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SERIES X: DATA NETWORKS AND OPEN SYSTEM COMMUNICATION

Public data networks – Network aspects

Portion boundaries and packet-layer reference events: Basis for defining packet-switched performance parameters

ITU-T Recommendation X.134

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION X.134

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

Summary

This Recommendation provides the performance model for the X.130-Series Recommendations on PSPDN performance.

Source

FOREWORD

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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.

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

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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As of the date of approval of this Recommendation, the ITU had/had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Recommendation X.134

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

(revised in 1997)

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 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 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.
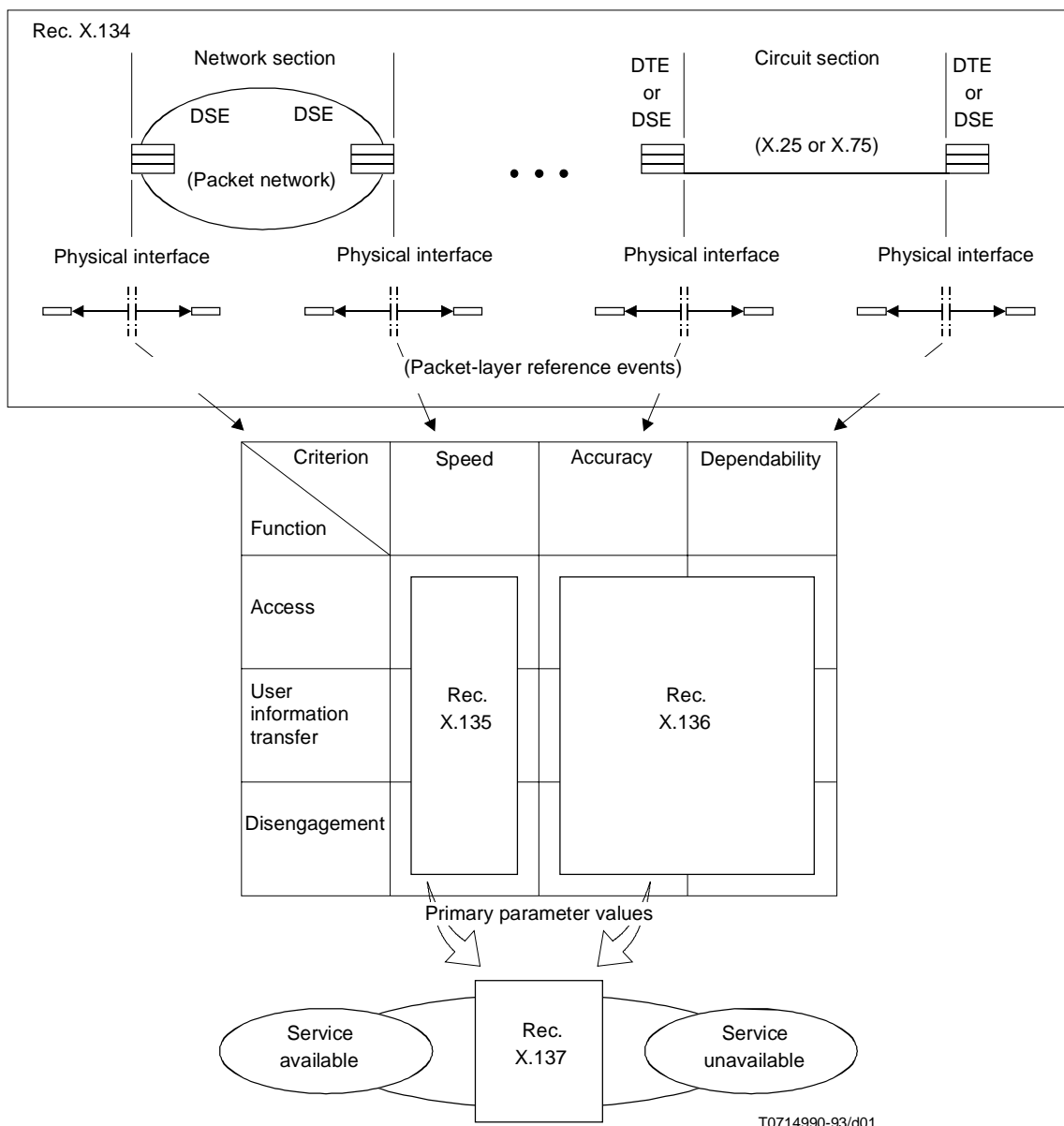
Figure 1/X.134 – Packet-switched service performance description framework

2 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.

– 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).*

– ITU-T Recommendation X.2 (1996), *International data transmission services and optional user facilities in public data networks and ISDNs.*

– 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.*

– ITU-T Recommendation X.75 (1996), *Packet-switched signalling system between public networks providing data transmission services.*

– ITU-T Recommendation X.96 (1993), *Call progress signals in public data networks.*

– ITU-T Recommendation X.110 (1996), *International routing principles and routing plan for public data networks.*

– ITU-T Recommendation X.135 (1997), *Speed of service (delay and throughput) performance values for public data networks when providing international packet-switched services.*

– ITU-T Recommendation X.136 (1997), *Accuracy and dependability performance values for public data networks when providing international packet-switched services.*

– ITU-T Recommendation X.137 (1997), *Availability performance values for public data networks when providing international packet-switched services.*

– ITU-T Recommendation X.138 (1997), *Measurement of performance values for public data networks when providing international packet-switched services.*

– 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.*

– CCITT Recommendation X.140 (1992), *General quality of service parameters for communication via public data networks.*

– ITU-T Recommendation X.213 (1995), *Information technology – Open Systems Interconnection – Network service definition.*

– CCITT Recommendation X.323 (1988), *General arrangements for interworking between Packet-Switched Public Data Networks (PSPDNs).*

3 Abbreviations

This Recommendation uses the following abbreviations:

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

4 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 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.

5 Packet-layer reference events

5.1 Definitions

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

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.
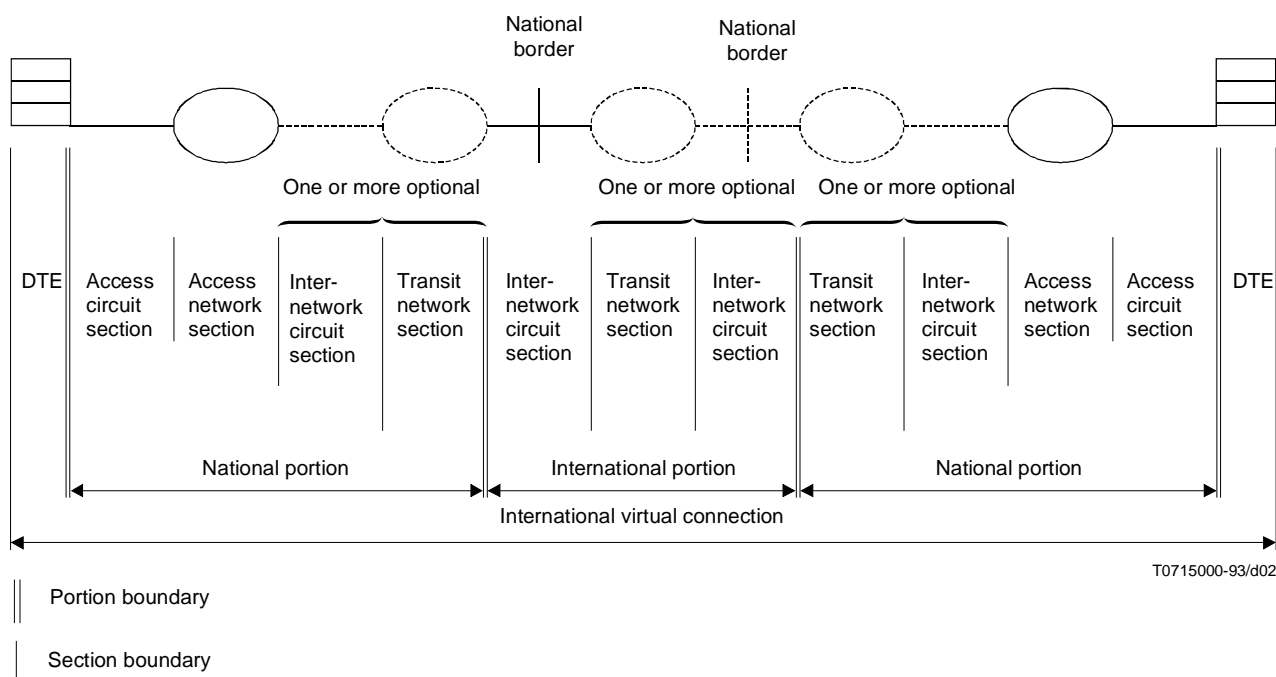
Figure 2/X.134 – Apportionment of an international virtual connection

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 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.

5.2   Performance-significant reference events

The performance-significant reference events are the packet-layer reference events useful in defining performance parameters. Table 1 lists performance-significant X.25 packet-layer reference events associated with the boundaries of access circuit sections. Table 2 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.
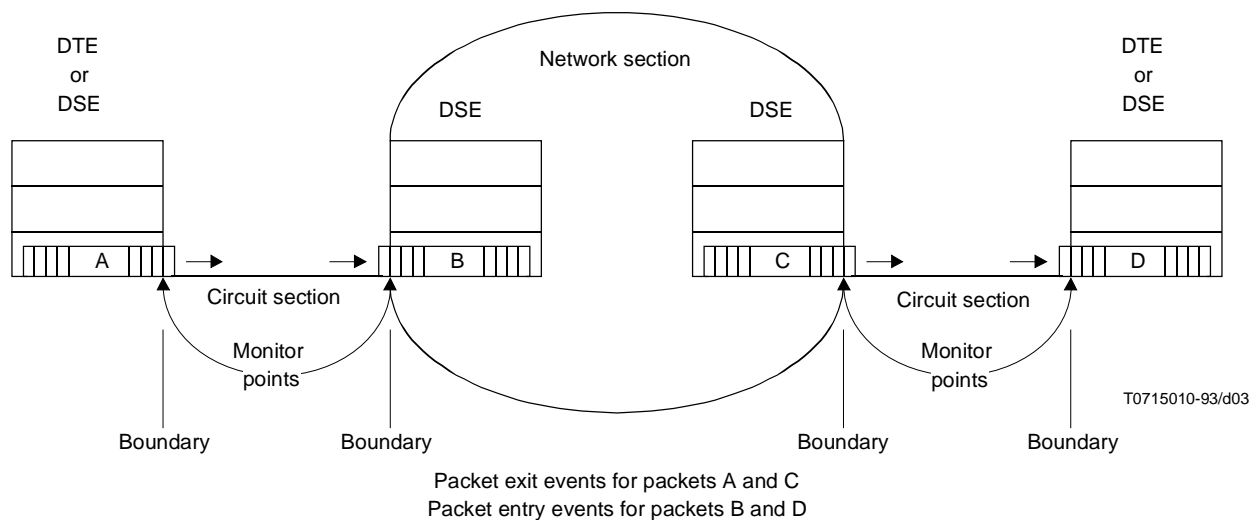
Figure 3/X.134 – Example packet-layer reference events

The entries in Tables 1 and 2 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. A state diagram for the ancillary X.75 flow control states is shown in Figure 5. 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, 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.
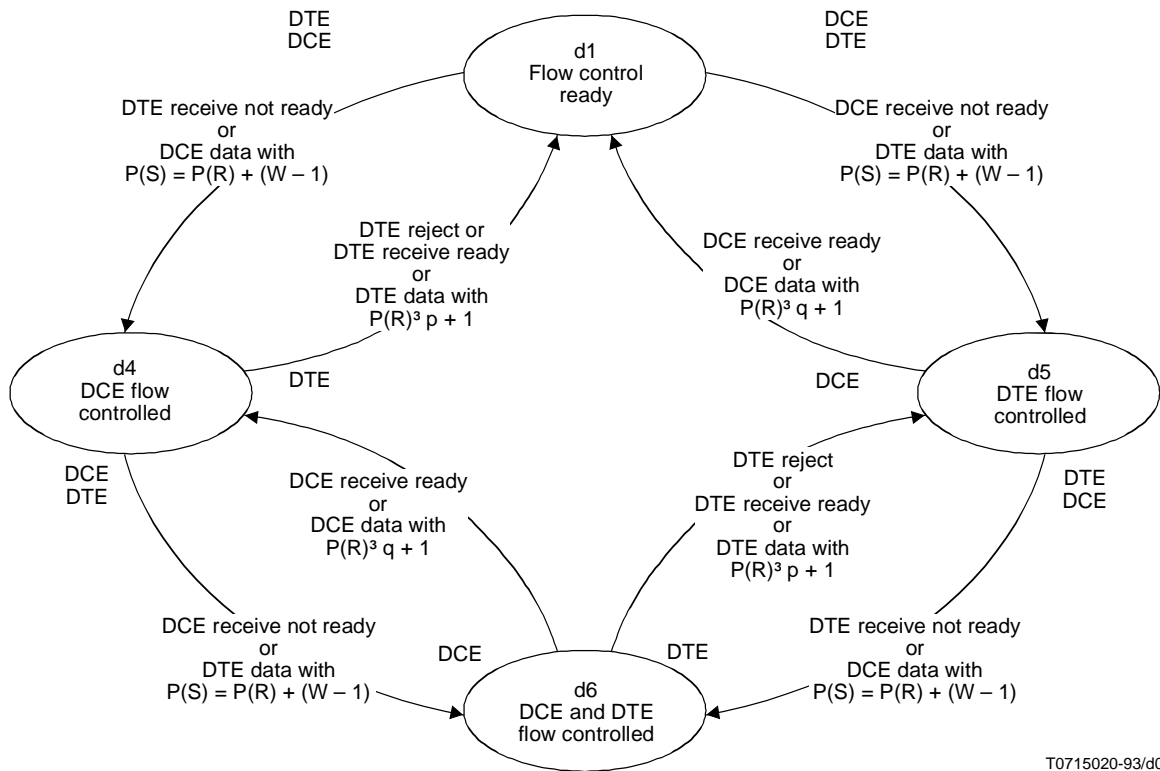
NOTE – Variables p and q represent the send sequence numbers of the last DTE data and DCE data packets transferred across the DTE/DCE interface, respectively.

Figure 4/X.134 – Diagram of DTE/DCE flow control states
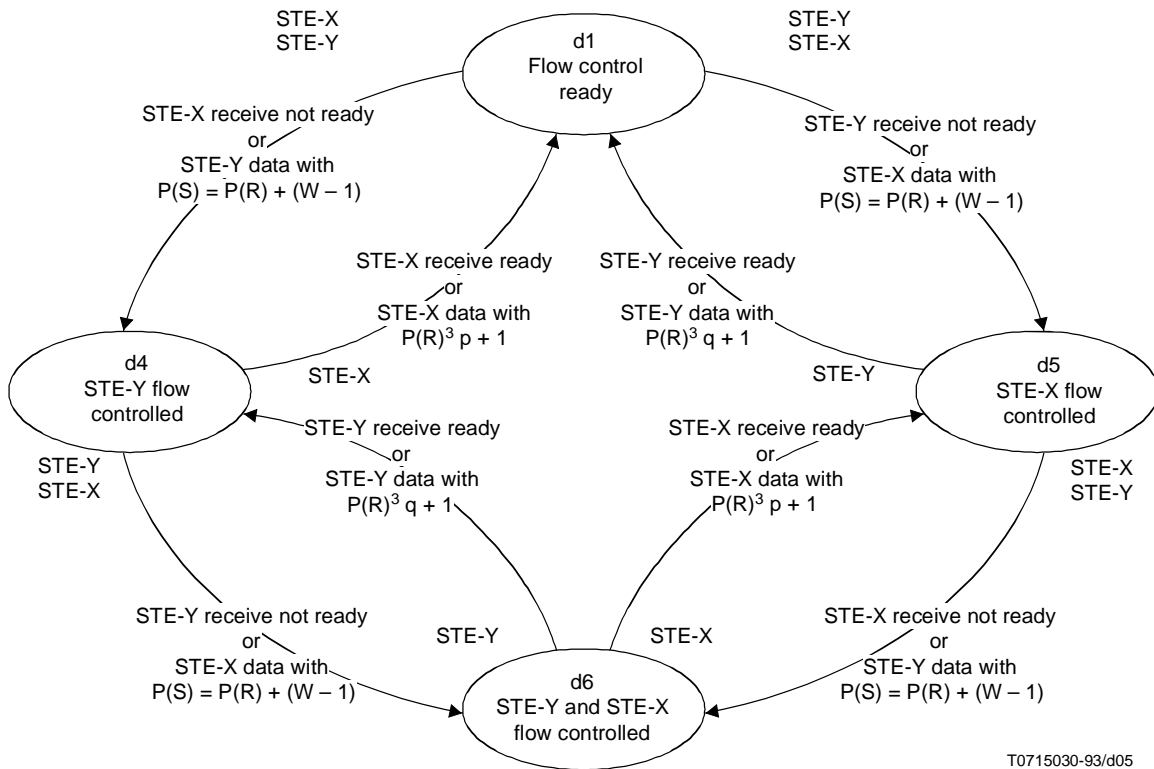
NOTE – Variables p and q represent the send sequence numbers of the last STE-X data and STE-Y data packets transferred across the STE-X/STE-Y interface, respectively.

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	d1	
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	p1	
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	

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