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CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

X.140

(09/92)

**DATA COMMUNICATION NETWORKS
NETWORK ASPECTS**

**GENERAL QUALITY OF SERVICE
PARAMETERS FOR COMMUNICATION VIA
PUBLIC DATA NETWORKS**



Recommendation X.140

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT 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 Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation X.140 was revised by Study Group VII and was approved under the Resolution No. 2 procedure on the 10th of September 1992.

CCITT NOTES

- 1) In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized private operating agency.
- 2) A list of abbreviations used in this Recommendation can be found in Annex D.

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Recommendation X.140

GENERAL QUALITY OF SERVICE PARAMETERS FOR COMMUNICATION VIA PUBLIC DATA NETWORKS

(Malaga-Torremolinos, 1984; amended at Melbourne, 1988;
revised 1992)

The CCITT,

considering

(a) that users of data transmission services need general parameters which express their quality of service requirements without reference to any particular service or the means of its provision;

(b) that providers of data transmission services need similar general parameters for representing offered services, and for relating user quality of service requirements to network performance capabilities;

(c) that Recommendations X.130 and X.131 define protocol-specific performance parameters and objectives for circuit-switched public data networks;

(d) that Recommendation X.134 specifies portion boundaries and packet-layer reference events for defining packet-switched performance parameters;

(e) that Recommendations X.135, X.136 and X.137 define protocol-specific performance parameters and values for packet-switched public data networks;

(f) that Recommendation X.200 defines the Reference Model of Open Systems Interconnection (OSI) for CCITT applications;

(g) that Recommendation X.213 defines the OSI network service;

(h) that Recommendation X.300 defines general principles and arrangements for interworking among public data networks, and between public data networks and other networks,

unanimously recommends

that the general parameters defined below be used in specifying the end-to-end quality of public data network services as seen from the user's point of view.

1 Scope and application

1.1 This Recommendation defines a set of general quality of service (QOS) parameters for public data networks (PDNs). The parameters have two essential characteristics:

- 1) they focus on performance *effects* which are observable at the network interfaces, rather than their causes within the network; and
- 2) their definitions are based on protocol-independent events (e.g. access request) rather than protocol-specific interface events (e.g. issuance of an X.21 *call request* signal).

These characteristics make the parameters independent of application, network, and service. With proper specialization, they may be used to specify or measure the quality of any data communication service, irrespective of network internal design or network access protocol. Examples of data communication services to which the parameters may be applied are circuit-switched services, packet-switched services, and leased circuit services. The parameters are applicable to both connection-oriented and connectionless services.

1.2 The general quality of service parameters defined in this Recommendation are specifically designed to be used in relating the performance capabilities of particular network services with user requirements (see Figure 1/X.140). The network specific performance parameters defined in other X-Series Recommendations are focused on specific service interface protocols (e.g. X.21, X.25) and specific network configurations (e.g. X.92, X.110). They are essential for network design and operation and component performance specification, but are not necessarily understandable or relevant to users. Similarly, performance requirements of users are often focused on particular applications (e.g. electronic funds transfer (EFT), text editing) and may not be directly useful to network providers. An example is the data processing parameter "response time". The general parameters provide a "common language" for relating the two. They enable users to specify communication requirements without presupposing any particular service, network, or protocol, and enable providers to describe service performance in terms that are relevant to users, but not specialized to any particular application.

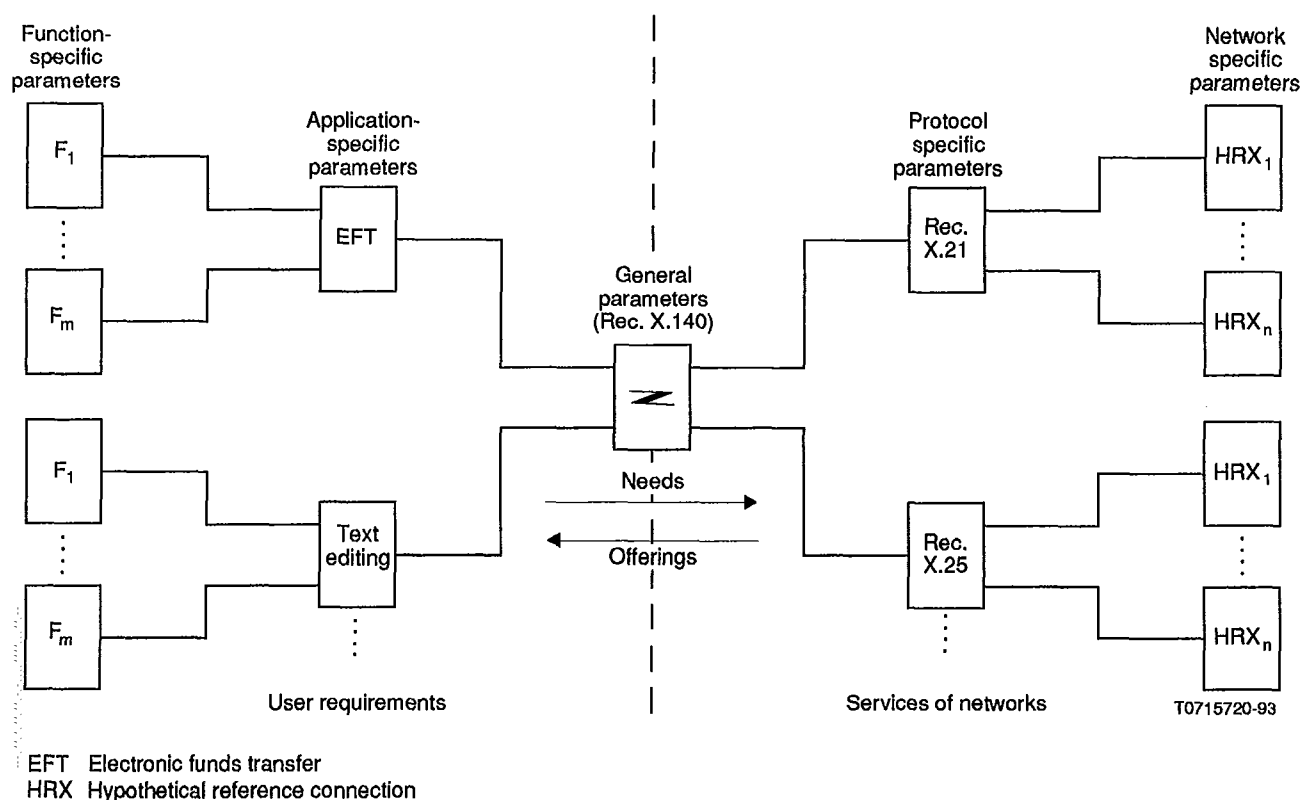
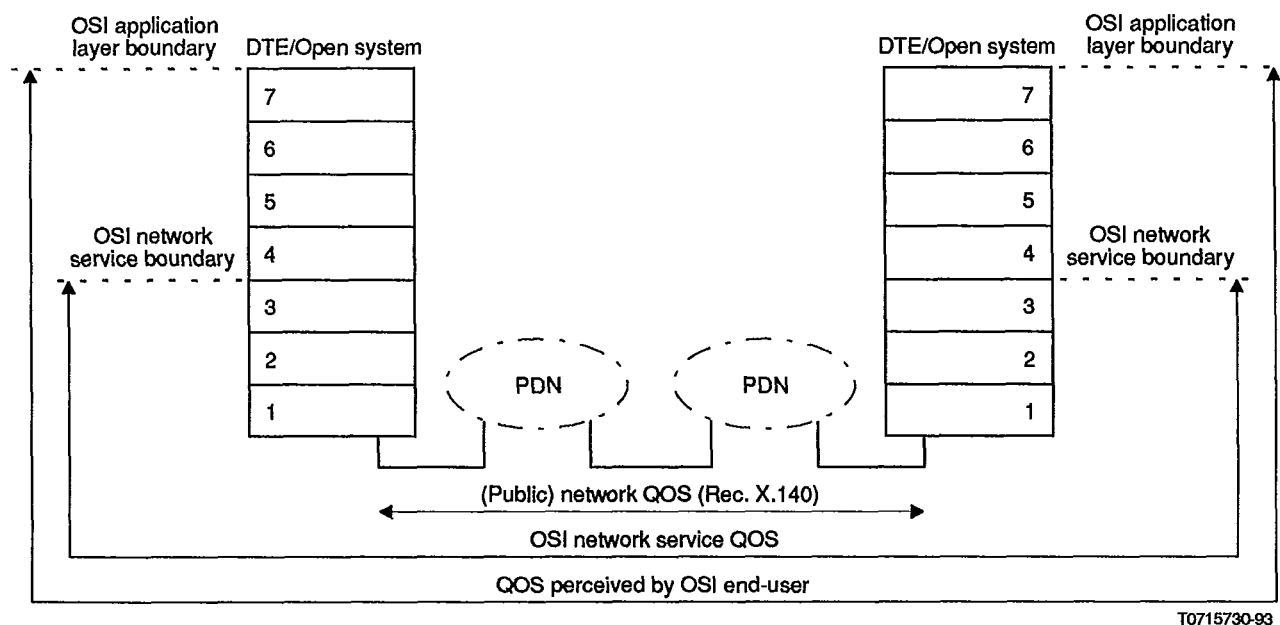


FIGURE 1/X.140

"Common language" function of the general QOS parameters

1.3 The general parameters are principally intended to describe communication performance at interfaces between public data networks and customer DTEs. The detailed characteristics of such network-user interfaces depend on the type of network service and the user application. The quality of X.21-based circuit-switching networks is described in terms of signals occurring at the physical DTE/DCE interfaces (e.g. *call request*, *incoming call*). The quality of X.25-based packet-switching networks is described in terms of corresponding events (or state transitions) occurring at the packet layer of X.25. Specific relationships between the X.140 parameters and the circuit-switching and packet-switching network performance parameters defined in the X.130-Series Recommendations are described in Annexes A and B, respectively.

1.4 Many applications of public data networks will conform to the Reference Model of Open Systems Interconnection for CCITT applications (Recommendation X.200). In that model, QOS parameters are defined at abstract boundaries between layers. Public data networks provide support for the OSI network service (see Recommendation X.213). The QOS parameters defined in the OSI network service reflect those aspects of public data network quality of service that are observable and significant to OSI network service users. The general relationship between PDN quality of service and OSI network service quality is illustrated in Figure 2/X.140. Specific relationships between the X.140 QOS parameters and the network layer QOS parameters are defined in Annex C. Relationships among the general parameters, the X.130-Series parameters, and the OSI network service performance QOS parameters are summarized in Figure 3/X.140.



Note 1 – QOS parameters and values for specific PDN's (CSPDN, PSPDN) are specified by separate Recommendations.

Note 2 – The signalling of QOS information in various interworking situations is not the subject of this Recommendation.

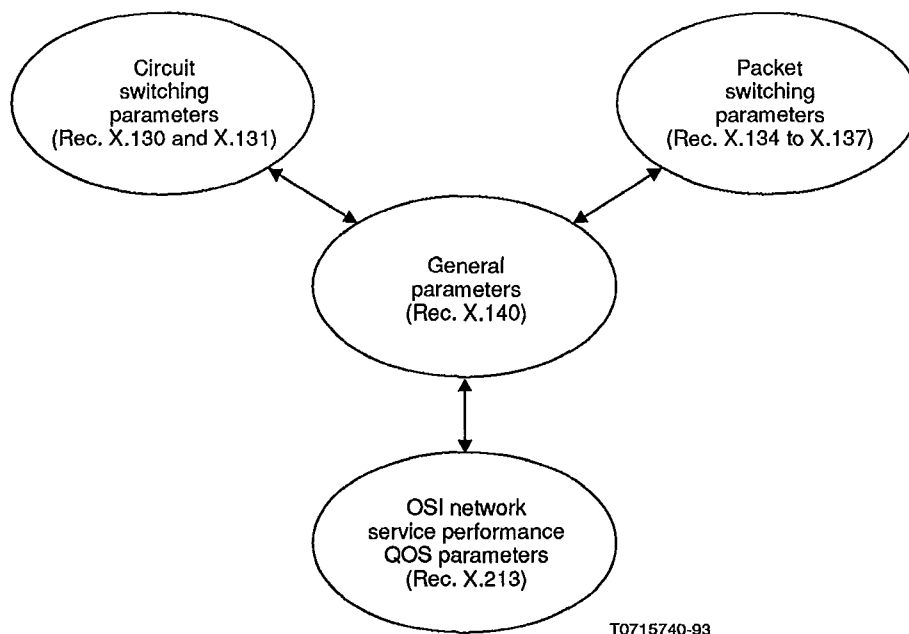
Note 3 – Interfaces are defined in § 1.3.

Note 4 – Application to private networks may be possible at the discretion of individual Administrations.

FIGURE 2/X.140
QOS relationships in an OSI context

1.5 Because the X.140 parameters are based on protocol-independent events, they may also be applied at higher layers in the OSI model. Application of the X.140 parameters at the OSI end user interfaces is illustrated in Figure 2/X.140. Details of parameter specialization, relationships to application-specific parameters, and the mapping of end user QOS values into corresponding lower layer values are for further study.

1.6 A requirement also exists to describe QOS at higher layers (above the network layer) in non-OSI applications. An example is the X.28/X.29 PAD facility. Use of the X.140 parameters to express QOS characteristics in such applications, and possible relationships to PDN QOS parameters, are also for further study.



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FIGURE 3/X.140

Relationships among the general parameters, the X.130-Series parameters, and the OSI network service performance QOS parameters

1.7 Some public networks will have the capability to signal QOS requests and conditions, or to permit users to “negotiate” certain QOS characteristics of the network. This Recommendation does not describe any public data network capabilities of this kind, nor does it specify how they might be used. The provision and use of such capabilities will be the subject of other Recommendations (for example, Recommendations describing how public data networks may support the OSI network service). In the case of interworking between networks, such capabilities are described in Recommendation X.300.

1.8 This Recommendation does not specify values for the general QOS parameters. Values may be specified either by the service user, in characterizing a particular data communication requirement, or by the service provider, in characterizing a particular service offering. Values may be measured by either the users or the provider.

1.9 To ensure comparability, stated values for the general parameters should be accompanied by supplementary information which clearly identifies their scope of application and statistical meaning. User delays may be “factored out” of stated delay and transfer rate values using the method defined below. The same method can be used to factor out provider delays in cases where an assessment of user performance is desired.

1.10 Figure 4/X.140 identifies the general QOS parameters defined in this Recommendation. The parameters are of two types: primary parameters and availability parameters. The primary parameters describe performance during periods of normal service operation, in the absence of service outages. The availability parameters describe the frequency and duration of service outages.

Function Criterion	Speed	Accuracy	Dependability
Access	Access delay	Incorrect access probability	Access denial probability
User information transfer	- User information transfer delay - User information transfer rate	- User information error probability - Extra user information delivery probability - User information misdelivery probability	User information loss probability
Disengagement	Disengagement delay	Disengagement denial probability	

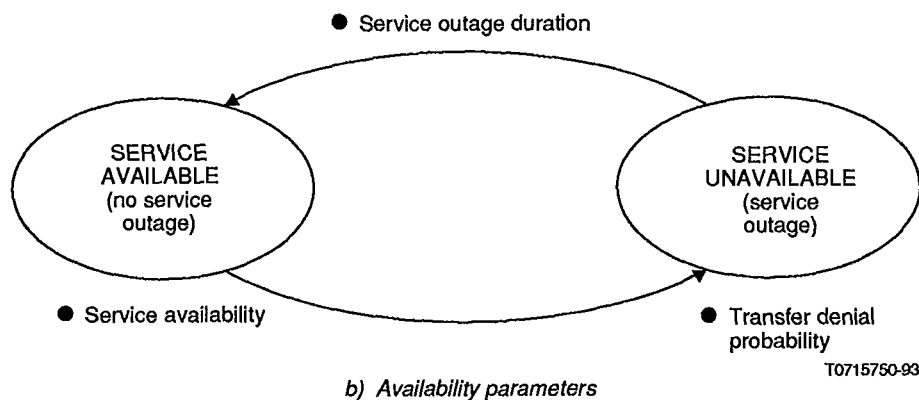


FIGURE 4/X.140
Summary of user-oriented QOS parameters

1.11 Three protocol-independent data communication functions are considered in defining the primary parameters: access, user information transfer, and disengagement. These general functions correspond to connection set-up, data transfer, and connection clearing in connection-oriented services. They are also applicable to connection-less services. Each function is considered with respect to three general performance concerns (or "performance criteria"): speed, accuracy, and dependability. These express, respectively, the delay or rate, degree of correctness, and degree of certainty with which the function is performed.

1.12 An associated two-state model provides a basis for describing overall service availability. A specified availability function compares the values for a subset of the primary parameters with corresponding outage thresholds to classify the service as "available" (no service outage) or "unavailable" (service outage) during scheduled service time. The availability parameters characterize the resulting binary random process.

1.13 The remainder of this Recommendation is comprised of three sections. Section 2 defines the set of user-oriented QOS parameters. Section 3 describes a method of separating delays into user and network components and determining "responsibility" for timeout performance failures. Section 4 specifies supplementary information which should be provided in conjunction with any statement of parameter values.

2 Parameter definitions

This section provides definitions for the fourteen user-oriented QOS parameters.

2.1 access parameters

Performance of the access function is described by three parameters: access delay, incorrect access probability, and access denial probability.

2.1.1 Access delay

Access delay is the value of elapsed time between an access request and successful access.

An access request is any interface signal that notifies the network of a user's desire to initiate a data communication session.

Elapsed time values are calculated only on access attempts that result in successful access. The successful access outcome is indicated in one of two ways:

- 1) by network issuance of a *ready for data* or equivalent signal to the calling user before access timeout, in networks that provide such a signal; or
- 2) by the fact that at least one bit of user information is input to the system before access timeout, in networks that do not provide a *ready for data* or equivalent signal. In connection-oriented services, there is the additional requirement that the intended called user must have been contacted and committed to the data communication session during the access attempt. This requirement distinguishes successful access outcomes from incorrect access outcomes, as discussed in § 2.1.2 below.

Access delay is divided into user-dependent and network-dependent components. Values for the network-dependent components are specified in network-specific Recommendations (e.g. Recommendation X.135).

2.1.2 Incorrect access probability

Incorrect access probability is the ratio of total access attempts that result in incorrect access to total access attempts in a specified sample.

Incorrect access is essentially the case of a "wrong number". It occurs when the network establishes a physical or virtual circuit connection to a user other than the one intended by the call originator, and then does not correct the error before the start of user information transfer. Incorrect access can only occur in connection-oriented services, since the network does not establish a connection between users in connectionless services. Incorrect access is distinguished from successful access (in connection-oriented services) by the fact that the intended called user is not contacted and committed to the data communication session during the access attempt. Values for network-specific parameters corresponding to incorrect access probability are contained in network-specific Recommendations (e.g. X.136).

2.1.3 Access denial probability

Access denial probability is the ratio of total access attempts that result in access denial to total access attempts in a specified sample.¹⁾

Access denial (also termed network blocking) can occur in two ways:

- 1) the network issues a blocking signal to the originating user during the access period (preventing the start of user information transfer); or
- 2) the network delays excessively in responding to user actions during the access period, with the result that user information transfer is not initiated before access timeout. Access denial is distinguished from service outage by the fact that some active response (i.e. interface signal) is issued by the network during the access attempt.

¹⁾ This ratio and all other probability ratios defined in this Recommendation are actually *estimates* of the true probability values.

An access attempt can also fail as a result of user blocking. Such failures are excluded from network performance measurement. User blocking is defined as any case where an access attempt fails as a result of incorrect performance or non-performance on the part of a user. Examples of user blocking include the following:

- a) either the originating or the called user issues a termination (or blocking) signal to the network during the access period (preventing the start of the user information transfer); or
- b) the originating or the called user delays excessively in responding to network actions during the access period, with the result that user information transfer is not initiated before access timeout. An example of the latter is the case where the called user does not answer an incoming call.

Access timeout occurs (i.e. an access attempt is considered to have failed for performance assessment purposes) whenever the duration of an individual access attempt exceeds a specified value. A procedure for distinguishing access denial from user blocking is described in § 3. Values for network-specific parameters corresponding to access denial probability are contained in network-specific Recommendations (e.g. X.136).

Note – Delay to access denial is not included as a parameter because its effect on the users is considered to be insignificant.

2.2 user information transfer parameters

Performance of the user information transfer function is described by six parameters: user information transfer delay, user information transfer rate, user information error probability, extra user information delivery probability, user information misdelivery probability, and user information loss probability.

2.2.1 User information transfer delay

User information transfer delay is the value of elapsed time between the start of transfer and successful transfer of a specified user information unit (e.g. block).

The start of user information unit transfer occurs, for any given user information unit, when two conditions have been met:

- 1) all bits in the unit are physically present within the network facility; and
- 2) the network has been authorized to transmit them. Authorization may either be an explicit user action (e.g. typing carriage return at a buffered CRT terminal) or an implicit part of inputting the user information itself (e.g. typing a single character at an unbuffered asynchronous terminal).

The successful transfer outcome is declared (on end of transfer) when an information unit is transferred from the source user to the intended destination user within the specified transfer timeout period, and the delivered unit has exactly the form and content intended by the source. The form or content of an information unit successfully delivered to a destination user may differ from that input by the source if desired conversions are performed within the network.

The end of user information unit transfer records the output of user information units to the destination user in essentially the same way as the start of transfer records their input at the source. It is defined to occur when:

- a) all bits in the unit are physically present within the destination user facility; and
- b) the destination user has been notified that the information is available for use. The notification may be explicit or implicit.