INTERNATIONAL TELECOMMUNICATION UNION

CCITT

X.134

THE INTERNATIONAL
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CONSULTATIVE COMMITTEE

(09/92)

DATA COMMUNICATION NETWORKS

NETWORK ASPECTS

PORTION BOUNDARIES AND PACKET LAYER REFERENCE EVENTS: BASIS FOR DEFINING PACKET-SWITCHED PERFORMANCE PARAMETERS

Recommendation X.134

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.134 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 A.

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Recommendation X.134

PORTION BOUNDARIES AND PACKET LAYER REFERENCE EVENTS: BASIS FOR DEFINING PACKET SWITCHED PERFORMANCE PARAMETERS

(Melbourne, 1988, revised 1992)

The CCITT,

considering

(a) that Recommendation X.1 specifies the international user classes of service in public data networks;

(b) that Recommendation X.2 specifies the international data transmission services and optional user facilities in public data networks;

(c) that Recommendation X.25 specifies the DTE/DCE interface for packet mode terminals connected to public data networks by dedicated circuit;

(d) that Recommendation X.75 specifies the packet-switched signalling system between public networks providing data transmission services;

(e) that Recommendation X.323 specifies general arrangements for interworking between packet-switched public data networks;

(f) that Recommendation X.96 specifies call progress signals in public data networks;

(g) that Recommendation X.110 specifies the international routing principles and routing plan for public data networks;

(h) that Recommendation X.213 defines the OSI Network Layer service;

(i) that Recommendation X.140 defines general quality of service parameters for communication via public data networks;

(j) that Recommendation X.135 specifies speed of service performance values for public data networks when providing international packet-switched service;

(k) that Recommendation X.136 specifies accuracy and dependability (including blocking) performance values for public data networks when providing international packet-switched service;

(l) that Recommendation X.137 specifies availability performance values for public data networks when providing international packet-switched service,

unanimously declares

(1) that the portion boundaries defined in this Recommendation shall be used in apportioning the performance of an international packet-switched data communication service provided in accordance with Recommendations X.25 and X.75;

(2) that the packet layer reference events specified in this Recommendation shall be used in the definition of packet-switched performance parameters for data communication services provided in accordance with Recommendations X.25 and X.75.

1 Introduction

1.1 This Recommendation is the first 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/X.134 illustrates the scope of these four Recommendations and the relationships among them.

1.2 This Recommendation divides a virtual connection into basic sections whose boundaries are associated with X.25 and X.75 interfaces. The performance of collections of these basic sections can be estimated using the packet-switched performance parameters defined in Recommendations X.135 to 137 and the measurement techniques defined in Recommendations X.138 and X.139. In order to apportion the performance of an international virtual connection, this Recommendation defines two particular collections of basic sections for which performance values will be specified: national portions and international portions. As defined, every international virtual connection contains two national portions and one international portion. The performance of these three portions can be combined in the calculation of the end-to-end virtual connection performance. These Recommendations do not specify performance values for other collections of basic sections; however, the ability to decompose a virtual connection into its basic sections will be useful in planning the performance of national and international portions.

1.3 The performance parameters in Recommendations X.135 to X.137 are defined in terms of packet layer reference events which can be observed at the boundaries between basic sections and thus can be observed at the portion boundaries. This Recommendation defines the performance significant packet layer reference events.

1.4 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 defined 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 the 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.

1.5 Recommendation X.135 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. X.135 and X.136 parameters are called "primary parameters" to emphasize their direct derivation from packet layer reference events.

1.6 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.

1.7 In order to relate the network performance values given in Recommendations X.135 to X.137 to the service receivable at points within the scope of the DTEs, further elements must be included.

1.7.1 In particular, specification of service performance at the layer 3/4 boundary (OSI Network service) must include those processes within the DTEs concerned with the transfer of packets from the physical circuit of the DTE/DCE interface to the layer 3/4 boundary at each end of the virtual connection, however they may be implemented. This processing may include elements associated with OSI layers 1, 2 and 3 and may involve transmission across private wide-area and/or local-area networks.

1.7.2 Specification of service performance for the user or application, if required, must similarly include in addition those processes within the DTEs concerned with the transfer of information from the layer 3/4 boundary to the layer 7 upper boundary beyond each end of the virtual connection, however they may be implemented. This processing may include elements associated with OSI layers 4, 5, 6 and 7.

1.7.3 Additional protocol- or service-specific reference events would need to be defined to cover these aspects, but are outside the scope of this Recommendation. However, the parameter definitions of Recommendations X.135 to X.137 can readily be adapted to correspond to any extension of scope.

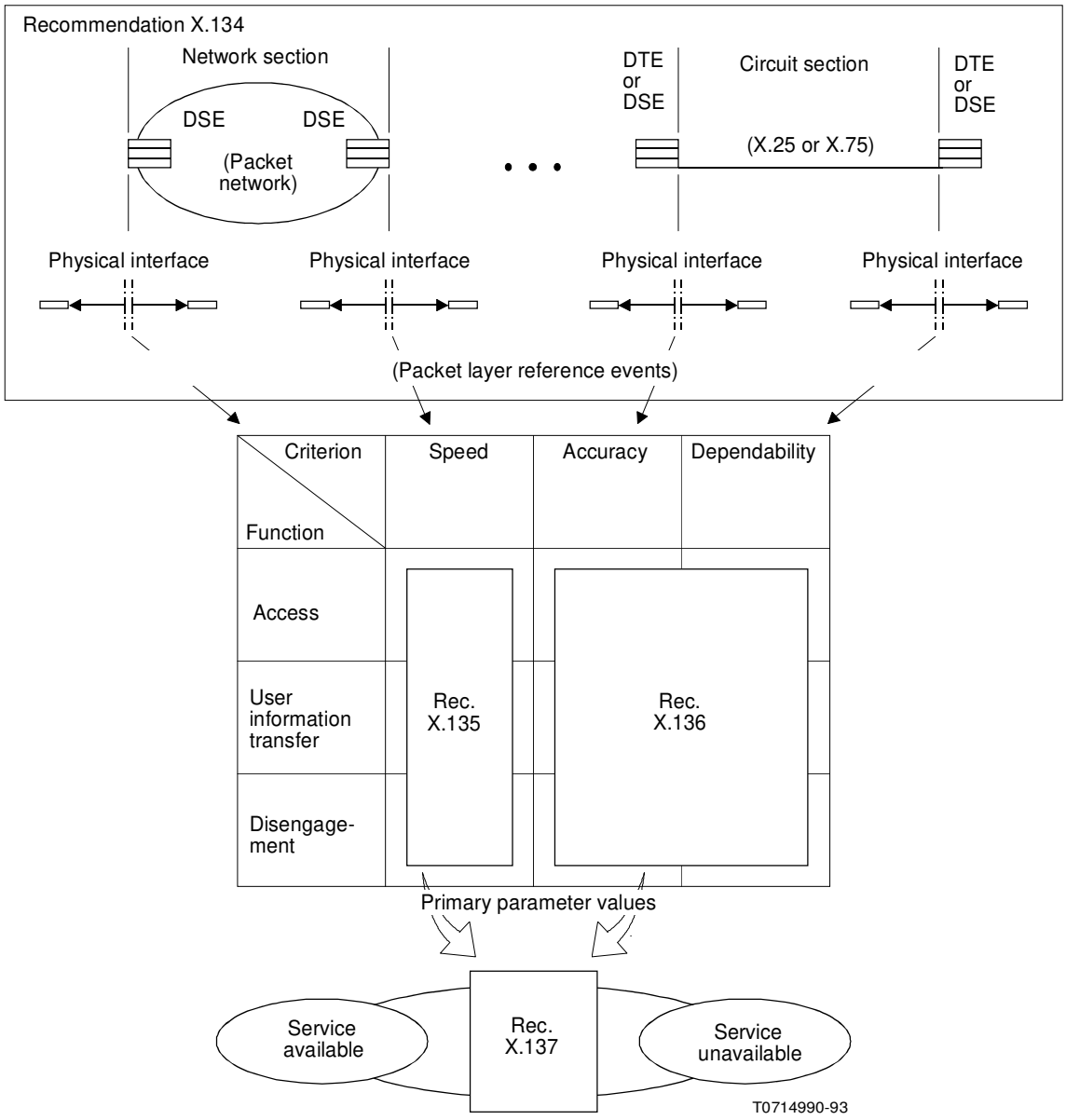


FIGURE 1/X.134

Packet-switched service performance description framework

2 Virtual connection sections and portions

In the context of Recommendations X.134 to X.137, the following definitions apply:

An **access circuit section** is the physical circuit or set of circuits connecting a DTE to the local DSE. It does not include any parts of the DTE or DSE. These Recommendations assume that X.25 procedures are used on an access circuit section.

An **internetwork circuit section** is the physical circuit or set of circuits connecting a DSE in one network with a DSE in a different network. It does not include any parts of either DSE. These Recommendations assume that X.75 procedures are used on an internetwork circuit section.

A **circuit section** is either an access circuit section or an internetwork circuit section.

A **network section** consists of the network components that provide a virtual connection between two circuit sections. The network provider is responsible for the performance of the network section.

An **access network section** is a network section connected to (at least) one access circuit section.

A **transit network section** is a network section between two internetwork circuit sections.

A **basic section of a virtual connection** is either an access network section, a transit network section, an access circuit section, or an internetwork circuit section.

A **section boundary (or boundary)** separates a network section from the adjacent circuit section or it separates an access circuit section from the adjacent DTE.

A **national portion of an international virtual connection** is a collection of adjacent alternating network sections and circuit sections entirely within the borders of one nation. The national portion connects a DTE to an internetwork circuit section that crosses the national border. The national portion includes the access circuit section and excludes the internetwork circuit section that crosses the national border. A national portion always includes one access circuit section and one access network section, and it may include one or more pairs of internetwork circuit sections and transit network sections.

There are two national portions of any international virtual circuit.

An **international portion of an international virtual connection** is the set of basic sections between the two national portions. An international portion may be a single internetwork circuit section crossing a national border or it may be two (or more) internetwork circuit sections together with one (or more) transit network sections.

There is one international portion of any international virtual circuit and that international portion will cross one or more national borders.

For purposes of allocating the performance of an international virtual connection, this Recommendation defines a **portion boundary** as a section boundary delimiting a national or international portion.

Figure 2/X.134 illustrates the definitions and delimitation of the virtual connection sections and portions. A typical international virtual connection is shown including the two access circuit sections and the two DTEs.

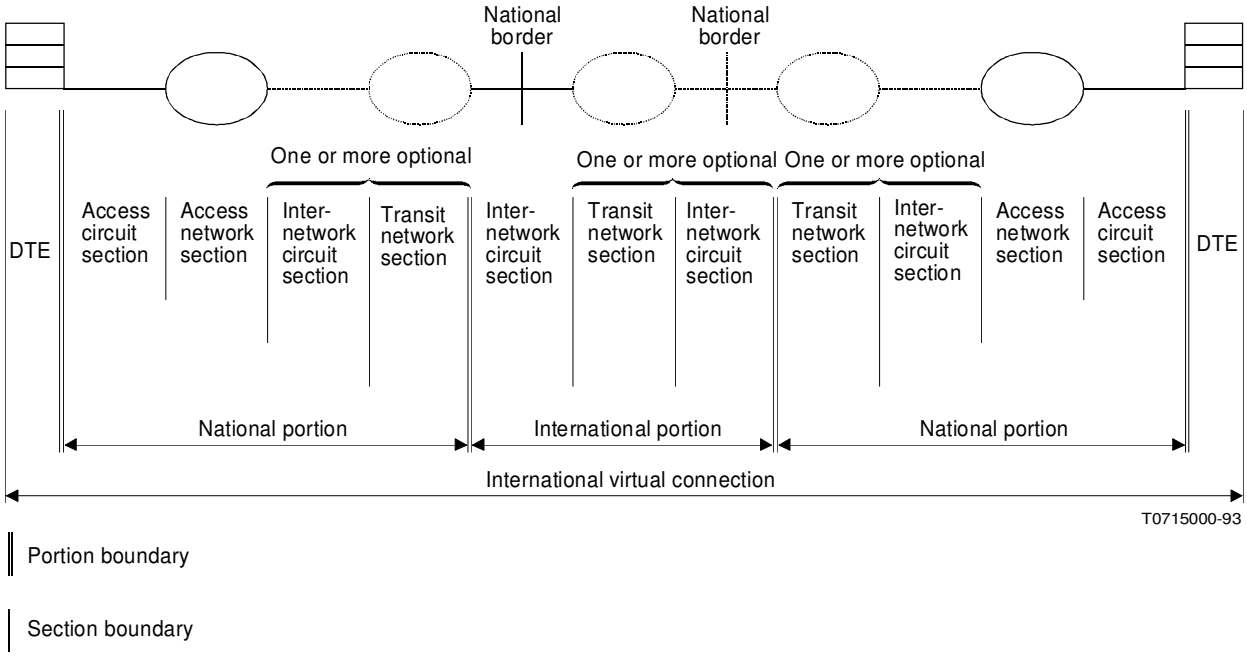


FIGURE 2/X.134

Apportionment of an international virtual connection

3 Packet layer reference events

3.1 *Definitions*

In the context of Recommendations X.134 to X.137:

A **packet layer reference event** occurs when a packet crossing a section boundary changes the state of the packet layer interface.

Note – The relevant state transitions are those defined explicitly or implicitly in Recommendations X.25 and X.75.

Two classes of packet layer reference events are defined.

A **packet entry event** is a packet layer reference event that corresponds to a packet entering a network section (from a circuit section) or a packet entering a DTE (from an access circuit section).

A **packet exit event** is a packet layer reference event that corresponds to a packet exiting a network section (to a circuit section) or a packet exiting a DTE (to an access circuit section).

The time of occurrence of a packet entry event is defined to coincide with the time at which the last bit of the closing flag of the frame carrying the packet crosses the boundary out of the circuit section. The time of occurrence of a packet exit event is defined to coincide with the time at which the first bit of the address field of the frame carrying the packet crosses the boundary into the circuit section. If frame retransmissions occur, the packet exit event occurs with the first transmission and the packet entry event occurs with the next transmission.

Figure 3/X.134 illustrates these terms.

A single packet crossing a boundary between two adjacent virtual connection sections may change more than one aspect of the packet layer interface, and consequently more than one packet layer reference event may be created. Particular reference events are specified by identifying:

1) the relevant boundary;
2) the type of packet transferred;
3) the event class (packet entry or packet exit);
4) the particular aspect of the state that was changed by the event.

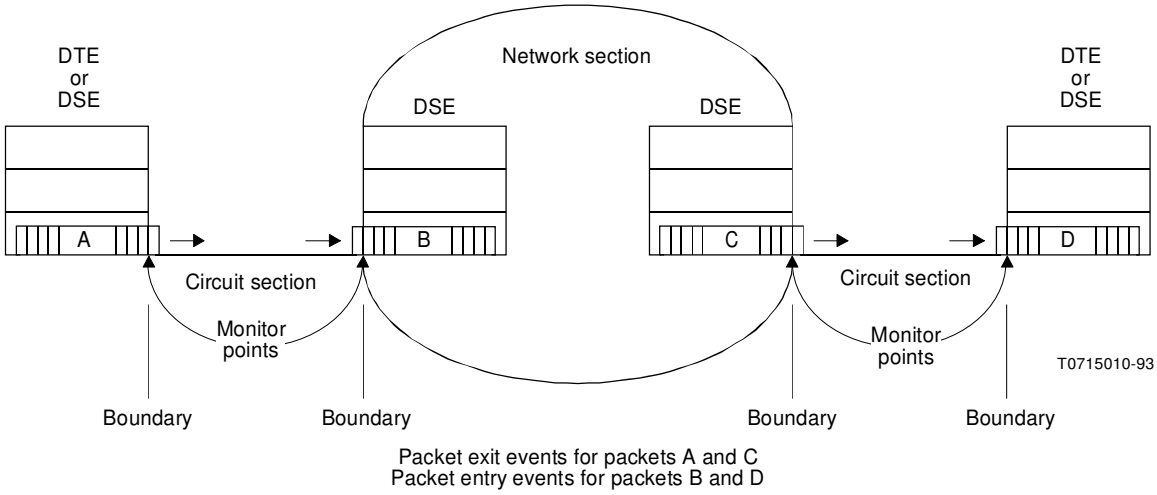


FIGURE 3/X.134

Example packet layer-reference events

3.2 *Performance-significant reference events*

The performance-significant reference events are the packet layer reference events useful in defining performance parameters. Table 1/X.134 lists performance-significant X.25 packet layer reference events associated with the boundaries of access circuit sections. Table 2/X.134 lists performance-significant X.75 packet-layer reference events associated with the boundaries of internetwork circuit sections. These events and their reference numbers are used in the performance parameter definitions specified in Recommendations X.135 to X.137.

The entries in Tables 1/X.134 and 2/X.134 describe the type of packet transferred and the resulting state of the packet layer interface. With the exception of the diagnostic and registration categories, all packet types identified in Recommendations X.25 and X.75 are addressed in the tables.

The states identified in the tables differ from those defined in Recommendations X.25 and X.75 in two respects:

1) Call collision states are omitted, since their specification is not required for performance parameter definition.

2) Several new ancillary states are defined, consistent with the existing X.25 and X.75 protocol specifications, to provide a basis for more detailed performance description.

Three ancillary X.25 states and three ancillary X.75 states are defined in this Recommendation to permit more accurate description of flow control effects. The new X.25 states are "DCE flow controlled," "DTE flow controlled," and "DTE and DCE flow controlled." The new X.75 states are "STE X flow controlled," "STE Y flow controlled," and "STE X and STE Y flow controlled." A state diagram for the ancillary X.25 flow control states is shown in Figure 4/X.134. A state diagram for the ancillary X.75 flow control states is shown in Figure 5/X.134. In each case, the new states are numbered d4-d6.

Three ancillary state variables are defined:

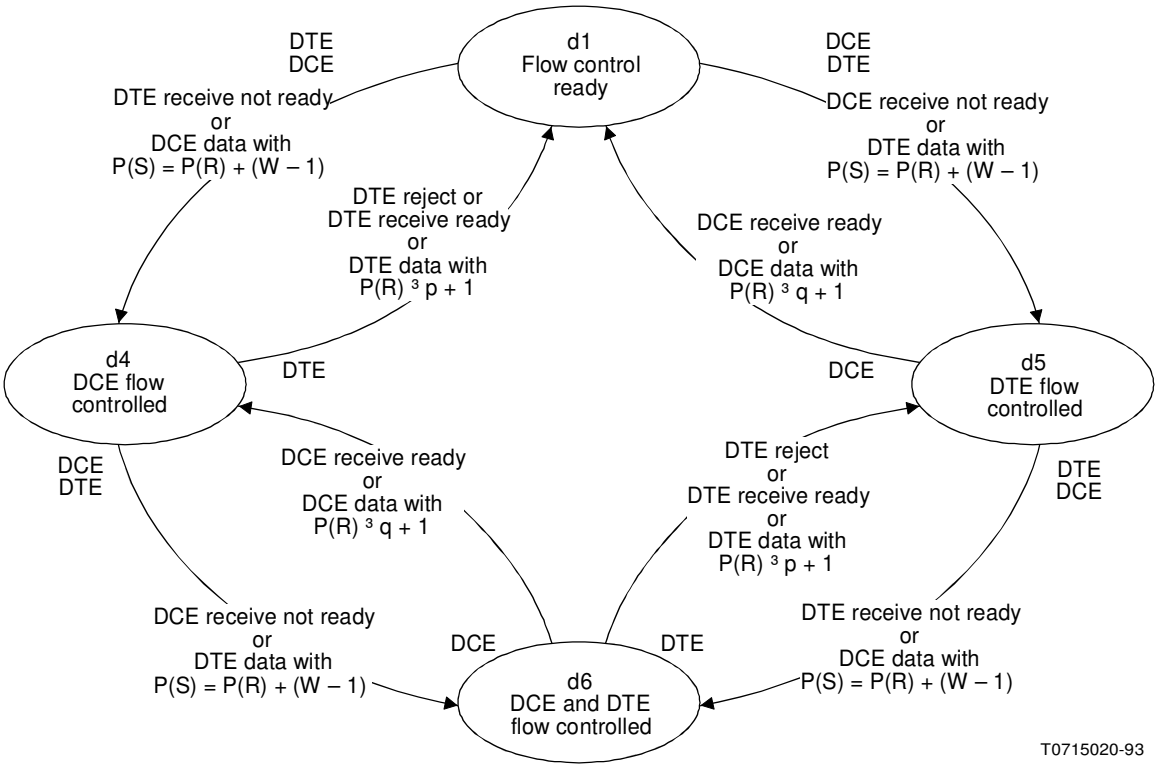
– *lwt* – Lower edge of the window on the transmit side. This variable contains the latest P(R) received either in a data packet, an RR, or an RNR. The value may be implicitly represented using the upper window edge (and the window size).

– *npr* – Next data packet to be received. This variable contains the P(S) of the next data packet to be received.

– *ric* – Received interrupt count. Because only one unacknowledged interrupt packet can exist in a particular direction, the interface must record the reception of an interrupt across the circuit section. This variable is used to record such events. The variable is cleared when the interrupt confirmation is transmitted.

If the state resulting from packet transfer is not the one listed in the relevant table or the state remains unchanged as a result of the packet transaction, the reference event does not occur. Aspects of the state other than those listed in these tables may change during packet entry or exit, but those events are not viewed as performance-significant reference events.

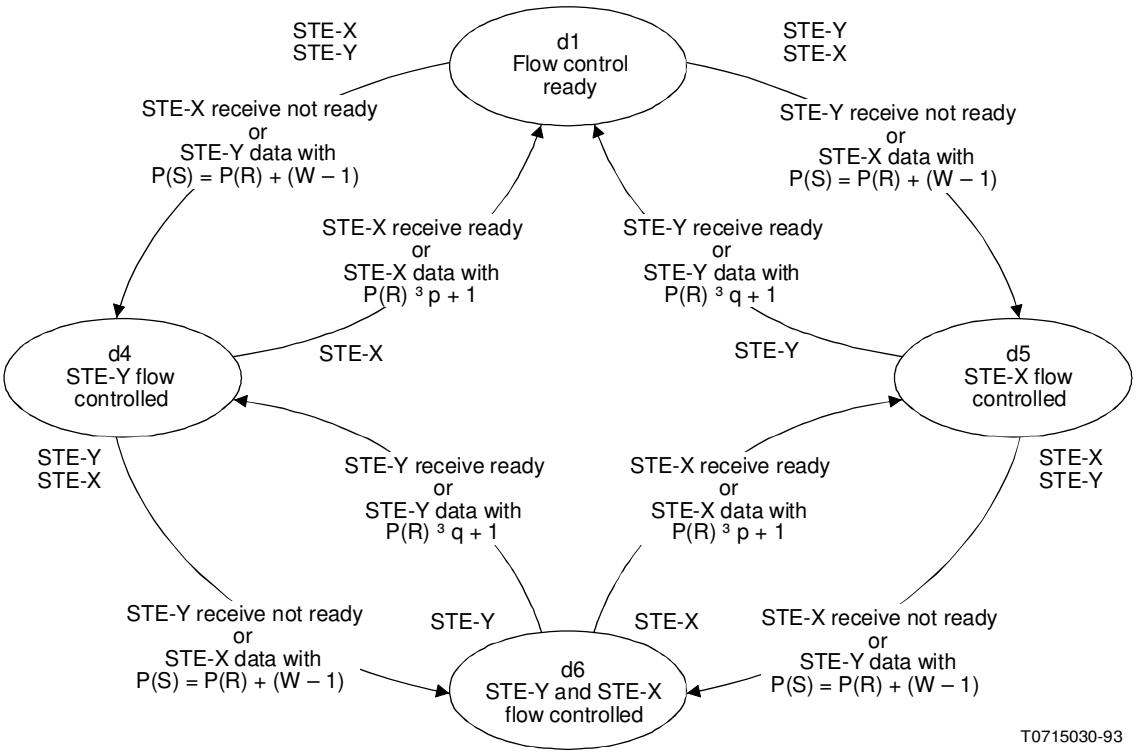
When the tables list more than one aspect of the state that might be changed as a result of a particular packet's entry or exit, each of those changes represents a distinct packet layer reference event that can be used in defining different performance parameters. For example, in Table 1/X.134, event 9a would be used where the correct receipt of the data is relevant, and 9b would be used when the receipt of the acknowledgement is relevant. Event 26b would be used in association with permanent virtual circuits and 26a with other logical channels.



Note – Variables p and q represent the send sequence numbers of the last DTE data and DCE data packets transferred across the DTE/DCE interface, respectively.

FIGURE 4/X.134

Diagram of DTE/DCE flow control states



Note – Variables p and q represent the send sequence numbers of the last STE-X data and STE-Y data packets transferred across the STE-X/STE-Y interface, respectively.

FIGURE 5/X.134

Diagram of STE-X/STE-Y flow control states

TABLE 1/X.134

X.25 packet layer reference events

Number	Packet type	Resulting state	
1	Incoming call	p3	(DCE waiting)
2	Call request	p2	(DTE waiting)
3	Call connected	p4	(Data transfer)
4	Call accepted	p4	
5	Clear indication	p7	(DCE clear indication)
6	Clear request	p6	(DTE clear request)
7	DCE clear confirmation	p1	(Ready)
8	DTE clear confirmation	p1	
9a	DCE data	npr	becomes P(S) + 1
9b	DCE data	lwt	becomes P(R)
9c	DCE data	d1	Flow control ready)
10a	DTE data	npr	becomes P(S) + 1
10b	DTE data	lwt	becomes P(R)
10c	DTE data	dl	(Flow control ready)
11	DCE interrupt	ric	becomes 1
12	DTE interrupt	ric	becomes 1
13	DCE interrupt confirmation	ric	becomes 0
14	DTE interrupt confirmation	ric	becomes 0
15a	DCE RR	lwt	becomes P(R)
15b	DCE RR	d1	
16a	DTE RR	lwt	becomes P(R)
16b	DTE RR	dl	
17a	DCE RNR	lwt	becomes P(R)
17b	DCE RNR	d5	(DTE flow controlled)
17c	DCE RNR	d6	(DTE + DCE flow controlled)
18a	DTE RNR	lwt	becomes P(R)
18b	DTE RNR	d4	(DCE flow controlled)
18c	DTE RNR	d6	
19	DTE REJ	npr	becomes P(R) (Note 1)
20	Reset indication	d3	(DCE reset indication)
21	Reset request	d2	(DTE reset request)
22	DCE reset confirmation	d1	
23	DTE reset confirmation	d1	
24	Restart indication	r3	(DCE restart indication)
25	Restart request	r2	(DTE restart request)
26a	DCE restart confirmation	p1	
26b	DCE restart confirmation	d1	
27a	DTE restart confirmation	pl	
27b	DTE restart confirmation	d1	
(Note 2)			

Note 1 – This is npr from the perspective of the DTE.

Note 2 – Diagnostic packets are for information only and they do not change the perceived state. Reference events for registration request and confirmation packets are left for further study.

TABLE 2/X.134

X.75 packet layer reference events

Number	Packet type	Resulting state
1	Call request	p2 or p3 (STE call request)
2	Call connected	p4 (Data transfer)
3	Clear request	p6 or p7 (STE clear request)
4	Clear confirmation	p1 (Ready)
5a	Data	npr becomes P(S) + 1
5b	Data	lwt becomes P(R)
5c	Data	d1 (Flow control ready)
6a	Interrupt	i2 or i3 (STE interrupt request)
6b	Interrupt	i4 (STE-X and Y interrupt request)
7a	Interrupt confirmation	i1 (No interrupt request)
7b	Interrupt confirmation	i2 or i3
8a	RR	lwt becomes P(R)
8b	RR	d1
9a	RNR	lwt becomes P(R)
9b	RNR	d4 or d5 (STE flow controlled)
9c	RNR	d6 (STE-X and Y flow controlled)
10	Reset request	d2 or d3 (STE reset request)
11	Reset confirmation	d1
12	Restart request	r2 or r3 (STE restart request)
13a	Restart confirmation	p1
13b	Restart confirmation	d1

ANNEX A

(to Recommendation X.134)

Alphabetical list of abbreviations used in this Recommendation

DCE	Data-circuit terminating equipment
DSE	Data switching exchange
DTE	Data terminal equipment
REJ	Reject
RNR	Receive not ready
RR	Receive ready
STE	Signalling terminal equipment