Recommendation E.543

GRADES OF SERVICE IN DIGITAL INTERNATIONAL TELEPHONE EXCHANGES

1 Introduction

1.1 The grade of service (GOS) parameters and values to be used as dimensioning standards and as performance objectives for international telephone exchanges are indicated below. Procedures to monitor the actual GOS performance of the exchanges are also recommended.

1.2 The GOS standards for international telephone exchanges defined in this Recommendation assume "fully operative" conditions for the exchange and they are based on the load levels specified in Recommendation E.500.

2 Scope of the Recommendation

2.1 The GOS standards are specified for an exchange as a whole, i.e. neither the delay nor the loss parameters are associated solely with the control area or with the connecting network, so that no particular system concept is favoured.

2.2 Although the GOS parameters defined in this Recommendation apply to the digital as well as to the analogue exchanges, the numerical values recommended for these parameters are primarily intended for digital exchanges. The GOS may be too stringent for analogue exchanges and Administrations are advised to make suitable allowances when applying to the analogue exchanges.

Administrations may also consider these GOS values for dimensioning the national transit exchanges so that the end—to—end GOS performance for international connections is maintained at a high level.

3 Grade of service parameters

The loss and delay GOS standards are defined as follows:

3.1 *Loss grade of service*

internal loss probability: for any call attempt, it is the probability that an overall connection cannot be set up between a given incoming circuit and any suitable free outgoing circuit within the switching network.

The loss grade of service is to be met by every pair of incoming and outgoing trunk groups averaged over all inlets of the incoming group.

This approach takes explicit account of the fact that the Administrations will take actions such as the favourable loading of switch blocks in order to balance access to all trunk groups. These actions will minimize the impact of the worst case upon the traffic flow capacity of the switch, by confining the necessary adjustments to localized regions of the switching network.

These actions should ensure that the switching system operates as efficiently as possible within the constraints imposed by this loss standard.

3.2 *Delay grade of service in case of channel—associated signalling*

incoming response delay: The interval from the instant when an incoming seizure signal has arrived at the incoming side of the exchange to the instant when a proceed—to—send signal is returned to the preceding exchange by the receiving exchange.

The incoming response delay may affect the holding time of the preceding trunks and of the common control equipment in the preceding exchange(s). It may also be perceived by the subscriber as dial—tone delay, in case of special dial tone for international calls in outgoing international exchanges, or may contribute to the post—dialling delay experienced by the subscriber in all other cases. The contribution to post—dialling delay does not necessarily comprise the whole of the incoming response delay.

Note — The above definition of incoming response delay does not explicitly mention that it includes receiver attachment delay. However, for the purpose of this Recommendation, it is assumed that receiver attachment delay is a part of the incoming response delay.

3.3 *Delay grade of service in case of any combination of channel—associated and common channel signalling*

exchange call set—up delay: The interval from the instant when the address information required for setting up a call is received at the incoming side of the exchange to the instant when the seizing signal or the corresponding address information is sent to the subsequent exchange.

through—connection delay (end—to—end channel associated or common channel signalling): the interval from the instant when the information required for setting up a through—connection in an exchange is available for processing in the exchange to the instant when the switching network through—connection is established between the incoming and outgoing circuits.

through—connection delay (link—by—link channel associated signalling): the interval from the completion of outpulsing to the establishment of a communication path through the exchange between the incoming and the outgoing circuits.

4 Grade of service standards

The values shown in Table 1/E.543 are recommended for GOS standards of international digital telephone exchanges. The normal and high load levels are the ones defined in Recommendation E.500.

TABLE 1/E.543

	Normal load	High load
Incoming response delay [a) b)]	P (> 0.5 sec.) ≤ 5 %	P (> 1 sec.) ≤ 5 %
Exchange call set—up delay [b)]	P (> 0.5 sec.) ≤ 5 %	P (> 1 sec.) ≤ 5 %
Through—connection delay [b)]	P (> 0.5 sec.) ≤ 5 %	P (> 1 sec.) ≤ 5 %
Internal loss probability [c)]	0.002	0.01

a) See Note in § 3.2.

b) The determination of the number of bids for the different devices or exchange modules at normal and high load levels should be made according to Rec. E.500. Circuit group or exchange load levels will be used according to the devices or exchange modules affected.

c) The values of traffic offered to the circuit group and to the switching network of the exchange, to be used for loss probability evaluation, should correspond to the traffic flow levels defined for circuit groups and exchanges, respectively, in Rec. E.500.

In case of differences between exchange and circuit group busy hours it is recommended to use models which can take account of the different traffic values in the different parts of the exchange. For example, models used for dimensioning the auxiliary equipment could take advantage of the differences of busy hour of the different circuit groups using the same auxiliary equipment.

5 Measurements to monitor exchange GOS performance

In the context of traffic Administration, monitoring the GOS performance in an exchange is a means of detecting potential problems which can affect the GOS performance of that exchange. By analysing deviations from previously established GOS performance thresholds, problem areas can be detected. After having identified the problems, actions such as load balancing, fault removal, extensions, etc., can be derived from GOS performance monitoring. These actions are not taken on a real—time basis, and consequently the data collection and analysis do not have real—time constraints. The traffic measurements recommended below do not separate the causes of call attempt failure or excessive delay.

When the values of the GOS performance are consistently worse than the GOS standards specified in § 4, it will be necessary to identify the causes of such a situation through the analysis of ad—hoc measurement procedures. Considering the above framework, errors in GOS estimation are only important to the extent that they can generate over— or under—reactions to exchange situations.

For each of the GOS parameters a statistical estimator has been defined. The measurements must be made on a per circuit group and per exchange basis. Eventually, savings could be derived from delay measurements made on the basis of signalling types when several circuit groups share the same auxiliary devices. All measurements described below refer to a specific measurement period.

5.1 *Delay measurements*

5.1.1 *Incoming response delay*

The exchange GOS performance with respect to this parameter can be estimated by means of the ratio:

$$p = \frac{B}{A},$$

where

A is the number of call attempts accepted for processing from a given incoming circuit group

B is the number of call attempts out of the set *A*, for which the incoming response delay exceeded the predetermined value *X*

Note — In SPC exchanges a certain time may elapse from the moment that the incoming seizure signal appears at the incoming circuit until the moment that the processor accepts the call attempt for processing. Measuring this delay would require external equipment to the call handling processors. The above measurement only provides an indication of the incoming response delay after the call has been accepted for call processing. In the case where this delay is significant, it should be taken into account in dimensioning and should be subtracted from the total time allowed for the incoming response delay.

5.1.2 *Exchange call set—up delay*

The exchange performance with respect to this parameter can be measured by means of the following ratio:

$$q = \frac{D}{C},$$

where

C is the number of call attempts for which sufficient address information has been received at the incoming side of the exchange, which are addressed to a certain outgoing circuit group and for which the seizing signal or the corresponding address information is sent to the subsequent exchange.

D is the number of call attempts already counted in *C* for which the call set—up delay exceeds the predetermined value, *T*.

5.1.3 *Through—connection delay*

The exchange performance with respect to this parameter can be measured by means of the following ratio:

$$r = \frac{F}{E},$$

where

E (for end—to—end channel associated and common channel signalling) is the number of call attempts for which the required information for setting up a through—connection is available for processing in the exchange for a certain circuit group.

E (for link—by—link channel associated signalling) is the number of call attempts which have completed outpulsing in a certain circuit group.

F is the number of call attempts already counted in *E* for which the through—connection delay has exceeded the predetermined value *V*.

Note 1 — The loss of call attempts caused by the exchange itself, premature subscriber release or time—out expiration in an upstream exchange may modify the outcome of the above delay measurements. However, the effect will only be significant under abnormal conditions which should be investigated separately.

Note 2 — It is recommended that values for *X*, *T*, and *V* be either 0.5 s (normal load) or 1 s (high load).

Note 3 — Measuring delays on a per call basis could produce severe cost penalties to the exchange. Since the accuracy requirements from the statistical viewpoint are not very high, call sampling procedures or test calls can be sufficient for GOS monitoring purposes.

5.2 *Loss measurements*

One estimator of this parameter per circuit group is:

$$s = \frac{H}{G},$$

where:

G is the number of call attempts which require a connection from an inlet to the desired outgoing circuit group having at least one free circuit and for which sufficient call handling information was made available to the exchange.

H is the number of those call attempts described by *G* which failed to build up the required connection.

Note — The loss of call attempts caused by premature subscriber release or time—out expiration in an upstream exchange, may modify the outcome of the above measurement.