling terminal. The component that is measurable by a network switch is t_1^A. Therefore, the methodology recommended is that, for each local exchange area, the mean and 95% values of t_1^A are determined for the local exchange area in the manner described below. Each of those values are then added to 2 × {maximum propagation time from terminal to local exchange} + {set-up message emission time} + {set-up ACK message emission time}. This gives an estimate of the mean and 95% for t_1 that is conservative since a worst case has been used for propagation delays. The variability in propagation delay within a local exchange area is small enough that this approximation introduces little error.

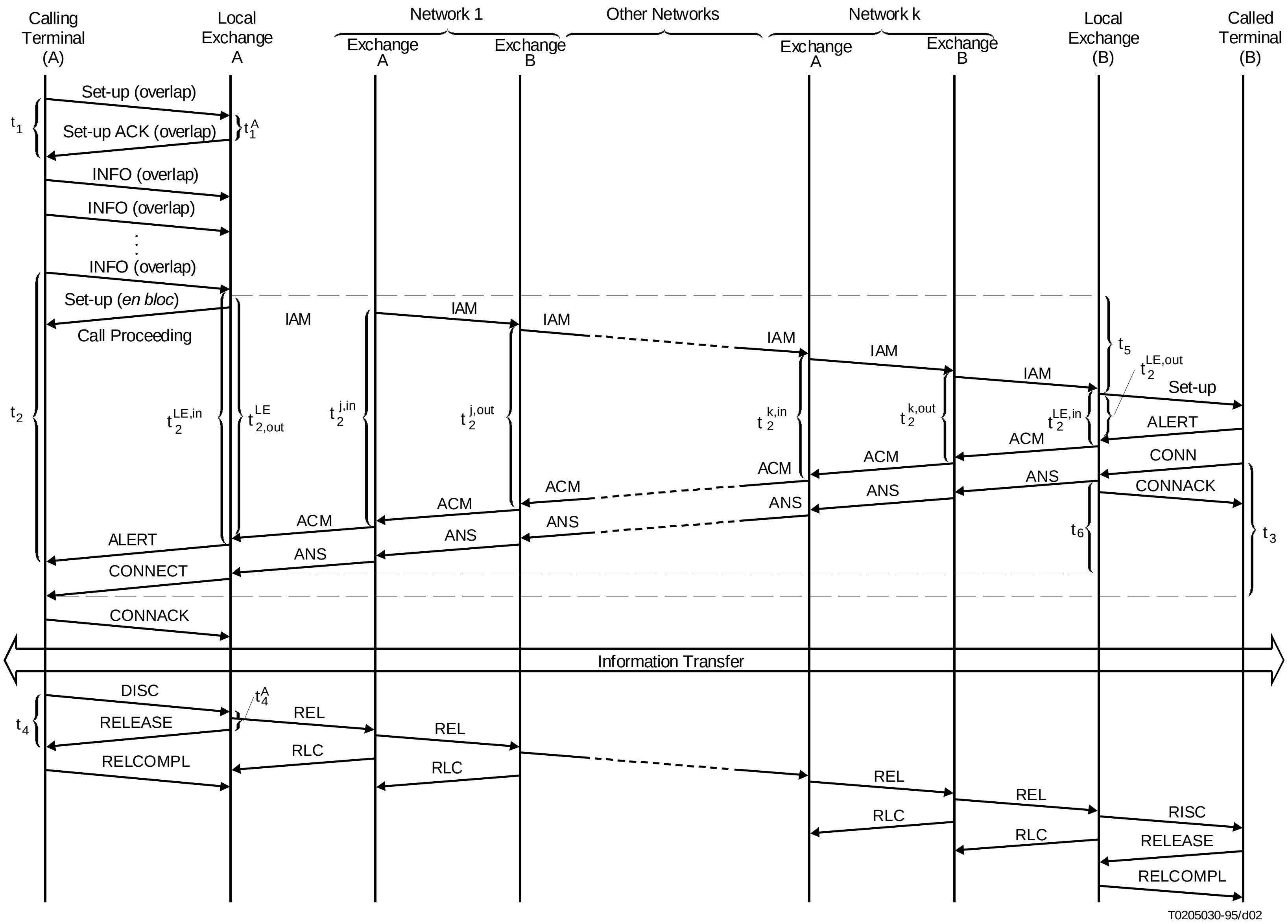

FIGURE 2/E.493

Signal flow diagram for a circuit-switched connection in ISDN

To determine the mean and 95% values for t_1^A within a local exchange area, the time t_1^A should be collected for each call or an appropriate sampling of calls at each local exchange during the traffic reference periods specified in Recommendation E.492. The mean and 95% value for each local exchange should be determined for each traffic reference period, and from these, an overall mean and 95% can be determined for the local exchange area. Specifically, if $\bar{\tau}_i$ and τ_i^{95} denote the measured mean and 95% values for t_1^A at exchange *i*, the mean and 95% values for the local area, $\bar{\tau}_{area}$ and τ_{area}^{95}, are given by:

$$\bar{\tau}_{area} = \frac{1}{N} \sum_{i=1}^{N} \bar{\tau}_i$$

$$\tau_{area}^{95} = \bar{\tau}_{area} + \frac{1}{N} \left[\sum_{i=1}^{N} \left(\tau_i^{95} - \bar{\tau}_i \right)^2 \right]^{1/2}$$

where *N* is the number of exchanges in the local exchange area being considered.

The estimates determined for the mean and 95% values of t_1 by the above methodology should be compared with the target values given in Table 2/E.721 for pre-selection delay to assess how well the considered network is meeting objectives.

4.1.2 Monitoring post-selection delay t_2 and its components

The measurable times related to t_2 at any one network switch are:

1) the time between receiving an IAM and sending the corresponding ACM;

2) the time between sending an IAM and receiving the corresponding ACM.

These time intervals are identified in Figure 2 at network boundaries; that is, intervals of type 1) are indicated when an IAM first enters a network for a call, and intervals of type 2) are indicated when an IAM is sent from a network to another network. The time $t_2^{j,in}$ denotes for network *j* the time between receipt of the entering IAM and sending the corresponding ACM. The time $t_2^{j,out}$ denotes for network *j* the time between sending the IAM to another network and receiving the corresponding ACM from that other network. The time $t_2^{j,in} - t_2^{j,out}$ gives the contribution network *j* makes to t_2.

The time $t_2^{LE,in}$, which is taken by the local exchange serving the calling customer, gives a direct measure of t_2 – set-up message delay – ALERT message delay. The recommended monitoring methodology is to monitor $t_2^{LE,in}$ and the contribution each network makes to $t_2^{LE,in}$. The specific steps are as follows.

The recommended monitoring methodology for $t_2^{LE,in}$ is for each local exchange area:

1) For each exchange in the local exchange area, measure $t_2^{LE,in}$ for every call, or appropriate sample of calls, that enter the network at that exchange.

2) The above measurements should be taken over the appropriate traffic reference period (see Recommendation E.492), and for each traffic reference period the mean and 95% values for $t_2^{LE,in}$ should be computed for each exchange. Let $\bar{\tau}_{k,LE}$ and $\tau_{k,LE}^{95}$ denote the results for exchange *k*.

3) Let the mean and 95% values of $t_2^{LE,in}$ for the local exchange network be denoted by $\bar{\tau}_{LE}$ and τ_{LE}^{95}. These are computed from the results of 2) as follows:

$$\bar{\tau}_{LE} = \frac{1}{N} \sum_{k=1}^{N} \bar{\tau}_{k,LE}$$

$$\tau_{LE}^{95} = \bar{\tau}_{LE} + \frac{1}{N} \left[\sum_{k=1}^{N} \left(\tau_{k,LE}^{95} - \bar{\tau}_{k,LE} \right)^2 \right]^{1/2}$$

where N is the number of exchanges in the local exchange area being considered.

The target values for $\bar{\tau}_{LE}$ and τ_{LE}^{95} are determined from the target values for t_2 specified in Recommendation E.721 less the worst case set-up and ALERT delays (similar to what is done above for pre-selection delay t_1). When a network is involved in more than one type of connection (local, toll, international), the above measurements, allocations and calculations should be done for the different connection types.

The recommended monitoring methodology for each network contribution to post-selection delay, t_2, is for each network j:

1) For each switch in network j measure $t_2^{j,in}$ for every call, or appropriate sample of calls, that enter the network at that switch.

2) For each switch in the network measure $t_2^{j,out}$ for every call, or appropriate sample of calls, that leave the network at that switch.

3) The above measurements should be taken over the appropriate traffic reference period (see Recommendation E.492) and for each traffic reference period the mean and 95% values for $t_2^{j,in}$ and $t_2^{j,out}$ should be computed for each switch. Let $\bar{\tau}_{j,k,in}$, $\bar{\tau}_{j,k,out}$, $\tau_{j,k,in}^{95}$ and $\tau_{j,k,out}^{95}$ denote the results for switch k in network j.

4) Let the mean and 95% values of $t_2^{j,in}$ and $t_2^{j,out}$ for network j be denoted by $\bar{\tau}_{j,in}$, $\bar{\tau}_{j,out}$, $\tau_{j,in}^{95}$ and $\tau_{j,out}^{95}$. These are computed from the results of 3) as follows:

$$\bar{\tau}_{j,in} = \frac{1}{N_j} \sum_{k=1}^{N_j} \bar{\tau}_{j,k,in}$$

$$\bar{\tau}_{j,out} = \frac{1}{N_j} \sum_{k=1}^{N_j} \bar{\tau}_{j,k,out}$$

$$\tau_{j,in}^{95} = \bar{\tau}_{j,in} + \frac{1}{N_j} \left[\sum_{k=1}^{N_k} \left(\tau_{j,k,in}^{95} - \bar{\tau}_{j,k,in} \right)^2 \right]^{1/2}$$

$$\tau_{j,out}^{95} = \bar{\tau}_{j,out} + \frac{1}{N_j} \left[\sum_{k=1}^{N_j} \left(\tau_{j,k,out}^{95} - \bar{\tau}_{j,k,out} \right)^2 \right]^{1/2}$$

where N_j denotes the number of switches in network j.

5) Let $t_{2,j}$ denote the contribution of network j to the post-selection delay t_2. The mean and 95% of $t_{2,j}$ are given by:

$$\bar{t}_{2,j} = \bar{\tau}_{j,in} - \bar{\tau}_{j,out}$$

$$t_{2,j}^{95} = \bar{t}_{2,j} + \left[\left(\tau_{j,in}^{95} - \bar{\tau}_{j,in}\right)^2 - \left(\tau_{j,out}^{95} - \bar{\tau}_{j,out}\right)^2\right]^{1/2}$$

Each network operator needs to determine what allocation it has of the mean and 95% target values for t_2 given in Recommendation E.721 (Table 2/E.721) and the monitored values of $\bar{t}_{2,j}$ and $t_{2,j}^{95}$ determined above should be compared with those allocated values. Also, when a network is involved in more than one type of connection (local, toll, international), the above measurements, allocations and calculations should be done for the different connection types. It must be noted that with this methodology, the allocations are determined for some reference connection that specifies the number of networks involved in an end-to-end connection. Thus, the allocation of the mean and 95% target GOS parameter values are in regards to this end-to-end reference connection.

4.1.3 Monitoring the components of answer signal delay t_3

The recommended methodology is, for each network j, to:

1) Measure at each element of the network being considered (switching offices and signal transfer points) the cross-office delay of the answer message for appropriate traffic reference periods.

2) Determine a reference connection model for different connection types for the network being considered. This should specify the number of switches, the number of signalling links and the number of STPs an answer signal must pass through. Also, the total propagation delay should be specified.

3) From the data collected in 1), determine the mean and 95% answer signal cross-office delay for switches and STPs in the network being considered.

4) Using the reference connection model in 2) and the data from 3) for switches and STPs, determine the mean and 95% contribution to answer signal delay from the switches and STPs in the reference connection. Add to these the propagation delay and total emission time (the number of signalling links times the emission time of an answer message on one signalling link) to determine the estimated mean and 95% answer signal delay in the considered network.

5) An allocation of the target values for answer signal delay given in Table 2/E.721 should be made for the network being considered. The allocation is based on an end-to-end reference connection model appropriate for the network being considered. The results obtained in 4) should be compared with this target allocation.

4.1.4 Monitoring call release delay t_4

Monitoring of call release t_4 is similar to monitoring pre-selection delay t_1. The component that is measurable by a network switch is the cross-office delay t_4^A shown in Figure 2. The mean and 95% values of t_4^A for a local exchange area should be determined for the appropriate traffic reference periods in the same manner as was indicated above for t_1^A. Each of these is then added to 2 × {maximum propagation time} + {DISC message emission time} + {RELEASE message emission time} to obtain an approximation of the mean and 95% call release delay. These results should be compared to the target values given in Table 2/E.721.

4.2 Monitoring blocking GOS parameters

The blocking GOS parameter specified in Recommendation E.721 is the probability of end-to-end blocking. It is recommended that each network provider monitor the probability of blocking within their network, and thereby determine their contribution to the overall end-to-end blocking probability. The call blocking probability should be measured for different connection types (local, toll, international). The network operator needs to determine an allocation of the target end-to-end blocking probability so they have a target value for their network GOS measurements.

The measurements required to monitor the call blocking in a network are for each traffic reference period and each connection type:

1) At each switch there should be a count of the number of incoming calls (i.e. the number of calls incoming from another network or a direct connect to a subscriber). For switch *i*, this count will be denoted by C_i.

2) At each switch there should be a count of the number of calls blocked. For switch *i*, this count will be denoted by B_i.

The measure of average call blocking, *P*, is then given by:

$$P = \frac{\sum_{i=1}^{N} B_i}{\sum_{i=1}^{N} C_i}$$

where *N* is the number of switches in the network being considered.

5 Monitoring GOS parameters for mobile services

5.1 Circuit-switched land mobile services

The GOS parameters and target values for circuit-switched land mobile services are provided in Recommendation E.771 and the following traffic GOS parameters are recommended:

1) post-selection delay;

2) answer signal delay;

3) call release delay;

4) probability of end-to-end blocking; and

5) probability of connection cut-off due to unsuccessful land cellular hand over.

The first four of these parameters are the same as those discussed in clause 4. The method for monitoring these GOS parameters is the same as discussed in 4.1.1, 4.1.3 and 4.2. In the case of mobile networks, the Mobile Switching Centres (MSCs) must take measurements analogous to what local exchanges do in the fixed networks. Figures 1/E.771 and 2/E.771 illustrate the mobile side of the call set-up procedure.

The probability of connection cut-off due to unsuccessful land cellular handover is monitored by the MSCs. Each MSC should measure the total number of calls established during the traffic reference period and the number of calls cut-off due to unsuccessful handover. From these measurements, the probability of cut-off can be computed for each MSC and an average for the mobile carrier can also be determined.

5.2 Maritime and aeronautical mobile services

This is for further study.

6 Monitoring GOS parameters for IN-based services

6.1 Monitoring GOS parameters for freephone-like services

The GOS parameters and target values for freephone-like services an provided in Recommendation E.724. The methodology used in Recommendation E.724 is to define IN-based delay GOS in terms of "incremental delay for processing IN-based services". For IN-based services the call set-up procedure illustrated in Figure 2 will be interrupted at certain points and transactions between a Service Switching Point (SSP) and a Service Control Point (SCP) will take place. After this transaction, the call set-up will proceed. The delay GOS parameters for IN-based services relate to the additional time required to carry out these IN transactions.

To monitor IN-based GOS, it is necessary to measure the time to carry out the SSP to SCP transactions. The following measurements are needed to monitor these delays:

- At each SSP within a network, measure for each service class defined in Recommendation E.724 the time to complete the related SSP to SCP transaction for each call (or appropriate sampling of calls) in that service class.

- At each SCP, measure for each transaction, or appropriate sampling of transactions, the total processing time (i.e. the time from when the last bit of the query message is received until the last bit of the response message is sent).

With these measurements being taken in the specified traffic reference periods, the impact of each network on the incremental IN processing delay for each service class can be determined. In addition, taking differences between SSP and SCP mean transaction times, the mean round trip delay for SCP access (a GOS parameter identified in Recommendation E.723) can be determined.

6.2 Monitoring GOS parameters for UPT

The GOS parameters for UPT are defined in Recommendation E.776 and the recommended parameters are:

1) pre-selection delay;

2) post-selection delay;

3) answer signal delay;

4) call release delay;

5) end-to-end blocking;

6) connection cut-off rate;

7) authentication delay.

The first six of these parameters are the same as have been previously discussed and the GOS monitoring is the same for UPT.

6.2.1 Monitoring authentication delay

The authentication delay should be monitored in a manner analogous to pre-selection delay and call release delay (see 4.1.1 and 4.1.4). Namely, the switching office receiving the authentication request should measure the time from receiving the request until it sends a decision to the user. The worst case propagation times and message sending times should be added to these measured quantities to determine estimates for the complete delay.

7 Monitoring GOS parameters for B-ISDN

The GOS parameters being considered for B-ISDN are:

- post-selection delay;
- answer signal delay;
- call release delay; and
- probability of end-to-end blocking.

The definitions for these parameters are the same as those parameters identified for circuit-switched services in ISDN. Therefore, the monitoring methodology is the same as given in clause 4.

8 Monitoring GOS in digital international telephone exchanges

The GOS parameters for digital international telephone exchanges are defined in Recommendation E.543. Recommendation E.543 defines the following GOS parameters (see clause 3/E.543) and gives corresponding GOS standards (see clause 4/E.543):

- internal loss probability;
- incoming response delay;
- exchange call set-up delay; and
- through-connection delay.

Measurements to monitor the GOS performance for the above GOS parameters are given in clause 5/E.543.

9 Monitoring GOS parameters for Signalling System No. 7 networks

The GOS parameters for Signalling System No. 7 networks are given in Recommendation E.723. The defined parameters are:

- end-to-end Initial Address Message (IAM) delay;
- end-to-end answer message (ANM) delay; and
- mean round trip delay for Service Control Point (SCP) access, not including the application processing at the SCP.

The round trip delay for SCP access is discussed in 6.1. The end-to-end IAM and ANS message delays are illustrated in Figure 2 and denoted by t_5 and t_6, respectively. Since the IAM and ANS messages pass through multiple networks, it is necessary for each network to monitor their contribution to the end-to-end delay. The network provider must determine an allocation of the end-to-end delay target values that pertain to their network.

The methodology for monitoring IAM and ANS delay is the same as that provided in 4.1.3 for monitoring answer signal delay. In fact, the monitoring done for answer signal delay provides monitoring for ANM delay, since in one network the ANM delay and answer signal delay are the same. For monitoring the IAM delay, the same procedure is used except cross-office IAM delays are measured.

10 History

This is a new Recommendation, to be first published in 1996.