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SERIES X: DATA NETWORKS AND OPEN SYSTEM
COMMUNICATION

Public data networks – Network aspects

**Speed of service (delay and throughput)
performance values for public data networks
when providing international packet-switched
services**

ITU-T Recommendation X.135

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION X.135

SPEED OF SERVICE (DELAY AND THROUGHPUT) PERFORMANCE VALUES FOR PUBLIC DATA NETWORKS WHEN PROVIDING INTERNATIONAL PACKET-SWITCHED SERVICES

Summary

This Recommendation defines protocol-specific speed of service parameters and values associated with each of the three data communication functions: access, user information, transfer and disengagement.

Source

ITU-T Recommendation X.135 was revised by ITU-T Study Group 7 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 9th August 1997.

FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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Recommendation X.135

SPEED OF SERVICE (DELAY AND THROUGHPUT) PERFORMANCE VALUES FOR PUBLIC DATA NETWORKS WHEN PROVIDING INTERNATIONAL PACKET-SWITCHED SERVICES

(revised in 1997)

1 Introduction

1.1 This Recommendation is the second in a series of four Recommendations (X.134 to X.137) that define performance parameters and values for international packet-switched data communication services. Figure 1 illustrates the scope of these four Recommendations and the relationships among them.

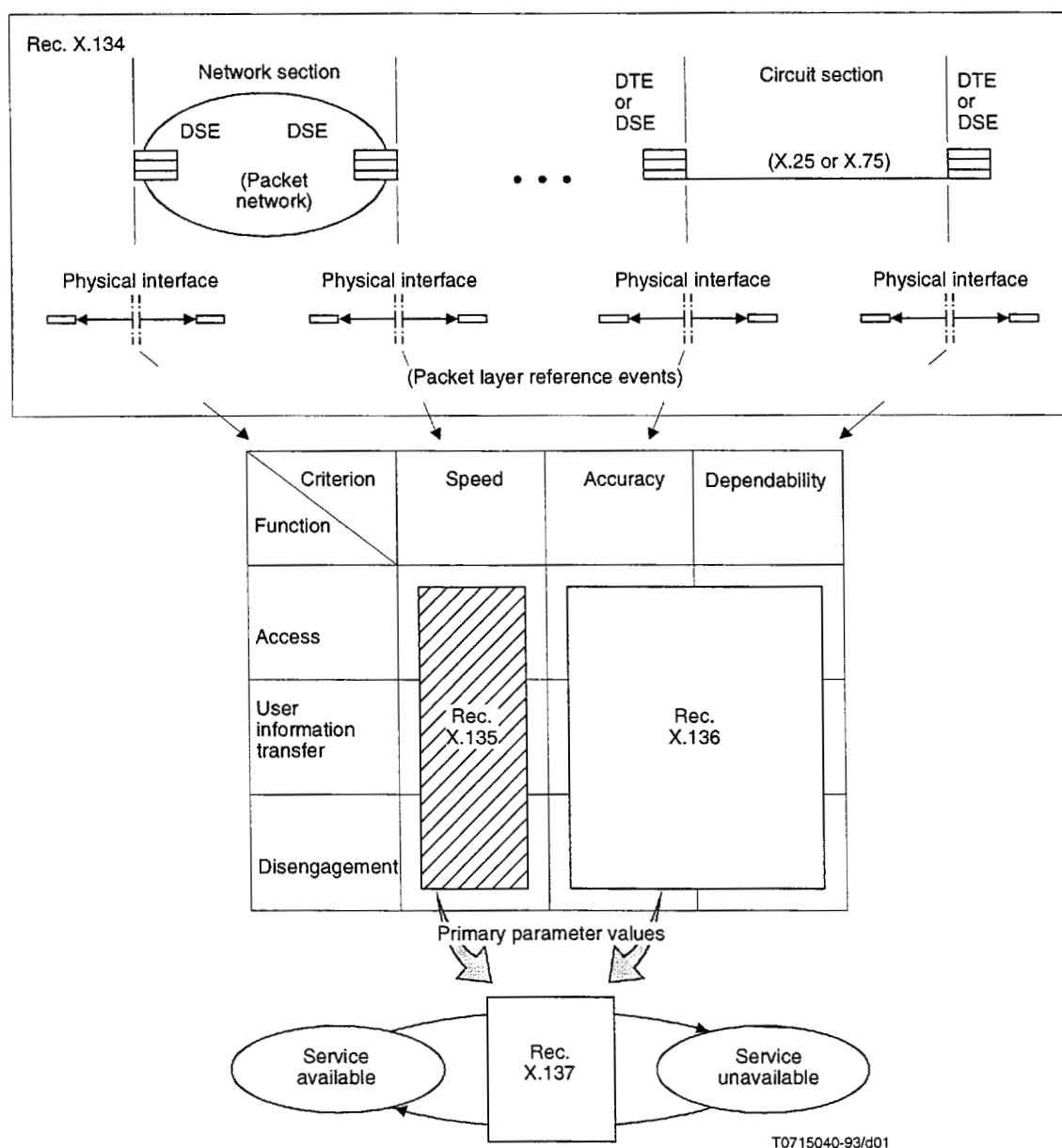


Figure 1/X.135 – Packet-switched service performance description framework

1.2 Recommendation X.134 divides a virtual connection into basic sections whose boundaries are associated with X.25 and X.75 interfaces; defines particular collections of basic sections, called virtual connection portions, for which performance values will be specified; and defines a set of Packet layer reference events (PEs) which provide a basis for performance parameter definition. The basic sections consist of network sections and circuit sections. They are delimited, in each case, by physical Data Terminal Equipment (DTE) or Data Switching Exchange (DSE) interfaces. Virtual connection portions are identified either as national portions or international portions. Each PE is defined to occur when a packet crossing a section boundary changes the state of the packet layer interface.

1.3 For comparability and completeness, packet-switched network performance is considered in the context of the 3×3 performance matrix defined in Recommendation X.140. Three protocol-independent data communication functions are identified in the matrix: access, user information transfer, and disengagement. These general functions correspond to call set-up, data (and interrupt) transfer, and call clearing in packet-switched virtual call services conforming to Recommendations X.25 and X.75. 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.

1.4 This Recommendation defines protocol-specific speed of service parameters and values associated with each of the three data communication functions. Recommendation X.136 defines protocol-specific accuracy and dependability parameters and values associated with each function. This Recommendation and Recommendation X.136 parameters are called "primary parameters" to emphasize their direct derivation from packet layer reference events.

1.5 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. Recommendation X.137 specifies the availability function and defines the availability parameters and values that characterize the resulting binary random process.

1.6 Four speed of service parameters are defined in this Recommendation: one access parameter (call set-up delay), two user information transfer parameters (data packet transfer delay and throughput capacity), and one disengagement parameter (clear indication delay). Each parameter can be applied to any basic section or portion of a virtual connection. This generality makes the parameters useful in performance allocation and concatenation.

1.7 This Recommendation specifies delay and throughput values for national portions and international portions of two types (see Table 1). Performance values for data terminal equipment are not specified, but the parameters defined in this Recommendation may be employed in such specification to assist users in establishing quantitative relationships between network performance and quality of service (see Recommendation X.140).

1.8 Worst-case mean and 95% probability values for call set-up delay, data packet transfer delay, throughput capacity, and clear indication delay are specified for each virtual connection portion type identified in Table 1. The term "worst case" means that these values should be met, during any hour of scheduled service time, in the worst-performing virtual connection portion used in providing international packet-switched services. The performance of a virtual connection portion will normally be much better than the worst-case values specified in this Recommendation¹. Design objectives that take into account more demanding user applications and network performance and connectivity enhancements are for further study.

Numerical methods for combining individual portion performance values to estimate end-to-end performance are also provided in this Recommendation. DTE to DTE values for two particular hypothetical reference connections are derived using these methods in Annex C.

¹ Supplement No. 1 presents delay and throughput values measured on particular connections at particular times and is for illustrative purposes only.

Table 1/X.135 – Virtual connection portion types for which performance values are specified^{a)}

Portion type	Typical characteristics
National A	Terrestrial connection via an access network section
National B	Connection via an access network section with one satellite circuit; or via an access network section and one or more transit network sections
International A	Connection via a direct terrestrial internetwork circuit section
International B	Connection via two satellite circuits and one transit network section; or via one satellite circuit and two or more transit network sections
a) The values specified for type B portions also apply to virtual connection portions not explicitly identified as type A or type B.	

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- [1] ITU-T Recommendation X.1 (1996), *International user classes of service in, and categories of access to, public data networks and Integrated Services Digital Networks (ISDNs)*.
- [2] ITU-T Recommendation X.2 (1996), *International data transmission services and optional user facilities in public data networks and ISDNs*.
- [3] ITU-T Recommendation X.25 (1996), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit*.
- [4] ITU-T Recommendation X.75 (1996), *Packet-switched signalling system between public networks providing data transmission services*.
- [5] ITU-T Recommendation X.96 (1993), *Call progress signals in public data networks*.
- [6] ITU-T Recommendation X.110 (1996), *International routing principles and routing plan for public data networks*.
- [7] ITU-T Recommendation X.134 (1997), *Portion boundaries and packet layer reference events: basis for defining packet-switched performance parameters*.
- [8] ITU-T Recommendation X.136 (1997), *Accuracy and dependability performance values for public data networks when providing international packet-switched services*.
- [9] ITU-T Recommendation X.137 (1997), *Availability performance values for public data networks when providing international packet-switched services*.
- [10] ITU-T Recommendation X.138 (1997), *Measurement of performance values for public data networks when providing international packet-switched services*.

- [11] ITU-T Recommendation X.139 (1997), *Echo, drop, generator and test DTEs for measurement of performance values in public data networks when providing international packet-switched services.*
- [12] CCITT Recommendation X.140 (1992), *General quality of service parameters for communication via public data networks.*
- [13] ITU-T Recommendation X.213 (1995), *Information technology – Open Systems Interconnection – Network service definition.*
- [14] CCITT Recommendation X.323 (1988), *General arrangements for interworking between Packet-Switched Public Data Networks (PSPDNs).*

3 Abbreviations

This Recommendation uses the following abbreviations:

CA	Call Accepted
CC	Call Connected
cdf	Cumulative distribution function
CR	Call Request
DSE	Data Switching Exchange
DTE	Data Terminal Equipment
IC	Incoming Call
pdf	Probability density function
PE	Packet layer reference event

4 Call set-up delay

Call set-up delay applies only to the virtual call capability of packet-switched networks.

Call set-up delay observed at a single section boundary, B_i , is defined first and then call set-up delay between a pair of section boundaries (B_i, B_j) is defined based on the former definition. In the former case, the call set-up delay includes the delay for all virtual connection sections on the called user side of B_i and the called user response time. In the latter case, the call set-up delay includes only the delays between B_i and B_j . Values are specified for call set-up delay observed between section boundaries.

4.1 definition of call set-up delay at a single section boundary

Call set-up delay at a section boundary, B_i , is defined using two X.134 packet layer reference events (PEs). It is the period of time that starts when either a call request or an incoming call packet creates a PE at B_i , and ends when the corresponding call connected or call accepted packet, accepting the virtual call, returns and creates its PE at B_i .

$$\text{Call set-up delay at a section boundary} = \{t_2 - t_1\}$$

where:

- t_1 is the time of occurrence for the first PE;
- t_2 is the time of occurrence for the second PE.

The two PEs can occur at any single section boundary within a virtual connection. The identities of the packets depend on the boundary of interest, as shown in Figure 2. The first packet is the call request packet and the second packet is the corresponding call connected packet at every boundary except the two boundaries that delimit the access circuit section associated with the called DTE. The first packet is the incoming call packet and the second packet is the call accepted packet at the latter two boundaries. The specific X.134 PEs used in measuring call set-up delay at each section boundary are identified in Table 2.

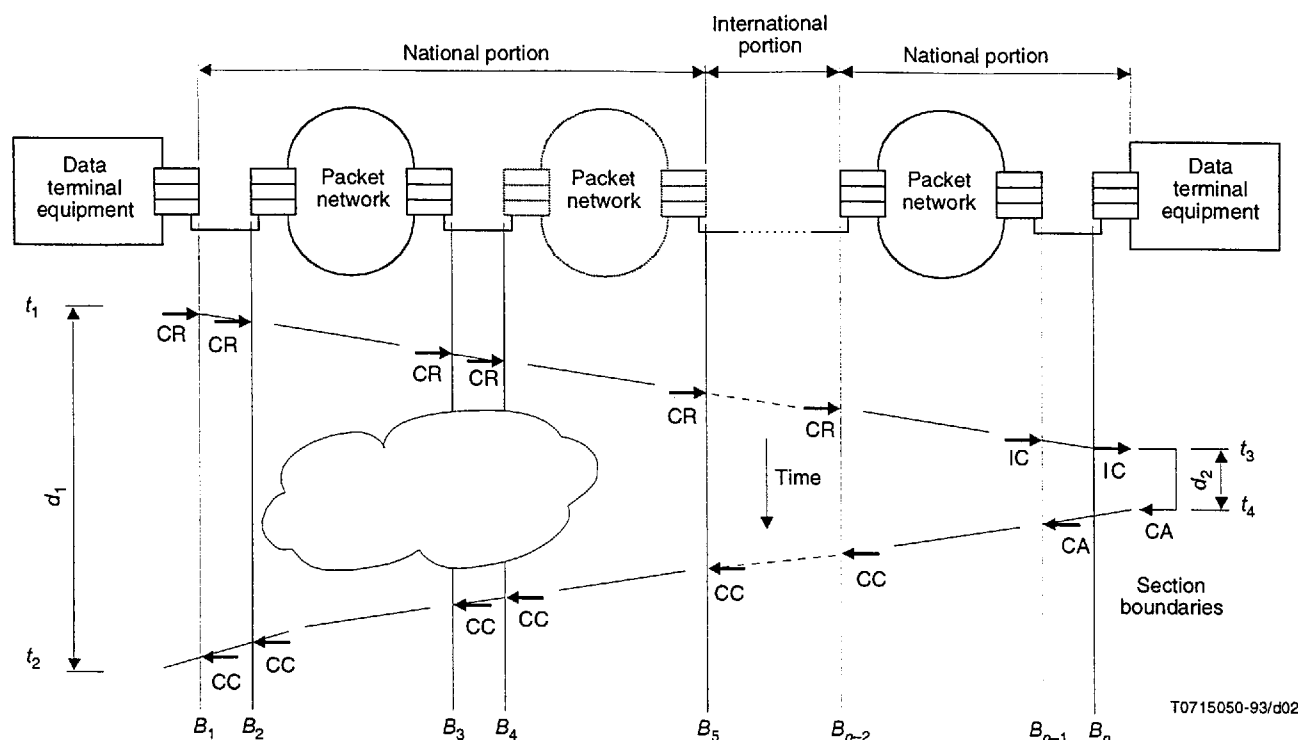


Table 2/X.135 – Packet layer reference events (PEs) used in measuring call set-up delay^{a)}

X.134 packet layer reference event	Starting PE	Ending PE
Circuit section		
Calling DTE access circuit section	2 (X.25)	3 (X.25)
Calling DTE access circuit section	1 (X.25)	4 (X.25)
Internetwork circuit section	1 (X.75)	2 (X.75)
a) The PE numbers in this table refer to Tables 1/X.134 and 2/X.134.		

4.2 definition call set-up delay between two section boundaries

For a particular virtual call, call set-up delay can be measured at one boundary, B_i , and measured at another boundary, B_j , further from the calling DTE. The difference in the values obtained is the call set-up delay contributed by the virtual connection section(s) between the two boundaries.

Call set-up delay between two section boundaries = $\{d_1 - d_2\}$

where:

d_1 is the call set-up delay measured at B_i ;

d_2 is the call set-up delay measured at B_j .

The **end-to-end call set-up delay** is the call set-up delay between DTE boundaries, e.g., B_1 and B_n in Figure 2. This end-to-end delay excludes the called user response time. The **national portion call set-up delay** is the call set-up delay between the boundaries delimiting a national portion, e.g. B_1 and B_5 in Figure 2. The **international portion call set-up delay** is the call set-up delay between the boundaries delimiting an international portion, e.g. B_5 and B_{n-2} in Figure 2.

4.3 Values

Table 3 defines worst-case call set-up delay values for each of the four virtual connection portion types identified in Table 1. DTE to DTE call set-up delay values for two hypothetical reference connections are calculated in Annex C. All values are based on (and only apply under) the following assumptions²:

- 1) a basic call, in which none of the optional user facilities defined in Recommendation X.25 are used and no call user data is sent;
- 2) data link layer windows of entities outside the portion being specified are open (not flow controlled).

The defined values consist of mean and 95% probability values. The mean is the expected value of the call set-up delay distribution. The 95% probability value is the value below which 95% of the call set-up delay values lie. Call set-up attempts that are unsuccessful under the conditions of Recommendation X.136 are excluded and are addressed separately in that Recommendation.

In Table 3, the value X depends on the signalling rate of the access circuit section that is included in the national portion. Table 4 presents the X values for user classes of service 8 to 11 and 13 in Recommendation X.1³. The X values for other signalling rates may be computed using the formula:

$$X = \frac{400}{R} \text{ ms}$$

where R is the signalling rate in kilobits per second⁴.

The call set-up delay values defined in Table 3 are intended to be used as worst-case limits in planning international packet-switched services. The actual delay performance achieved on a virtual connection portion will depend on many factors, including the traffic expected and actually offered, the internal network topology, and the signalling rates on the internetwork circuit sections. Variation away from the worst-case value for each factor can improve the performance.

The overall call set-up delay value for a set of concatenated virtual connection portions can be calculated directly by adding the individual portion means defined in Table 3. A method of calculating an overall 95% probability call set-up delay value for a set of concatenated virtual connection portions from the individual 95% probability values is described in Annex C.

² Values for other conditions are for further study. In the case of extremely long access lines and excessive delays in the access circuit section transmission equipment, these values may be exceeded.

³ These X values are not intended to represent the delay performance of the access circuit section, since these values do not include propagation delays, multiplexing delays, or the effects of retransmission.

⁴ The formula assumes that the transfer of each call set-up packet (i.e., both the Call Request Packet and the corresponding Call Accepted Packet) across an access circuit section involves the transmission of 25 octets: 5 octets of frame level overhead, a 5-octet packet header, and 15 octets of DTE address information.