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A PROJECTION OF THE CHARACTERISTICS OF GROUP 4 FACSIMILE EQUIPM--ETC(U)
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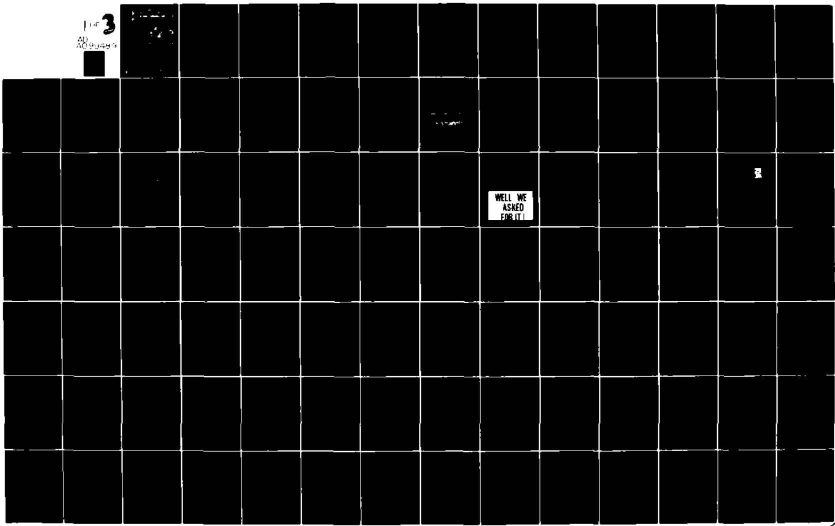

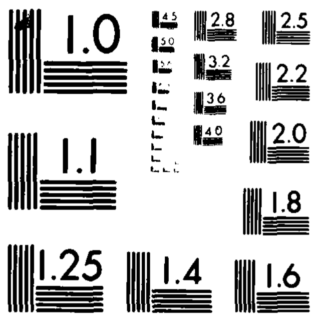

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NCS TIB 81-2

NATIONAL COMMUNICATIONS SYSTEM

TECHNICAL INFORMATION BULLETIN

81-2

A PROJECTION OF THE CHARACTERISTICS OF GROUP 4 FACSIMILE EQUIPMENT

FEBRUARY 1981

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The International Telegraph and Telephone Consultative Committee (CCITT) has defined a new category or group of facsimile systems, Group 4. According to the CCITT definition, Group 4 facsimile apparatus incorporates means for reducing the redundant information in the document signal prior to transmission, mainly via Public Data Networks (PDN). The apparatus will utilize procedures applicable to the PDN and will assure error-free reception of the document. The apparatus may also be used on the public telephone network where an

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appropriate modulation process will be utilized. The process of standardization for Group 4 is in its very early formative stages. The purpose of this study is to anticipate and support this standardization effort to insure that future facsimile systems will be available to the U.S. Government having a high level of reliability, interoperability, and overall performance. Specifically, the purpose of the study is to identify those facsimile parameters requiring standardization, and the analysis of these parameters to determine likely trends and options.

2

NCS TECHNICAL INFORMATION BULLETIN 81-2

A PROJECTION OF THE CHARACTERISTICS OF GROUP 4 FACSIMILE EQUIPMENT

FEBRUARY 1981

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FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program which is an element of the overall GSA Federal Standardization program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee identifies, develops, and coordinates proposed Federal standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards, a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the Electronic Industries Association, the American National Standards Institute, the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunications Union. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of digital facsimile standards. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs, or statements of requirements which could assist in the advancement of this work are welcome, and should be addressed to:

Office of the Manager
National Communications System
ATTN: NCS-TS
Washington, D.C. 20305
(202) 692-2124

A PROJECTION OF THE CHARACTERISTICS OF GROUP 4 FACSIMILE EQUIPMENT

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APPENDICES

1.0 INTRODUCTION

This document is the final report summarizing the work performed by Delta Information Systems, Inc. for the Office of Technology and Standards of the National Communications System under Purchase Order No. DCA100-80-M-0200. The Office of Technology and Standards, headed by National Communications' System Assistant Manager Marshall L. Cain, is responsible for the management of the Federal Telecommunications Standards Program, which develops telecommunication standards whose use is mandatory by all Federal agencies.

The CCITT (International Telegraph and Telephone Consultative Committee) has classified all facsimile systems into four categories or Groups in accordance with the parameters listed in Table 1-1. Groups 1 and 2 employ analog transmission and transmit a page in a fixed period of time. The vast majority of facsimile units in the field today conform to Groups 1 and 2. In Group 3 the page is digitally transmitted over the switched telephone network. Compression techniques are employed to reduce the transmission time. The recommended standards for Group 3 were recently finalized by the CCITT.

According to the CCITT definition, Group 4 facsimile apparatus "incorporates means for reducing the redundant information in the document signal prior to transmission, mainly via Public Data Networks (PDN). The apparatus will utilize procedures applicable to the PDN and will assume error-free reception of the document. The apparatus may also be used on the public telephone network where an appropriate modulation process

TABLE 1-1

CCITT FACSIMILE STANDARDS

CCITT GROUP NO.	RESOLUTION		TRANSMISSION			DIGITAL COMPRESSION ALGORITHM
	HORIZ.	VERTICAL	MEDIUM	ANALOG/ DIGITAL	TIME	
1	ANALOG	3.85 li/mm	SWITCHED PHONE CIRCUITS	ANALOG	6 min fixed	NA
2	ANALOG	3.85 li/mm	SWITCHED PHONE CIRCUITS	ANALOG	3 min fixed	NA
3	7.7 li/mm	3.85 li/mm std. 7.7 li/mm opt.	SWITCHED PHONE CIRCUITS	DIGITAL	VARIABLE	MOD. HUFF. CODE - STD. MOD. READ CODE - OPT.
4	TBD	TBD	DATA NETWORKS	DIGITAL	NA	TBD

will be utilized." The process of standardization for Group 4 is in its very early formative stages. The purpose of this study is to anticipate and support this standardization effort to insure that future facsimile systems will be available to the U.S. Government having a high level of reliability, interoperability, and overall performance. Specifically the purpose of the study is to identify those facsimile parameters requiring standardization, and the analysis of these parameters to determine likely trends and options.

To provide a general background for the standardization study, Section 2.0 reviews the general nature of data networks with particular emphasis on Public packet switched networks. Section 3.0 examines the generic structure of a Group 4 facsimile system and identifies those parameters which require standardization, and those which do not. There are four major characteristics of the Group 4 system which must be standardized--resolution, compression technique, data rates, and communications protocol. Each of these parameters is analyzed independently in Sections 4.0, 5.0, 6.0, and 7.0 respectively. Section 8.0 contains a summary and conclusion of the investigation. Finally, recommendations for further study are included in Section 9.0.

Delta Information Systems is greatly indebted to those members of the facsimile and packet switching communities who contributed information to this report. We also acknowledge the support and guidance of Dennis ~~Bolsan,~~ BODSON, the Contractor's Technical Representative from the National Communications System.

2.0 DATA NETWORKS

A large demand for data communications has stemmed from computer users accessing remote computers via the switched telephone network.

Typically, a user would dial the computer over a switched phone circuit which would be tied up for the entire period of the data "conversation." The data interchange between the computer and user terminal is usually very bursty. Consequently the cost of the voice circuit is excessive relative to the typical amount of data interchanged. In addition, when the telephone network employs conventional modems for digital communications, a relatively large number of transmission errors frequently occur. Data networks have been developed during the 1970's to attack these two critical problems which have plagued computer communications--excessive communication cost and excessive transmission errors. Consequently the two most distinguishing characteristics of the new data networks are 1) the efficient use of the communications resource by sophisticated switching, routing, and multiplexing techniques, and 2) the virtual elimination of end-to-end errors by error-control procedures.

Table 2-1 is a summary of some of the key characteristics of public data networks. Note that one way of describing a network is by the type of switching employed. In the case of store-and-forward message switching (e.g. Graphnet, Telex and Autodin) the entire message is transmitted sequentially through the network from node to node. In this way the entire message is received and stored at a node before being relayed to the next node. The

TABLE 2-1 CHARACTERISTICS OF PUBLIC DATA NETWORKS

Name of Network	Location	Operator	Type of Switching	Data Rates (KBPS)	X.25 Compatible	Comments
ACS	U.S.	ATT	-	-	-	In planning stage
ARPANET	U.S.	U.S. Govt.	Packet	-	No	
FAXPAK	U.S.	ITT	Packet	-	No	Facsimile only
GRAPHNET	U.S.	Graphnet	S & F Message	.11, .3, 1.2	-	Data-to-Fax conversion is available
INFONET	U.S.	C.S.C.				
TELENET	U.S.	GTE	Packet	2.4, 4.8, 9.6, 56	Yes	-Dynamic adaptive routing -Broadcast
TELEX	U.S.	Western Union	S & F Message		No	
TYMNET	U.S.	Tymshare	Packet	-Asyn .050-1.8 -Sync 2. - 9.6	Yes	Fixed path
CYCLADES	France	PTT	Packet			-Datagram -Experimental
DATAPAC	Canada	Bell Canada	Packet		Yes	
EIN	Europe					Datagram Service
EURONET	Europe	PTT's	Packet		Yes	
EPSS	U.K.	BPO				
GMDNET	Germany	PTT	Packet		Yes	Experimental
NTT	Japan	NTT				
TRANSPAC	France	PTT	Packet		Yes	
	Scandinavia	PTT's	Circuit		-	

thruput of such a system becomes severely limited as the traffic level increases and as the raw channel error rate increases. Packet switched networks have been developed to achieve a higher level of throughput and responsiveness to the user when compared to message switching networks. In a packet switched network the information to be transmitted is divided into packets, where a typical packet may contain 1,024 bits. By reducing the size of this basic transmitted unit of information from the entire message to a small packet, the thruput of the network is greatly increased.

By employing sophisticated switching, multiplexing, and storage techniques at the network nodes, the data links which interconnect the nodes are utilized with a very high level of efficiency. In this way the communication costs have been significantly reduced. For example: the basic cost element for Telenet is 50¢ per kilopacket; and the basic rate for Tymnet is 3¢ per kilocharacter. Other advantages and characteristics of the data networks are listed below.

- Transmission charges are independent of distance.
- Terminals having several optional bit rates may be connected to the network. The network will automatically adapt to the particular appropriate data rate which the user has selected.
- The user pays only for the data which was transmitted.
- Some networks (e.g. Telenet) have a multipoint broadcast capability. The user feeds the network only one message along with a list of addresses.

At this point it is useful to define several of the key terms which are related to data networks.[1]

Packet: A packet of information is a finite sequence of bits, divided into a control header part and a data part. The header will contain enough information for the packet to be routed to its destination. There will usually be some checks on each such packet, so that any switch through which the packet passes may exercise error control. Packets are generally associated with internal packet-network operation and are not necessarily visible to host computers attached to the network.

Datagram: A finite length packet of data together with destination host address information (and, usually, source address) which can be exchanged in its entirety between hosts, independent of all other datagrams sent through a packet switched network. Typically, the maximum length of a datagram lies between 1000 and 8000 bits.

Gateway: The collection of hardware and software required to effect the interconnection of two or more data networks, enabling the passage of user data from one to another.

Host: The collection of hardware and software which utilizes the basic packet-switching service to support end-to-end interprocess communication and user services.

Packet Switch: The collection of hardware and software resources which implements all intranetwork procedures such as routing, resource allocation, and error control and provides access to network packet-switching services through a host/network interface.

Protocol: A set of communication conventions, including formats and procedures which allow two or more end points to communicate. The end points may be packet switches, hosts, terminals, people, file systems, etc.

Protocol Translator: A collection of software, and possibly hardware, required to convert the high level protocols used in one network to those used in another.

Terminal: A collection of hardware and possibly software, which may be as simple as a character-mode teletype or as complex as a full scale computer system. As terminals increase in capability, the distinction between "host" and "terminal" may become a matter of nomenclature without technical substance.

Virtual Circuit: A logical channel between source and destination packet switches in a packet-switched network. A virtual circuit requires some form of "setup" which may or may not be visible to the subscriber. Packets sent on a virtual circuit are delivered in the order sent, but with varying delay.

PTT: Technically PTT stands for Post, Telegraph, and Telephone Authority; this authority has a different form in different countries. In this paper, by PTT we mean merely the authority (or authorities) licensed in each country to offer public data transmission services.

One of the most critical issues in the development of data networks is the standardization of the interface between the data network and user systems such as data terminals and host computers. The International Telegraph and Telephone Consultative Committee (CCITT) has led the way in this standardization process. In 1976 the CCITT approved Recommendation X.25 which is entitled "Interface between Data Terminal Equipment (DTE) and Data Circuit-

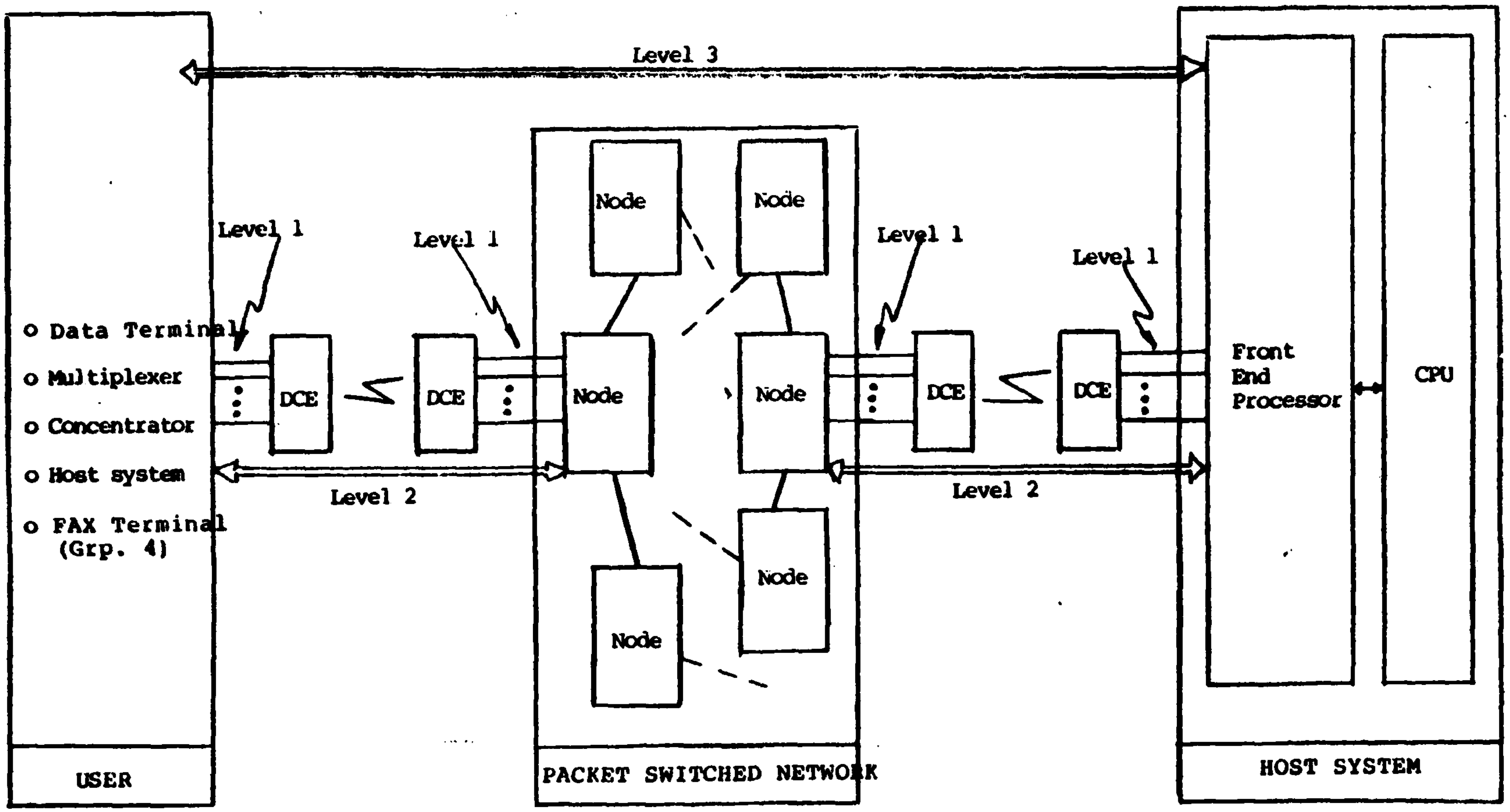
Terminating Equipment (DCE) for terminals operating in the packet mode on Public Data Networks." A copy of the recently revised version of this recommendation is included in Appendix A. Figure 2-1 is a block diagram which illustrates the three architectural levels of the X.25 interface standard.

-Level 1 - Physical level: The mechanical, electrical, functional and procedural characteristics to activate, maintain and de-activate the physical link between the DTE and the DCE. The X.25 standard recommends the use of X.21 for the physical level standard. EIA Standards RS232C and RS449 are also physical level standards which are applicable.

-Level 2 - Link level: The link access procedure for reliable data interchange across the link between the DTE and the data network; error handling, flow control; e.g. "rcvr ready," "rcvr not ready." The X.25 standard recommends the use of the HDLC/LAPB standard proposed by ISO.

-Level 3 - Network/Packet level: Defines the packet formats and control prcoedures; controls the addressing, switching, and routing of the information to establish a virtual circuit connection through the network.

Table 1 points out that most of the major data networks provide an X.25 interconnect capability at the present time. Since the X.25 interface is generally recognized as the primary standard



Level 1- Physical; RS232C, RS449, X.21
Level 2- Link Access Procedure; HDLC LAPB
Level 3- Network; X.25

Figure 2-1
BLOCK DIAGRAM ILLUSTRATING ARCHITECTURAL LEVELS OF THE
X.25 INTERFACE STANDARD

for the data network interconnection, it is anticipated that this standard will be selected for Group 4 facsimile. Section 7.0 of this report discusses X.25 in more detail along with the higher levels of interconnect architecture.

The reader will note in Figure 2-1 that the Group 4 facsimile terminal may be viewed as any other user's data terminal connected to a data network. Section 2.0 looks at the general nature of a digital facsimile system from a Group 4 perspective.

3.0 GENERAL DISCUSSION OF GROUP 4 FACSIMILE

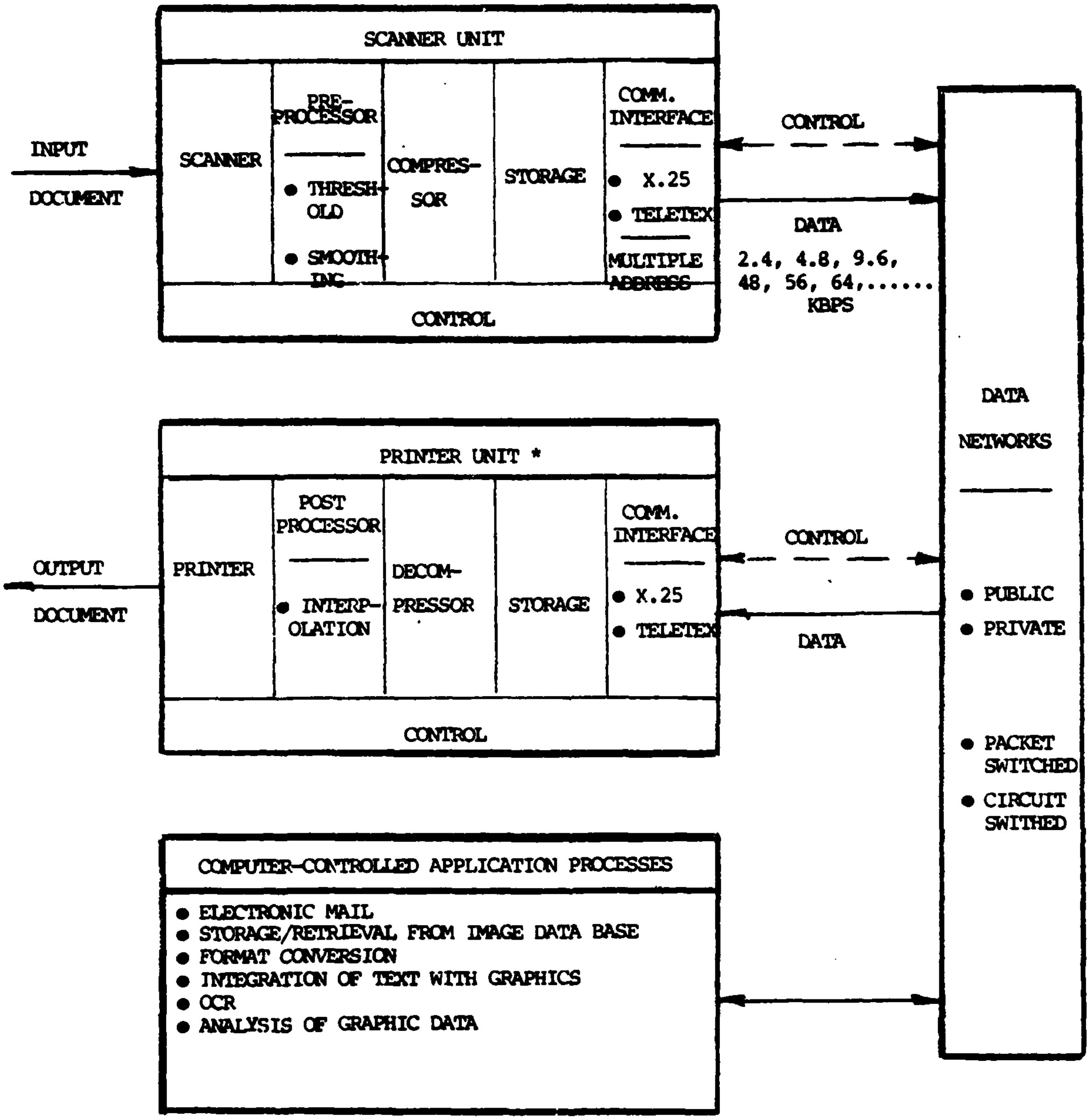
Figure 3-1 is a functional block diagram illustrating the general organization of Group 4 facsimile scanners/printers and how they may relate to data networks and remote computer systems. The key characteristic of the scanner and printer elements of the facsimile units is their resolution. This parameter is discussed in detail in Section 4.0 and will not be reviewed here. Similarly the compressor/decompressor, communications interface, and data rates are handled in Sections 5.0, 6.0, and 7.0 respectively. The remaining elements--pre-processing, post-processing, storage, and computer application processes are discussed below in Sections 3.1 through 3.4.

3.1 Pre-Processing

One fundamental pre-process which must be performed in all digital facsimile systems is the threshold operation where the analog video output from the scanner is sampled and converted to a binary, black-white signal.

This threshold operation can vary widely in complexity from a simple fixed-level slicing circuit to a sophisticated unit which dynamically senses the document background level and adaptively controls the threshold level relative to that background. Since there is no need to standardize this process, it will not be discussed further in this report.

Figure 3-2 illustrates how digital facsimile systems generate an inherent spatial noise pattern which has two disadvantages: 1) the output image appears noisy; 2) a reduction in the compres-



* May be part of local printing/duplicating operation

GROUP 4 FACSIMILE, FUNCTIONAL BLOCK DIAGRAM
Figure 3-1

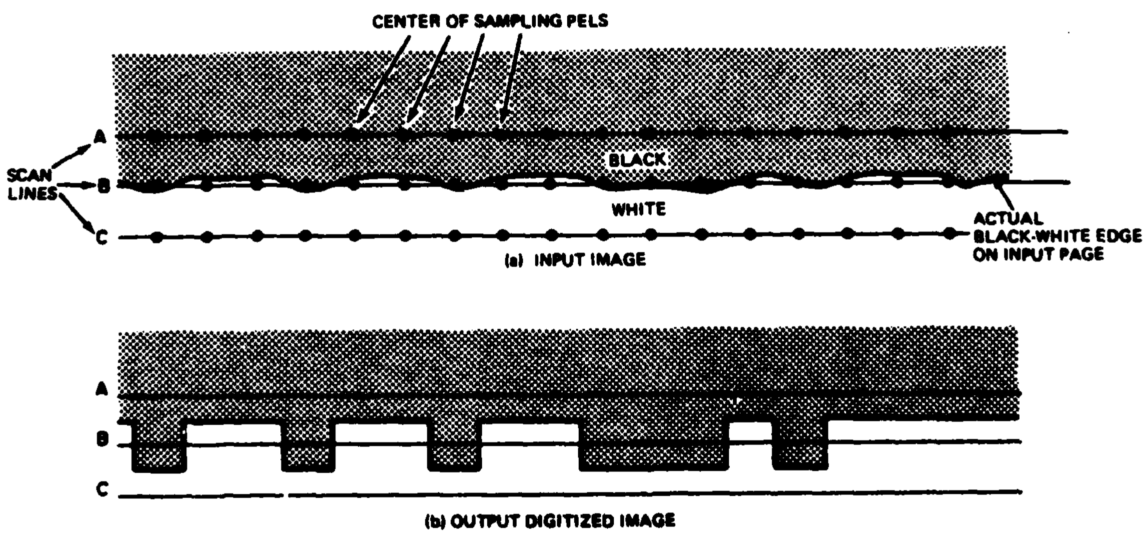


Figure 3-2 **Digital Input Image Noise**

sion ratio. Spatial noise filters such as that illustrated in Figure 3-3 may be employed to reduce this distortion. This process, like the threshold operation, need not be standardized to achieve compatibility. Hence it will not be treated further in this report.

3.2 Post-Processing

In some instances there are advantages to performing a post-processing operation at the facsimile receiver just prior to printing. This process could have several possible functions, two of which are listed below:

- Error processing -- It is not difficult for a facsimile receiver to sense when a transmission error has occurred in a particular scan line. It is then possible to process the received data in such a manner as to minimize the subjective effect of that error.

- Interpolation -- One may consider the general case where the resolution of the printer is greater than that of the scanner. In this situation it would be possible to "interpolate" the likely colors of those printed pels which were not transmitted. An intelligent interpolator will usually be correct in its estimate.

Post-processing, like pre-processing is not an important parameter to be standardized since it need not be specified to achieve interoperability. Therefore it will not be discussed further in this report.

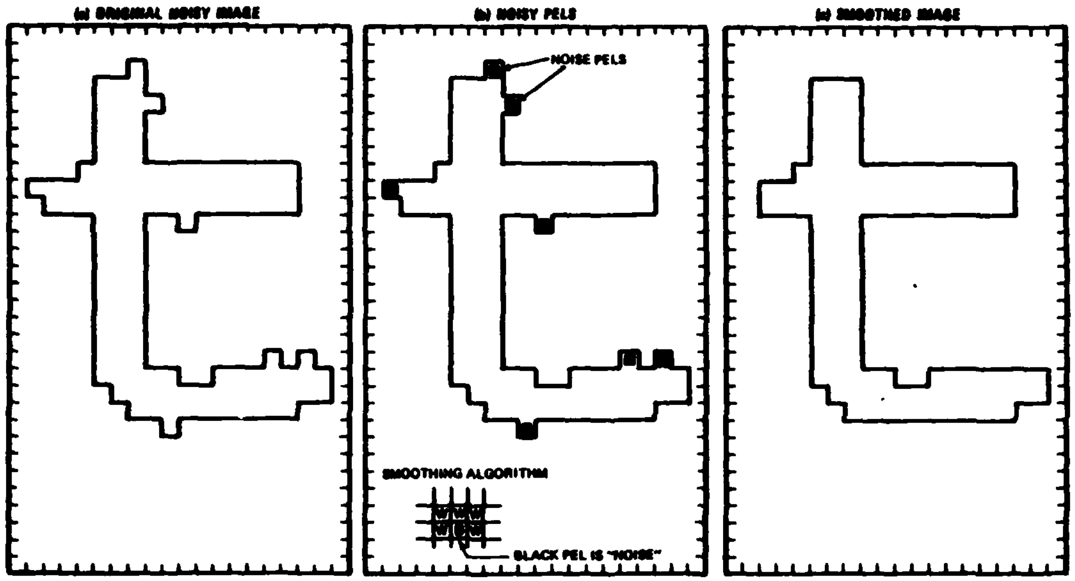


Figure 3-3 Input Smoothing

3.3 Storage

The Group 4 facsimile scanner and printer units must store a minimal amount of compressed data to accommodate the uncertainties of the error control system in the data network and terminal/network interface link. It is useful to consider two extreme example of Group 4 facsimile terminals. The first operates at a relatively slow speed (e.g. many seconds per page) such that, if the network has problems, the paper transport in the scanner or printer can be slowed/stopped until the network recovers.

On the other hand it is likely that some future Group 4 facsimile systems will be developed which will operate at sufficiently high speed (e.g. one page per second) that the document transport cannot be stopped/slowed within a document cycle. In this case it is likely that digital storage must be provided for at least one complete page. In either case the communication takes the form of a memory-to-memory transfer. If one page, or less, is stored it is possible that a solid state memory could be utilized. If several pages are to be stored it is likely that a magnetic media would be used, e.g. hard or floppy disc.

3.4 Computer Applications

There are two general application areas for Group 4 facsimile. The first is the conventional scanner-to-printer transmission as is most commonly accomplished in facsimile today. The second application is a relatively new one. It considers the use of a facsimile terminal as an input/output device for a remote computer. It is true that there is some limited degree of facsimile/

computer interactions today--e.g. Graphnet. However it is anticipated that the development of Group 4 facsimile will usher in a totally new era in the facsimile business. A few of the potential computer applications are described below.

- Electronic Mail - A large fraction of business mail could be potentially exchanged via the Public Data Network using Group 4 facsimile terminals.

- Storage/Retrieval from Image Data Base - Large quantities of documents could be stored in computer form so they could readily be printed on a remote facsimile printer. This is an example of what has been called the remote copier application.

- Format Conversion - It is likely that Group 4 facsimile units will be compatible with a wide range of other facsimile standards. In those instances where two image communication devices were incompatible, an intermediate computer process could effect an exchange of information.

- Integration of Text with Graphics - Graphic data could be scanned by a Group 4 scanner and fed to a graphics/word processing system. CRT operators would view the scanned graphic data and add textual data. The combined text/graphic data could then be stored and distributed to Group 4 printers.

- OCR/Analysis of Graphic Data - Raw symbol/character data could be scanned by a Group 4 facsimile device and sent to a computer system where a pattern recognition function could be performed.

4.0 RESOLUTION

The resolution of the Group 4 facsimile system is one of the most important parameters to be standardized because it is the primary factor affecting the quality of the output page as well as the number of bits required for transmission.

For reasons of compatibility it is logical to first consider the adoption of the Group 3 resolution standards for Group 4.

Group 3 Resolution

The horizontal resolution for Group 3 equipment is fixed at 7.7 samples/mm (nominally 200 samples/inch). The Group 3 vertical resolution has been standardized at 3.85 lines/mm (nominally 100 lines/inch) with an option at 7.7 lines/mm. It is likely that these two resolution standards will be included in the Group 4 standard. The reasons are twofold. First, these resolutions have been found to be adequate for a wide range of applications many of which will persist in the Group 4 environment. Second, it is advantageous for Group 4 systems to be downward compatible with Group 3.

Higher Resolution

There is some consideration in the facsimile community of adding a third Group 4 resolution option which would be higher than 200 lines/inch. The primary rationale for such a standard is that the human observer, without benefit of optical magnification, is capable of perceiving more detail than is provided by 200 lines/inch. There may be a significant market for a facsimile system which has sufficiently high resolution that the output page could pass for an original to the casual observer.

Delta Information Systems is performing a study of resolution for Group 4 equipment for the National Communications System. The higher resolutions which are being examined include 240, 300, 400, and 480 lines/inch. One disadvantage of 240 lines/inch is that if may not be a sufficient increase relative to 200 lines/inch. It is unlikely that 480 lines/inch will be chosen due to the severe penalty in bits/document, and hardware cost to implement such a high resolution. Further it is unlikely that the image quality at 480 lines/inch would be significantly superior to that at 400 lines/inch.

It is possible that a higher resolution other than 300 lpi or 400 lpi may be chosen--e.g. 360 lpi. Nevertheless it is useful to focus our attention on the comparison between 300 and 400 lines/inch. These two resolutions are compared below from several different points of view.

-Image Quality -- The perceived legibility/quality of a facsimile image at 300 lines/inch is quite high. As an example of this quality Addressograph Multigraph International has provided output copies of the 8 CCITT documents which have been transmitted through their 300 lines/inch facsimile system. Copies are included in Figures 4-1 through 4-8. Experiments have been performed with 300 lines/inch output documents which suggest the casual observer considers them to be "originals."

-Bits/Page - There are 78% more pels in a 400 lines/inch page relative to a 300 lines/inch image. However, the compres-

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Our Ref. 350/PJC/EAC 18th January, 1972.

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal. This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

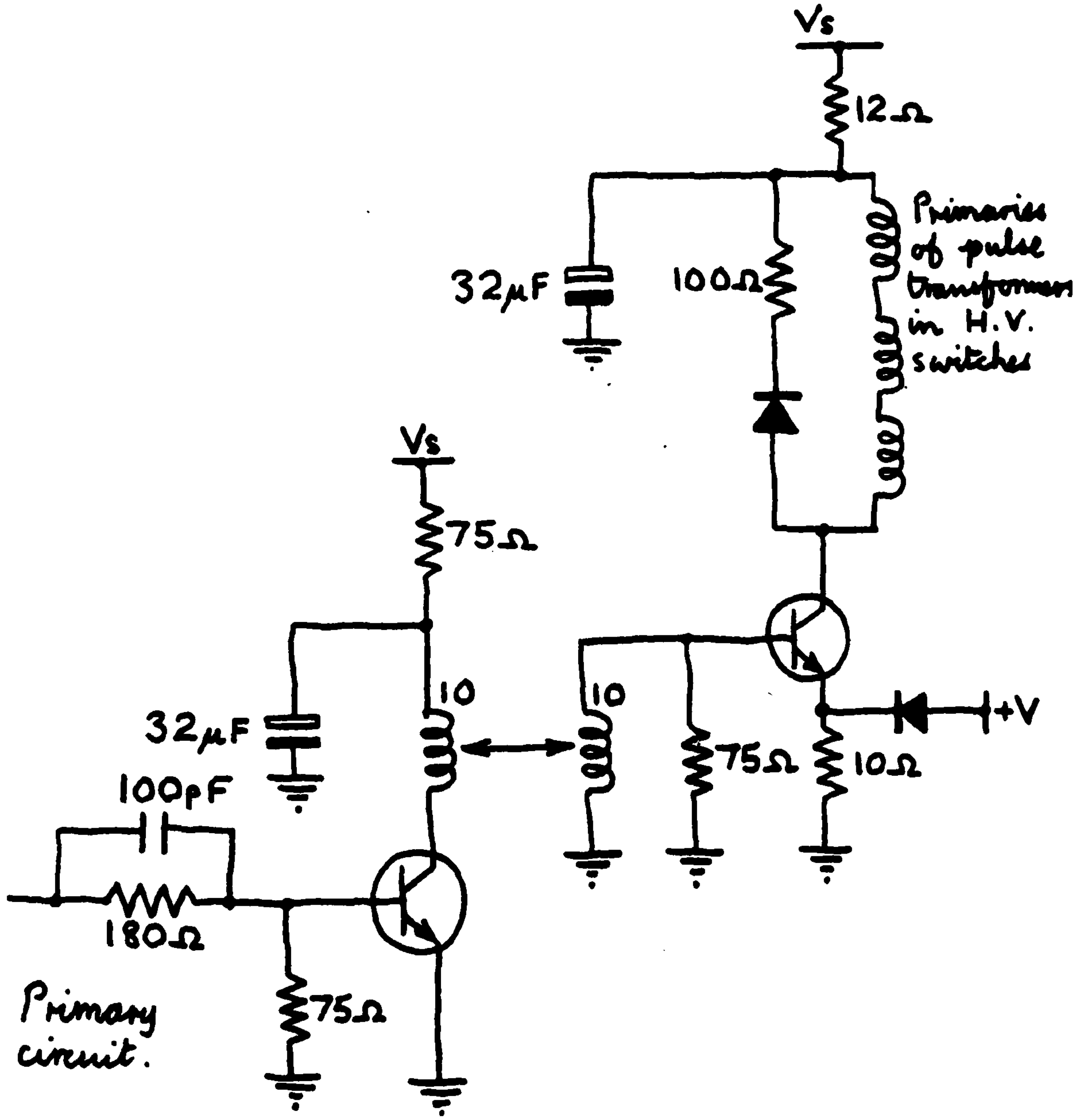
Probably you have uses for this facility in your organisation.

Yours sincerely,

Phil.

P.J. CROSS
Group Leader - Facsimile Research

Figure 4-1



This is current driver circuit.

Phil.

Figure 4-2

22-9-71

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39, RUE DU XVUTRSTSQL F 00000 NTBCLAG
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Télex : 31586 F IN : 718480070257
Transporteur (ou Transitaire)
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8 quai des bledfeh F 0000 NTBCLAG

Mot directeur

CLASSEMENT	FACTURE INVOICE	Exemplaire 15	
CODE CLIENT Z 04599	DATE 7-7-74	NUMERO 06	FEUILLET 01

Votre commande du 74-2-2 numéro 438
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PAYS D'ORIGINE PAYS DE DESTINATION
CONDITIONS DE LIVRAISON DATE 74-03-03
LICENCE D'EXPORTATION NATURE DU CONTRAT (monnaie)
CONDITIONS DE PAIEMENT (échéance, %...) FAB

MARQUES ET NUMÉROS / MARKS AND NUMBERS	NOMBRE ET NATURE DES COLIS : DÉNOMINATION DE LA MARCHANDISE / NUMBER AND KING OF PACKAGES: DESCRIPTION OF GOODS	NOMENCLATURE STATISTICAL No.	MASSE NETTE / NET WEIGHT / MASSE BRUTE / GROSS WEIGHT	VALEUR / VALUE / DIMENSIONS / MEASUREMENTS
74.21.456.44.2 A	1 Composants	U 123/4	5 kg 8 kg	1400 X 13x10x6

QUANTITÉ COMMANDÉE ET UNITÉ / QUANTITY ORDERED AND UNIT	N° ET RÉF. DE L'ARTICLE	DESIGNATION	QUANTITÉ LIVRÉE ET UNITÉ / QUANTITY DELIVERED AND UNIT	PRIX UNITAIRE / UNIT PRICE	MONTANT TOTAL / TOTAL AMOUNT
2	AF-809	Circuit intégré	2	104,33 F	208,66 F
10	S8-T4	Connecteur	10	83,10 F	831,00 F
25	ZI07	Composant indéterminé	20	15,00 F	300,00 F

		Inclus	Non inclus
Costs	Débours		
Packing	Emballages		92,14
Freight	Transport		
Insurance	Assurances		
Total invoice amount	Montant total de la facture		1431,80
Installment	Acomptes		

Figure 4-3

L'ordre de lancement et de réalisation des applications fait l'objet de décisions au plus haut niveau de la Direction Générale des Télécommunications. Il n'est certes pas question de construire ce système intégré "en bloc" mais bien au contraire de procéder par étapes, par paliers successifs. Certaines applications, dont la rentabilité ne pourra être assurée, ne seront pas entreprises. Actuellement, sur trente applications qui ont pu être globalement définies, six en sont au stade de l'exploitation, six autres se sont vu donner la priorité pour leur réalisation.
Chaque application est confiée à un "chef de projet", responsable successivement de sa conception, de son analyse-programmation et de sa mise en oeuvre dans une région-pilote. La généralisation ultérieure de l'application réalisée dans cette région-pilote dépend des résultats obtenus et fait l'objet d'une décision de la Direction Générale. Néanmoins, le chef de projet doit dès le départ considérer que son activité a une vocation nationale donc refuser tout particularisme régional. Il est aidé d'une équipe d'analystes-programmeurs et entouré d'un "groupe de conception" chargé de rédiger le document de "définition des objectifs globaux" puis le "cahier des charges" de l'application, qui sont adressés pour avis à tous les services utilisateurs potentiels et aux chefs de projet des autres applications. Le groupe de conception comprend 6 à 10 personnes représentant les services les plus divers concernés par le projet, et comporte obligatoirement un bon analyste attaché à l'application.

II - L'IMPLANTATION GEOGRAPHIQUE D'UN RESEAU INFORMATIQUE PERFORMANT

L'organisation de l'entreprise française des télécommunications repose sur l'existence de 20 régions. Des calculateurs ont été implantés dans le passé au moins dans toutes les plus importantes. On trouve ainsi des machines Bull Gamma 30 à Lyon et Marseille, des GE 425 à Lille, Bordeaux, Toulouse et Montpellier, un GE 437 à Massy, enfin quelques machines Bull 300 TI à programmes câblés étaient récemment ou sont encore en service dans les régions de Nancy, Nantes, Limoges, Poitiers et Rouen ; ce parc est essentiellement utilisé pour la comptabilité téléphonique.
A l'avenir, si la plupart des fichiers nécessaires aux applications décrites plus haut peuvent être gérés en temps différé, un certain nombre d'entre eux devront nécessairement être accessibles, voire mis à jour en temps réel : parmi ces derniers le fichier commercial des abonnés, le fichier des renseignements, le fichier des circuits, le fichier technique des abonnés contiendront des quantités considérables d'informations.
Le volume total de caractères à gérer en phase finale sur un ordinateur ayant en charge quelques 500 000 abonnés a été estimé à un milliard de caractères au moins. Au moins le tiers des données seront concernées par des traitements en temps réel.
Aucun des calculateurs énumérés plus haut ne permettait d'envisager de tels traitements.
L'intégration progressive de toutes les applications suppose la création d'un support commun pour toutes les informations, une véritable "Banque de données", répartie sur des moyens de traitement nationaux et régionaux, et qui devra rester alimentée, mise à jour en permanence, à partir de la base de l'entreprise, c'est-à-dire les chantiers, les magasins, les guichets des services d'abonnement, les services de personnel etc.
L'étude des différents fichiers à constituer a donc permis de définir les principales caractéristiques du réseau d'ordinateurs nouveaux à mettre en place pour aborder la réalisation du système informatif. L'obligation de faire appel à des ordinateurs de troisième génération, très puissants et dotés de volumineuses mémoires de masse, a conduit à en réduire substantiellement le nombre.
L'implantation de sept centres de calcul interrégionaux constituera un compromis entre : d'une part le désir de réduire le coût économique de l'ensemble, de faciliter la coordination des équipes d'informaticiens; et d'autre part le refus de créer des centres trop importants difficiles à gérer et à diriger, et posant des problèmes délicats de sécurité. Le regroupement des traitements relatifs à plusieurs régions sur chacun de ces sept centres permettra de leur donner une taille relativement homogène. Chaque centre "gérera" environ un million d'abonnés à la fin du VIème Plan.
La mise en place de ces centres a débuté au début de l'année 1971 : un ordinateur IRIS 50 de la Compagnie Internationale pour l'Informatique a été installé à Toulouse en février ; la même machine vient d'être mise en service au centre de calcul interrégional de Bordeaux.

Figure 4-4

Cela est d'autant plus valable que $T\Delta f$ est plus grand. A cet égard la figure 2 représente la vraie courbe donnant $|\phi(f)|$ en fonction de f pour les valeurs numériques indiquées page précédente.

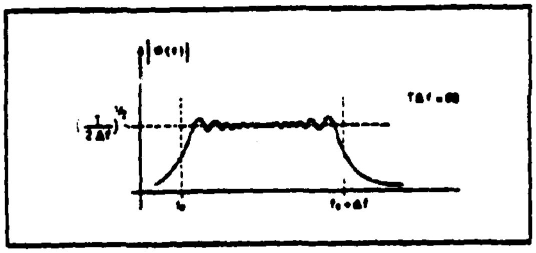


FIG. 2

Dans ce cas, le filtre adapté pourra être constitué, conformément à la figure 3, par la cascade :

— d'un filtre passe-bande de transfert unité pour $f_0 \leq f \leq f_0+\Delta f$ et de transfert quasi nul pour $f < f_0$ et $f > f_0+\Delta f$, filtre ne modifiant pas la phase des composants le traversant ;

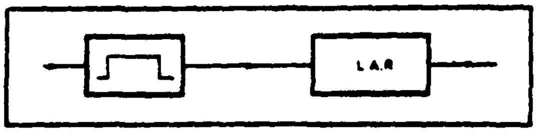


FIG. 3

— filtre suivi d'une ligne à retard (LAR) dispersive ayant un temps de propagation de groupe T_R décroissant linéairement avec la fréquence f suivant l'expression :

$$T_R = T_0+(f_0-f)\frac{T}{\Delta f} \quad \text{(avec } T_0 > T\text{)}$$

(voir fig. 4).

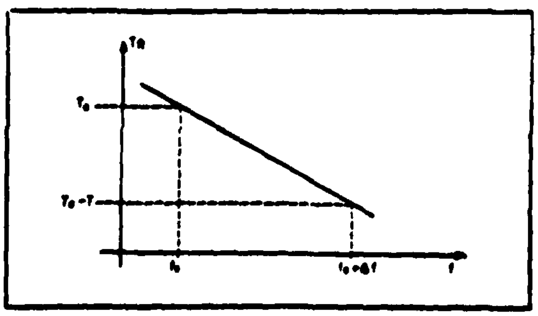


FIG. 4

telle ligne à retard est donnée par :

$$\varphi = -2\pi\int_0^f T_R \, df$$

$$\varphi = -2\pi\left[T_0+\frac{f_0 T}{\Delta f}\right]f + \pi\frac{T}{\Delta f}f^2$$

Et cette phase est bien l'opposé de $/\phi(f)$, à un déphasage constant près (sans importance) et à un retard T_0 près (inévitable).

Un signal utile $S(t)$ traversant un tel filtre adapté donne à la sortie (à un retard T_0 près et à un déphasage près de la porteuse) un signal dont la transformée de Fourier est réelle, constante entre f_0 et $f_0+\Delta f$, et nulle de part et d'autre de f_0 et de $f_0+\Delta f$, c'est-à-dire un signal de fréquence porteuse $f_0+\Delta f/2$ et dont l'enveloppe a la forme indiquée à la figure 5, où l'on a représenté simultanément le signal $S(t)$ et le signal $S_1(t)$ correspondant obtenu à la sortie du filtre adapté. On comprend le nom de récepteur à compression d'impulsion donné à ce genre de filtre adapté : la « largeur » (à 3 dB) du signal comprimé étant égale à $1/\Delta f$, le rapport de compression est de $\frac{T}{1/\Delta f} = T\Delta f$

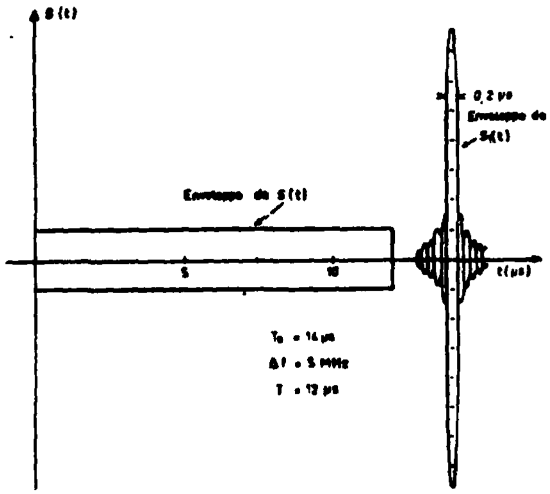
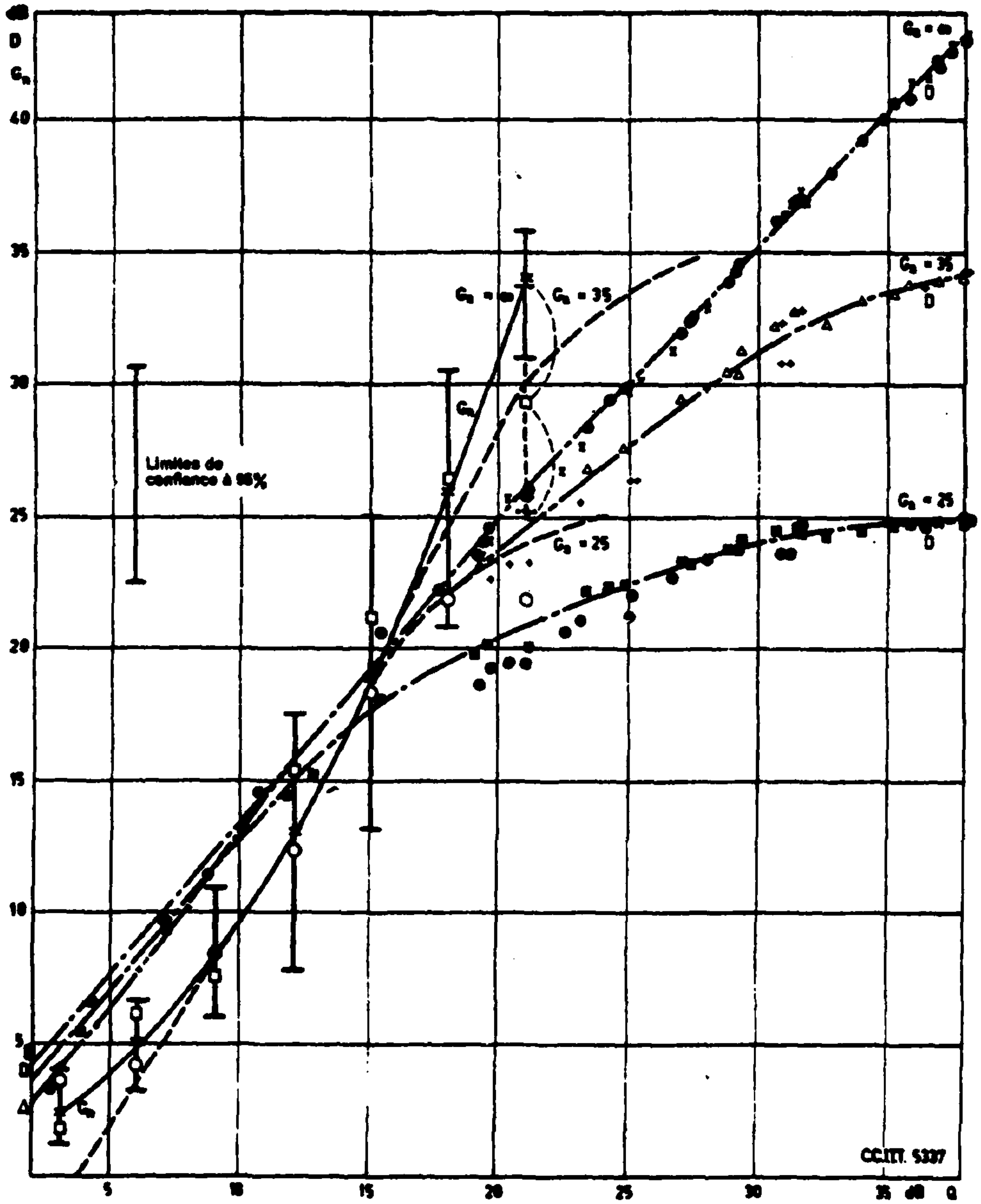


FIG. 5

On saisit physiquement le phénomène de compression en réalisant que lorsque le signal $S(t)$ entre dans la ligne à retard (LAR) la fréquence qui entre la première à l'instant 0 est la fréquence basse f_0, qui met un temps T_0 pour traverser. La fréquence f entre à l'instant $t = (f-f_0)\frac{T}{\Delta f}$ et elle met un temps $T_0-(f-f_0)\frac{T}{\Delta f}$ pour traverser, ce qui la fait ressortir à l'instant T_0 également. Ainsi donc, le signal $S(t)$

Figure 4-5



Courbes adaptées G_n (essais subjectifs) pour
$G_e = \infty$ $G_e = 35$ dB $G_e = 25$ dB
[10] ———— × □ Q
[23] — — — —

Points calculés $D(Q, G_e)$ pour
$G_e = \infty$ $G_e = 25$ $G_e = 35$ dB
● ■ △ - dans la partie montante
× ● - - dans la partie descendante

Courbes — · — · — $D(Q, G_e)$

FIGURE 3

Figure 4-6

Figure 4-7

CCITTの概要

沿革

CCITTは、国際電気通信連合（ITU）の四つの常設機関（事務総局、国際周波数登録委員会、CCIR、CCITT）の一つとして、ITUの中でも、世界の国際通信上の諸問題を真先に取上げ、その解決方法を見出して行く重要な機関である。日本名は、国際電信電話諮問委員会と称する。

CCITTの前身は、CCIF（国際電話諮問委員会）とCCIT（国際電信諮問委員会）である。CCIFは、1924年にヨーロッパに「国際長距離電話通信諮問委員会」が設置され、これが1925年のパリ電信電話会議のとき、正式に、「国際電話諮問委員会」として万国電信連合の公式機関となったものである。CCITは、同じく1925年の会議のとき、CCIFと併立するものとして設置された。

そこで、CCIFは、1956年の12月に第18回総会が開催されたのち、CCITは、同年同月に第8回総会が開催されたのち、併合されて現在のCCITTとなった。このCCITTは、CCIFとCCITが解散した直後、第1回総会を開催し、第2回総会は、1960年にニューデリーで、第3回総会は、1964年、ジュネーブで、第4回総会は、1968年、アルゼンチンで開催された。

CCIFとCCITが合併したのは、有線電気通信の分野、とくに伝送路について電信回線と電話回線とを技術的に分ける意味がなくなってきたこと、各国とも大体において、電信部門と電話部門は同一組織内にあること、CCIFの事務局とCCITの事務局の合併による能率増進等がおもな理由であった。

CCITTは、上述のように、ヨーロッパ内の国ぐにによって、ヨーロッパ内の電信・電話の技術・運用・料金の基準を定め、あるいは統一をはかってきたので、現在でも、その影響を受け、会合参加国は、ヨーロッパの国が多く、ヨーロッパで生起する問題の研究が多い。たとえば、1960年のCCITT勧告の中で、技術上配慮する距離は約2,500kmであったが、これはヨーロッパ内領域を想定したものである。

しかしながら、1956年9月に敷設された大西洋横断電話ケーブルは、大陸間電話通信の自動化および半自動化への技術的可能性を与え、CCITTがこの問題を取り上げるに及び、CCITTの性格は漸次、汎世界的色彩を実質的に帯びるに至った。この汎世界的性格は第2次世界大戦後目ざましくなったアジア・アフリカ植民地の独立に伴ってITUの構成員の中にこれらの国が加わり、ITUの中に新しい意見が導入されたことにも起因して、技術面、政治面の双方から導入されてきた。CCITTの汎世界化は、1960年の第2回総会がニューデリーで開催されたことにもあらわれている。この総会までは、CCIT、CCIFのいずれにしろ、アメリカやアジアで総会が開催されたことがなく、CCITT委員長も、ニューデリー総会の準備文書で、この点には注目すべきであるとのべている。

任務

ITUは、全権委員会議、主管庁会議を始めとして、七つの機関をもち、それぞれの機関の権限と任務は国際電気通信条約に明記されている。そこで条約を参照してみるならば、CCITTの任務は、つぎのとおりとなっている。

「国際電信電話諮問委員会(CCITT)は、電信および電話に関する技術、運用および料金の問題について研究し、および意見を表明することを任務とする。」（1965年モントルー条約第187号）

「各国際諮問委員会は、その任務の遂行に当たって、新しい国または発展の途上にある国における地域的および国際的分野にわたる電気通信の創設、発達および改善に直接関連のある問題について研究し、および意見を作成するように妥当な注意を払わなければならない。」（同第188号）

「各国際諮問委員会は、また、関係国の要請に基づき、その国内電気通信の問題について研究し、かつ、勧告を行なうことができる。」（同第189号）

上記第187号と第188号にいわれる「意見」とは、フランス語の Avis から訳したもので、英語では、「勧告(Recommendation)」となっている。CCITTの表明する意見は、国際法的には強制力をもたないものであって、この点が、条約、電信規則、電話規則等各国を拘束する力をもっているものと異なる。もっとも意見とは称しても、技術的分野では、電信規則のごとき、各国政府が承認してその内容を実施する強制規則をもたないので、実際にある機器の仕様を定める場合には、多くの国の意見が統一されたこの「意見」に従わなければ、円滑な国際通信を行なうことができない場合が多い。この意見（または勧告）は、国際通信を行なう場合各国が直面する問題について、具体的意見を表明するもので、たとえば、大陸間ケーブルで大陸間通話を半自動化しようとする場合、その信号方式や取り扱う通話の種類および料金は、どのようにするかを研究して意見を表明する。したがって、CCITTの活動は、つねに時代の最先端を行くもので、CCITTの活動方向は、そのまま世界の国際通信の活動方向であるともいえる。

この意見は、また、電信規則以下のその他の規則のごとく、数年以上の間隔をもって開催される主管庁会議というような大会議の決定をまたなくても表明することができ、また、その改正も容易であるので、現在のように進歩の早い国際通信界では、関係国の意見を統一した国際的見解としては非常に便利である。

memorandum

FROM: A.P. Sproggs Research	TO: G.V. Smith Project Planning
TEL: EXTN: 2041	DATE: 1-9-71

We know that, where possible, data is reduced to alphanumeric form for transmission by communication systems. However, this can be expensive, and also some data must remain in graphic form. For example, we cannot key-punch an engineering drawing or weather map.

I think we should realise that high speed facsimile transmissions are needed to overcome our problems in efficient graphic data communication. We need research into graphics data compression.

Any comments?

Albert.

WELL, WE ASKED FOR IT!

Figure 4-8

sion ratio is greater at 400 lpi than at 300 lpi so the net increase in the bits/page is undoubtedly less than 50%. Nevertheless the penalty in bits/page for 400 lpi over 300 lpi would be significant when considering the communication cost and computer storage cost.

-Compatibility with 200 lpi - The 400 lpi standard is advantageous since it is an integral multiple of 200 lpi--the anticipated lower resolution standard. One advantage stems from the fact that it would be easy to interpolate a 400 lpi image at the receiver from a transmitted 200 lpi signal. Another advantage is the manufacturing compatibility at these two resolutions.

-Existing Equipment - In the United States there is much more euipment in the marketplace operating at 300 lpi than at 400 lpi.

-Compatibility with Text - This text compatibility issue is not a major point but it is worth mentioning. The most standard spacing for text is 10 characters/inch horizontal and 6 characters/inch vertical. Therefore it would be desirable for the pel resolution to be an integral multiple of 60 so that a character space (1/10 inch horizontal x 1/6 inch vertical) could contain an integral number of pels. This issue favors 300 lpi. This issue is obviously raised in anticipation of those situations where text will be integrated with facsimile graphics.

5.0 COMPRESSION TECHNIQUE

There are two broad classes of black-white graphic coding techniques:

- Information preserving techniques - those which reproduce an exact replica of the original scanned and thresholded binary image.

- Approximation techniques - those which knowingly reproduce an approximation of the original scanned, thresholded binary image.

These two categories are discussed in Sections 5.1 and 5.2 respectively. A brief look at other coding techniques is provided in Section 5.3.

5.1 Information Preserving Techniques

The standard compression technique for Group 3 facsimile equipment is the Modified Huffman Code (MHC), a run length coding algorithm which reduces redundancy in only one dimension. The Group 3 standard also provides for an optional compression technique which reduces redundancy in two dimensions--the Modified Read Code (MRC). Both of these coding techniques are exact compression algorithms which preserve all the image information.

Table 5-1 is a summary of compression ratios for four of the more prominent coding techniques--MHC, MRC,[2] Ordering technique,[3] and Symbol Matching.[4] The compression data is provided for the 8 CCITT test documents shown in Figure 5-1. The Ordering

TABLE 5-1

COMPRESSION FOR DIGITAL FACSIMILE COMPRESSION TECHNIQUES**

CCITT Document No.	Modified Huffman		Ordering		Modified READ			Symbol * Matching
	20 ms.	0 ms.	0 ms. K=4	0 ms. K=∞	20 ms. K=4	0 ms. K=4	0 ms. K=∞	0 ms. K=32
1	10.20	13.72	21.73	23.85	12.16	19.77	23.37	54.5
2	12.67	14.94	27.85	36.07	15.75	26.12	35.00	37.2
3	7.40	7.89	13.98	17.04	10.28	12.58	15.76	27.7
4	4.46	4.75	6.65	7.16	5.65	6.27	7.02	22.4
5	7.06	7.51	12.84	15.17	9.60	11.62	14.22	28.7
6	9.09	10.03	19.48	26.58	13.50	18.18	25.02	26.8
7	4.64	4.82	6.10	6.60	5.95	6.30	7.02	7.4
8	7.80	8.17	14.8	20.50	12.33	15.55	22.35	16.8
AVG.	7.07	7.70	12.05	13.99	9.44	11.56	13.92	22.72

* High Performance Coder

** Vertical resolution- 7.7 li/mm

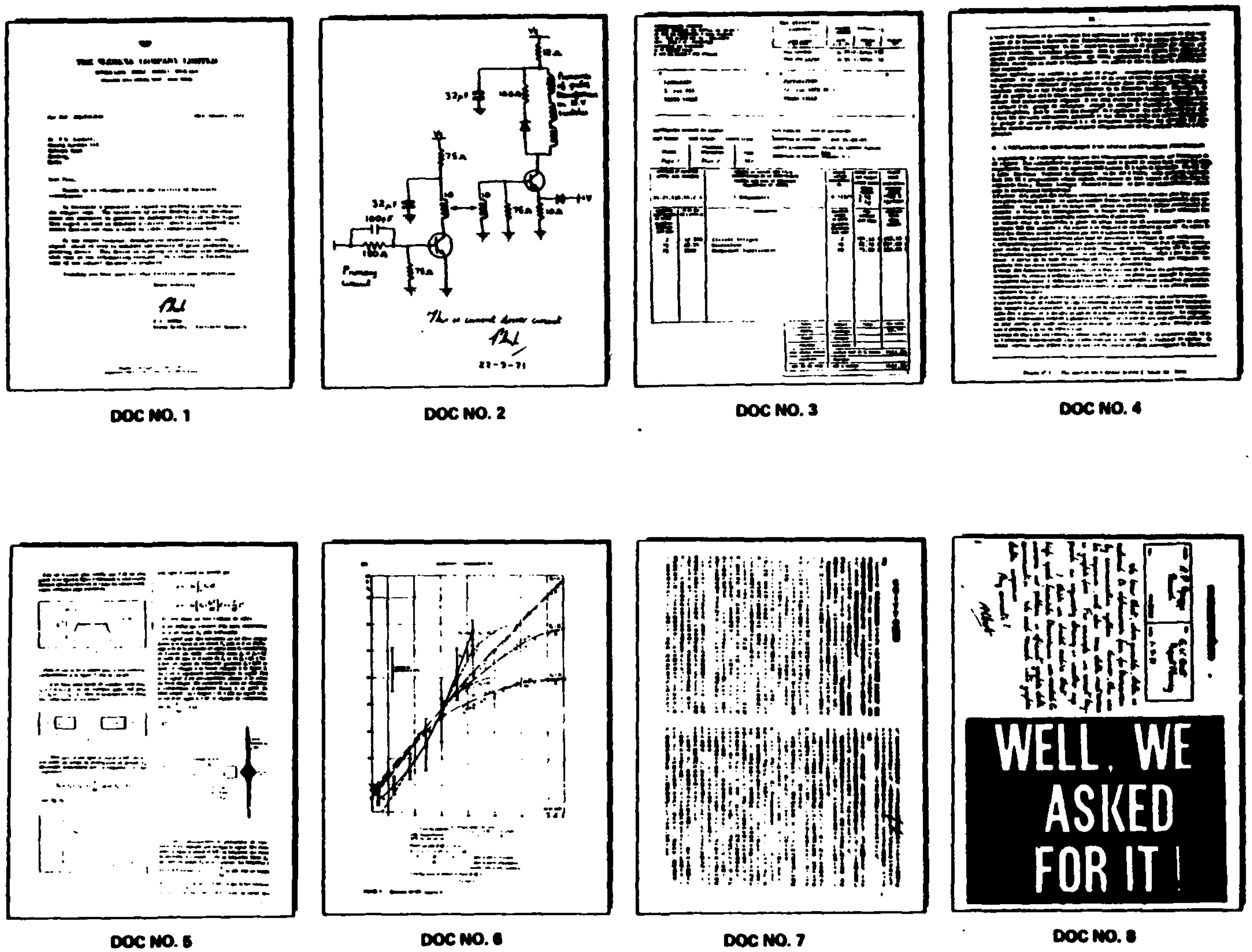


FIGURE 5-1 CCITT Standard Documents for Data Compression Analysis

technique is a two-dimensional compression concept which yields virtually the same compression as the Modified Read Code. Since the MRC is the Group 3 standard there is little motive to choose the Ordering technique for Group 4.

The standard Minimum Scan Line Time (MSLT) for Group 3 is 20 ms. The standard K-factor for the MRC at 200 lines/inch is 4 to 1. This means that every fourth line is transmitted with the MHC to minimize the vertical propagation of transmission errors. Under these operating conditions the average compression ratio for the MHC and MRC is 7.07 and 9.44 respectively; i.e., the performance of the MRC is only 33% superior to the MHC. However, in Group 4, the error rate will be very low so the K-factor can be made infinite. In addition, the limitations of the document transport can be ignored in Group 4 so the MSLT can be considered to be zero. Under these conditions the MRC outperforms the MHC by 81%. For the MRC, the compression ratio for document number four, the full page of text, is 7.02. The average ratio for all 8 documents is approximately 14 to 1.

The Group 3 standard requires the transmission of a 12-bit End-of-Line code between scan lines. To further increase the compression ratio it may be possible to delete these line synchronization codes. If this were done the compression ratio would increase by approximately 10%.

The data in Table 5-1 was measured for the Group 3 high resolution of 200 lines/inch. Compression ratios have been recently measured for the MRC, at 300 lines/inch, by AM International. The results are listed in Table 5-2. Data is included

TABLE 5-2

COMPRESSION RATIOS FOR THE MODIFIED*
READ CODE AT 300 lines/inch

CCITT Document No.	Horizontal Scan	Vertical Scan
1	36.9	38.3
2	52.2	57.1
3	25.5	25.7
4	10.9	11.1
5	22.9	22.8
6	38.2	40.9
7	10.8	11.1
8	33.4	34.3
AVG.	21.7	22.3

* K = Infinity; MSLT = 0

for the conventional horizontal scanning direction as well as for the vertical mode, where the scan lines are parallel to the 11 inch dimension of the paper. Note that the compression ratio in the vertical mode is slightly superior to that in the horizontal mode. Also note the large increase in average compression ratio at 300 lpi (21.7) relative to 200 lpi (13.92). This compression increase of 56% reduces the 225% increase in the number of pels for a net increase in the average number of transmitted bits to be 44%.

In summary, an extension of the Modified Read Code ($K = \infty$, MSLT = 0, perhaps with the EOL codes eliminated) is a strong candidate to be selected as a standard compression technique for Group 4.

5.2 Approximation Techniques

Smoothing algorithms, as described in Section 3.0, increase compression, and therefore could be considered a compression technique. However, in this section the discussion will be limited to two different types of coding techniques which make approximations--interpolation techniques and feature/symbol recognition. These coding concepts are discussed in Sections 5.2.1 and 5.2.2 respectively.

5.2.1 Interpolation Techniques

Interpolation techniques may be employed at the receiver if the resolution of the printer is greater than the resolution of the scanner. A good example of interpolation is the case where the scanner transmits alternate scan lines as shown in Figure 5-2. Of course the advantage of this procedure is that a compression ratio of 2 to 1 is achieved.

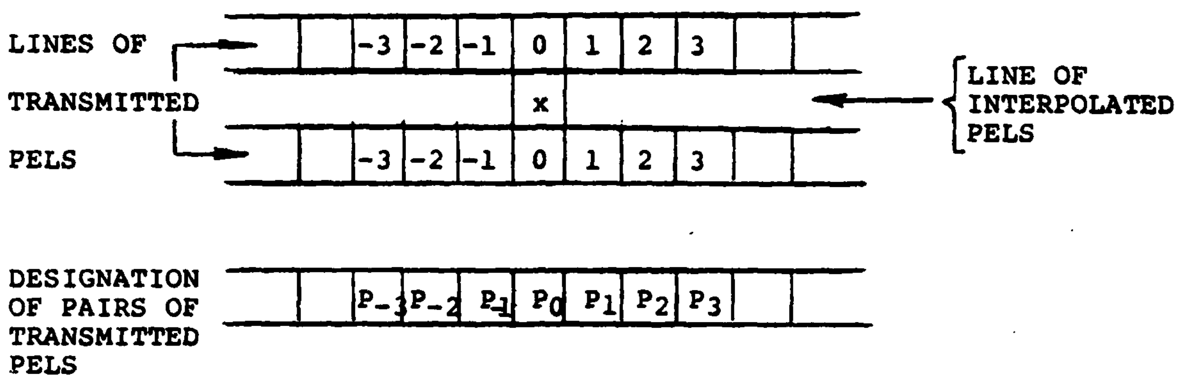
At the receiver those scan lines which were not transmitted are "interpolated" from the adjacent transmitted data. Figure 5-2 describes a possible algorithm for interpolating alternate lines.

5.2.2 Feature/Symbol Recognition

A large fraction of the documents transmitted through facsimile systems contain text as opposed to graphics. One facsimile compression technique involves the recognition of the text characters and the transmission of a short ASCII-like code defining the particular character recognized. The compression for a

FIGURE 5-2

ALTERNATE LINE INTERPOLATION



The pel to be interpolated is designated as "x". The first step in the interpolation process is to consider the pair of transmitted pels (P_0) which are adjacent to "x" in the line above and below. If the P_0 pels are both black interpolate "x" to be black. If the P_0 pels are both white interpolate "x" to be white. If the two P_0 pels are of different color, adjacent pairs ($P_{\pm1}$, $P_{\pm2}$, etc.) are examined to determine the color of the nearest pair where both pels are black or white. Pel "x" is interpolated to be the color of the nearest pair which is all black or all white. For example, if pairs P_{-2}, P_{-1}, P_0, and P_1 all have differing colored pels in each pair, but the pels in P_2 are both white then "x" is interpolated to be white. If opposite colors are found equidistant from "x" then "x" is interpolated to be white. For example, under the following conditions "x" is interpolated to be white.

P_{-2} - both black
P_{-1}, P_0, P_1 - pairs have different colored pels
P_2 - both white

system of this type is obviously very high. W. Pratt et al[4] have analyzed a system of this type (Combined Symbol Matching - CSM), and the compression results are listed in Table 5-1. Note that the compression ratio for document number 4, the page full of text, has a compression ratio of 22.4 for symbol matching as opposed to 7.02 for the Modified READ.

If conventional "OCR" techniques were used to recognize the symbols, a prohibitive amount of logic would be required to store the characteristics of all the possible text symbols which might be encountered. The CSM system gets around this problem by using the symbols in the input document itself as reference patterns for subsequently scanned characters. When a new symbol is encountered, the bit pattern is transmitted to the receiver and stored, as well as being stored in a library in the transmitter. When another symbol is encountered which is similar to that stored (it need not be identical), a short ASCII-like code is transmitted to the receiver. The appropriate bit pattern is retrieved from the library and printed. Of course those parts of the page which are not recognizable as symbols are transmitted by a conventional compression technique, such as the MRC.

Other types of recognition systems are possible. For example, it would be possible to recognize small "features", which are commonly found in documents, as opposed to complete characters. Possible features are short straight line segments at various angles, arcs, etc. In this way, complex characters would be synthesized from simple small features.

Recognition systems of this type are not without their problems. One difficulty, of course, is their complexity. Another is the potential substitution of one character for another--(e.g. B/8, a/e, s/o, etc.). Nevertheless, the general concept of recognition is very appealing for Group 4 operation since one is beginning to create "data" for the data network. Another advantage of the recognition technique is that it is compatible with the potential integration of facsimile and word processing systems.

5.3 Other Coding Techniques

It is probably premature to seriously consider setting standards for the transmission of continuous tone and color imagery. Nevertheless it may be appropriate to give some thought to these possible future requirements to avoid their exclusion at a later date. For example, continuous-tone imagery could possibly be coded by pseudorandomly dithering the threshold level in the transmitter.

6.0 DATA RATES

CCITT Recommendation X.1 defines four data signalling rates for packet switched networks--2.4, 4.8, 9.6, and 48.0 kbps. Therefore it is likely that these rates will be chosen as standard data rates for Group 4 operation. The lower data rates--2.4, 4.8, 9.6 kbps--are particularly appropriate since they also conform to the Group 3 standard.

There are two other data rates in the region of 48 kbps, which will be considered for standardization--56 kbps and 64 kbps. The 56 kbps is provided by AT & T as a switched data service (Dataphone) in metropolitan areas. Hence, it may be wise to select this rate as a standard. The INTELPOST electronic mail system is an example of a facsimile system transmitting at 56 kbps. It is useful to examine the typical document transport rates at 56 kbps. If one considers a resolution of 200 lpi, and an average compression of 14, the number of bits/page is approximately 300,000 bits. Such a document would be transmitted over a 56 kbps channel in approximately 5 seconds, a very reasonable time to mechanically transport a page.

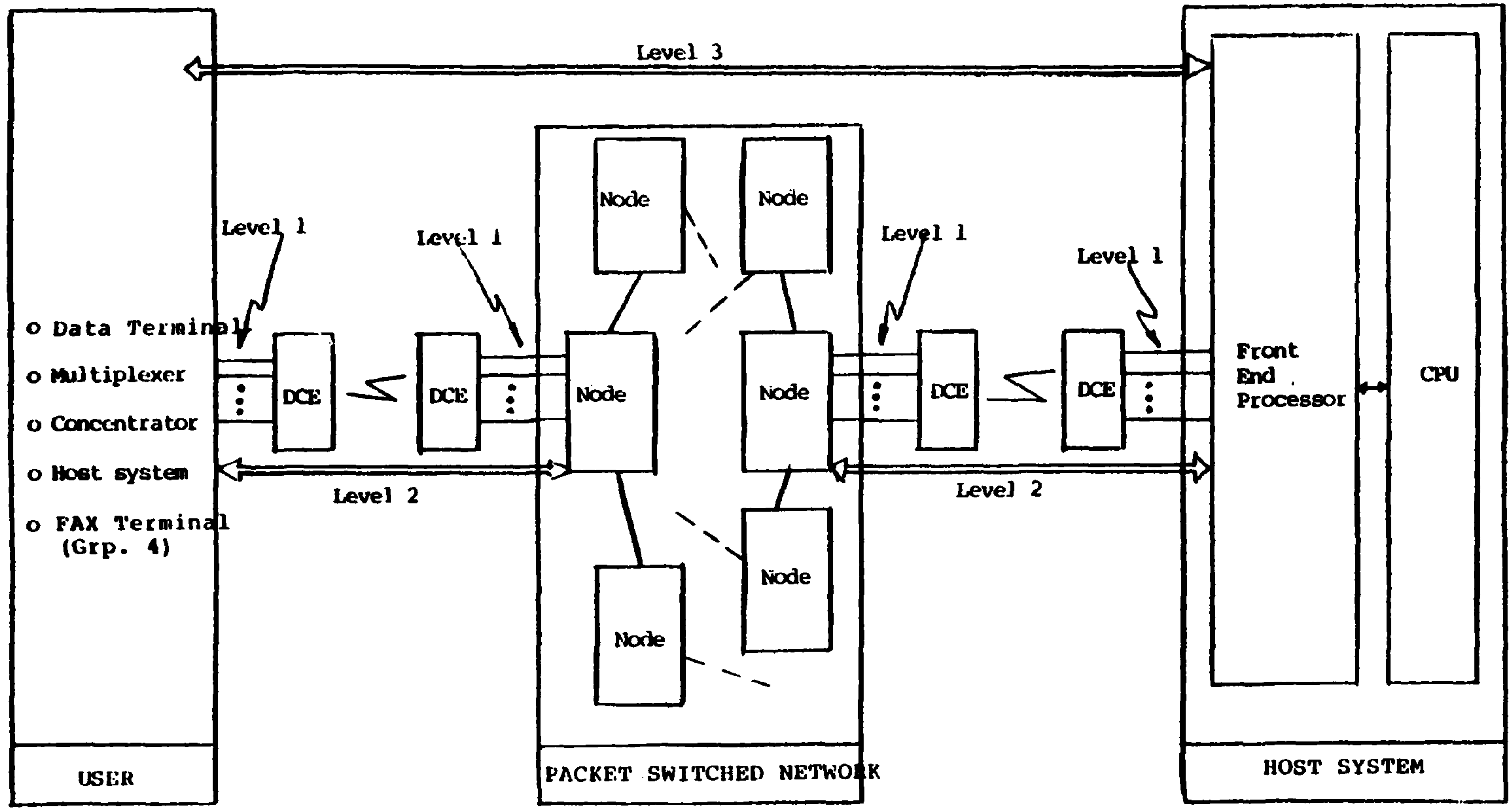
There is some consideration of facsimile equipment operating at data rates even higher than 56 kbps. For example, Satellite Business Systems offers data rates at 112, 224, and 448 kbps. And of course the T-1 rate of 1.544 mbps is commonly available.

7.0 COMMUNICATIONS PROTOCOL

As explained in Section 2.0 the CCITT has developed an interface standard--X.25--defining the interconnections between a data terminal equipment and a packet switched network. Figure 7-1 is a block diagram illustrating the three architectural levels of the X.25 standard. Appendix A contains a copy of the X.25 standard for reference purposes. It is clear that the X.25 protocol will be adopted as part of the Group 4 facsimile standard. As shown in Figure 7-1 and Table 7-1, the X.25 standard uniquely defines the third level--the network or packet level. At the second level X.25 embraces the HDLC/LAPB standard which has been promulgated by the ISO group. For the first level--the physical level--it refers to X.21 as the standard. It is likely that the Group 4 standard will also include two other commonly used physical standards as options--RS232C and RS449.

Figure 7-1 illustrates a user terminal connected to the data network via an external modem. It is possible that the Group 4 facsimile unit, like the Group 3 unit, may be used on the public telephone network. In these instances a new architectural layer--level 0--has been defined to specify the modem to be a V.27ter or V.29 modem. This corresponds to the Group 3 standard. Another layer--level 00--has also been defined to specify the means to interconnect the terminal to the telephone network.

The National Communications System has developed a series of Federal Standards which, in most instances, are closely related to certain CCITT and EIA standards. A list of the Federal



Level 1- Physical; RS232C, RS449, X.21
Level 2- Link Access Procedure; HDLC LAPB
Level 3- Network; X.25

Figure 7-1
BLOCK DIAGRAM ILLUSTRATING ARCHITECTURAL LEVELS OF THE
X.25 INTERFACE STANDARD

TABLE 7-1
COMMUNICATIONS INTERFACE FOR GROUP 4 FACSIMILE

LAYER NO.	LAYER NAME	APPLICABLE STANDARD	FUNCTION
7	APPLICATION	NONE	Defines a specific application; text editing, payroll processing, electronic mail, information retrieval,
6	PRESENTATION	TELETEX S.f S.61	Peripheral device coding; data transformation-code and character set translation; information formatting- modification of data layout, page rotation, B4/A4; encryption
5½	DOCUMENT	TELETEX S.d S.62	Document start/end; committment unit
5	SESSION	TELETEX S.d S.62	Synchronization of the application; who talks first, time, date, subscriber number; broadcast control
4	TRANSPORT	TELETEX S.h S.70	Assures end-to-end data integrity and provides for the required quality of service for exchanged information; intelligent front end deciding on type of network
3	NETWORK	X.25	Controls the addressing, switching, and routing of the information to establish a virtual circuit connection; defines packet formats and control procedures
2	LINK	HDLC LAPB	The link access procedure for reliable data interchange across the link between the DTE and the data network; error handling; flow control; e.g. "rcvr ready", "rcvr not ready"
1	PHYSICAL	X.21 RS449 RS232	The physical, electrical, functional, and procedural characteristics to establish, maintain, and disconnect the physical link between the DTE and the network
0	MODULATION	v.27 ter v.29	Used when the DTE is connected to the network via a communication chennel
00	INTERCONNECT	FCC Part 68 Connection	

standards, which correspond to the standards mentioned above, are listed below.

Federal Standard	Equivalent Standard
1041 (Interim)	X.25
1003	HDLC/LAPB
1040 (Proposed)	X.21
1031	RS449
1006	V.27ter
1007	V.29

The International Standards Organization (ISO) has developed an architectural framework for defining standards for linking heterogeneous computer networks. The proposed architecture--the Open Systems Interconnection (OSI) reference model--provides the basis for interconnecting "open" systems for distributed applications processing. The term "open" denotes the ability of an end-system (user terminal or host computer) of one manufacturer/design to connect with any other end-system conforming to the reference model.

The OSI reference model contains the seven layers which are listed in Table 7-1. Layers 00, 0, and 5½ do not correspond to the OSI model. If the Group 4 facsimile equipment is to take full advantage of the flexibility and universality of the future data networks it is clearly desirable to conform to the OSI reference model as much as possible.

The CCITT is in the process of developing a series of standards to permit the exchange of correspondence between communicating office typewriters. This new service, where the basic element of correspondence is the page, is called TELETEX. The

TELETEX standards are being developed to be as consistent as possible with levels 4, 5 and 6 of the OSI model. It is recognized that there is a great deal of similarity between textual systems like TELETEX and facsimile systems. For this reason there is a very active program to insure the TELETEX standards are written such that facsimile systems are included. One advantage of this dual-purpose structure is that the integration of facsimile graphics and work processing systems will be facilitated in the future.

The TELETEX standards have been recently consolidated into a set of five temporary documents listed below:

f.x	Teletex Service
s.c	Terminal Equipment
s.d	Control Procedures
s.f	Character Repertoire and Coded Character Sets
s.h	Network Independent; Basic Transport Service

The correspondence between these various documents and the OSI reference model is shown in Table 7-1. The two most important documents from a facsimile standards perspective are s.h and s.d. These documents are included in Appendices B and C respectively for reference purposes.

In summary, the trends for standardizing the communications protocol for Group 4 are becoming clearly established. X.25 will be the standard for levels 1, 2, and 3 of the OSI reference model.

A version of the TELETEX standard will probably be adopted for levels 4, 5, and 6.

8.0 SUMMARY AND CONCLUSIONS

It is concluded that there is no need to standardize the pre-processing, post processing, and storage functions of the Group 4 facsimile equipment. On the other hand it is concluded that the following parameters of the Group 4 apparatus must be standardized to achieve interoperability.

- o Resolution
- o Compression technique
- o Data rates
- o Communications protocol

Each of these parameters has been separately discussed in Sections 4.0, 5.0, 6.0, and 7.0 respectively. The results of these investigations are summarized in Table 8-1. For each of the four parameters those potential standards which are most likely to be selected are highlighted along with those which are secondary but receiving serious consideration.

TABLE 8-1

SUMMARY OF POTENTIAL GROUP 4 STANDARDS

PARAMETER		POTENTIAL STANDARDS	
		STRONG CANDIDATE	OTHER
RESOLUTION		GROUP 3 HORIZONTAL- 200 lpi VERTICAL - 100, 200	300 lines/inch 400 Other
COMPRESSION TECHNIQUE		EXTENSION OF THE MODIFIED READ CODE o K = ∞ o MSLT = 0 ms. o Eliminate EOL Codes	o Skip alternate lines/ Interpolate at Rcvr. o Symbol Recognition
DATA RATES KBPS		2.4, 4.8, 9.6, 48.0	56.0, 64.0 112, 224, 448 1,544.0
COMMUNICATIONS PROTOCOL	OSI LAYER #		
	1	X.21, RS 449, RS 232	
	2	HDLC/LAPB	
	3	X.25	
	4	TELETEX S.h/S.70	
	5, 5½	TELETEX S.d/S.62	
	6	TELETEX S.f/S.61	

9.0 RECOMMENDATIONS FOR FURTHER STUDY

Based upon the results of this study it is concluded that the Group 4 standardization process would be facilitated by additional studies in the three particular areas described below:

-RESOLUTION -- It is likely that the Group 4 standard will include a resolution higher than the 200 lpi Group 3 resolution. Unfortunately there is little hard data regarding the legibility/ quality of digital facsimile systems at varying resolutions. It is recommended that such a study be undertaken covering the resolutions range from 200 to 400 lines/inch or higher. Delta Information Systems is now performing a contract (DCA100-80-C-0042) for the National Communications System to generate this data. The final report is scheduled to be issued March 31, 1981.

-COMPRESSION BY SYMBOL RECOGNITION -- It is likely that the basic compression algorithm for Group 4 will be an extension of the Modified READ code. However, as pointed out in Section 5.0, the feature/symbol recognition technique is very attractive for operation over data networks and for future integration with word processing systems. Unfortunately there has been relatively little general analysis of this compression technique. It is recommended that a very preliminary study be undertaken to investigate one of the fundamental issues in symbol recognition system--i.e., how to segment the image into graphic and symbol parts and how to form the structure of the transmitted signal. Such a study would not answer all questions related to recognition coding techniques, but it is an important first step.

-THROUGHPUT ANALYSIS -- Packet switched networks have been designed primarily to accommodate short bursty messages between user data terminals and remote host computers. The network has been designed to be very responsive to such short messages in spite of the fact that the storage in the network node is somewhat restricted. Since the length of a facsimile message is extremely large relative to the typical data message, there is some concern about the potential throughput of Group 4 messages through today's data networks. Another source of concern about throughput stems from the potential use of the multi-level communications protocol. Since each protocol layer adds its own header to a message there is a concern about the potential buildup of the communication overhead. It is recommended that these concerns be addressed in an analysis of the potential throughput of Group 4 facsimile.

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APPENDIX A

DRAFT REVISED RECOMMENDATION X.25

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT(DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET MODE ON PUBLIC DATA NETWORKS

A1

Draft Revised Recommendation X.25

X3S37-80-25

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET MODE ON PUBLIC DATA NETWORKS

The establishment in various countries of public data networks providing packet-switching data transmission services creates a need to produce standards to facilitate international interworking.

The CCITT,

considering

a) that Recommendation X.1 includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 defines user facilities, Recommendations X.21 and X.21 *bis* define DTE/DCE physical level interface characteristics, Recommendation X.92 defines the logical control links for packet-switching data transmission services and Recommendation X.96 defines call progress signals;

b) that data terminal equipments operating in the packet mode will send and receive network control information in the form of packets;

c) that certain data terminal equipments operating in the packet mode will use a packet interleaved synchronous data circuit;

d) the desirability of being able to use a single data circuit to a DSE for all user facilities;

e) that Recommendation X.2 designates virtual call and permanent virtual circuit services as essential (E) services to be provided by all networks and designates datagram service as an additional (A) service which may be provided by some networks;

f) the need for defining an international recommendation for the exchange between DTE and DCE of control information for the use of packet-switching data transmission services;

g) that the necessary elements for an interface recommendation should be defined independently as:

Physical Level - The mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link between the DTE and the DCE.

Link Level - The link access procedure for data interchange across the link between the DTE and the DCE.

Packet Level - The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE.

(unanimously) declares the view

that for data terminal equipments operating in the packet mode:

1. The mechanical, electrical, functional and procedural characteristics to activate, maintain, and deactivate the physical link between the DTE and the DCE should be as specified in 1 below, *DTE/DCE interface characteristics.*

2. The link access procedure for data interchange across the link between the DTE and the DCE should be as specified in 2 below, *Link access procedure across the DTE/DCE interface.*

3. The packet level procedures for the exchange of control information and user data at the DTE/DCE interface should be as specified in 3 below, *Description of the packet level DTE/DCE interface.*

4. The procedures for virtual call and permanent virtual circuit services should be as specified in 4 below, *Procedures for virtual circuit services.*

5. The procedures for datagram service should be as specified in 5. below *Procedures for datagram service.*

6. The format for packets exchanged between the DTE and the DCE should be as specified in 6 below, *Packet formats.*

7. Procedures and formats for optional user facilities should be as specified in 7 below, *Procedures and formats for optional user facilities.*

CONTENTS

1. DTE/DCE INTERFACE CHARACTERISTICS (PHYSICAL LEVEL)

The DTE/DCE physical interface characteristics defined as the Physical Level element shall be in accordance with Recommendation X.21. For an interim period, some Administrations or RPOAs may offer a DTE/DCE interface at this level in accordance with Recommendation X.21 bis. The exact use of the relevant sections is detailed below.

1.1 The Interface Characteristics for a DTE Connected to a Packet Switched Data Transmission Service by a Dedicated Circuit

1.1.1 X.21

1.1.1.1 The DTE/DCE physical interface elements shall be according to section 2 of Recommendation X.21.

1.1.1.2 The operation of test loops shall be according to section 7 of Recommendation X.21.

1.1.1.3 The procedures for entering operational phases shall be as follows:

a) When the DTE signals c = ON, signals on circuit T shall be according to the higher level procedures described in the following sections of this Recommendation.

b) When the DCE signals i = ON, signals on circuit R shall be according to the higher level procedures described in the following sections of this Recommendation.

c) The DTE/DCE interface should normally remain in the operational condition with both c = ON and i = ON to enable proper operation of the higher level procedures described in the following sections of this Recommendation.

d) If a situation necessitates the DTE to signal DTE ready or DTE uncontrolled not ready, or the DCE to signal DCE ready or DCE not ready, the interface should return to the operational condition with both c = ON and i = ON when the situation is appropriate to enable normal operation of higher level procedures described in the following sections of this Recommendation.

1.1.2 X.21 bis

1.1.2.1 The DTE/DCE physical interface elements shall be according to section 1 of Recommendation X.21 bis.

1.1.2.2 Failure detection and fault isolation shall be according to section 3 of Recommendation X.21 bis.

1.1.2.3 When circuits 105, 106, 107, 108 and 109 are in the ON condition, signals on circuits 103 and 104 shall be according to the higher level procedures described in the following sections of this Recommendation.

1.2 The Interface Characteristics and Procedures for a DTE Connected to a Packet Switched Data Transmission Service through a Circuit Switched Data Transmission Service

Note: The full interworking regarding the user facilities and architectural aspects of the following interface characteristics and procedures are a subject of further study.

1.2.1 X.21

1.2.1.1 The DTE/DCE physical interface elements shall be according to section 2 of Recommendation X.21. The procedures for circuit switched access shall be according to sections 3, 4, 5.1 and 6 of Recommendation X.21.

1.2.1.2 The operation of test loops shall be according to section 7 of Recommendation X.21.

1.2.1.3 When c = ON and i = ON (X.21 state 12 or 13), signals on circuits T and R shall be according to the higher level procedures described in the following sections of this Recommendation.

1.2.2 X.21 bis

1.2.2.1 The DTE/DCE physical interface elements and call establishment procedures shall be according to section 2 of Recommendation X.21 bis.

1.2.2.2 Failure detection and fault isolation shall be according to section 3 of Recommendation X.21 bis.

1.2.2.3 When circuits 105, 106, 107, 108 and 109 are in the ON condition, signals on circuits 103 and 104 shall be according to the higher level procedures described in the following sections of this Recommendation.

2. LINK ACCESS PROCEDURE ACROSS THE DTE/DCE INTERFACE

2.1 Scope and Field of Application

2.1.1 The link access procedures (LAP and LAPB) are described as the Link Level elements and are used for data interchange between a DCE and a DTE operating in user classes of service 8 to 11 as indicated in Recommendation X.1.

2.1.2 The procedures use the principle and terminology of the High Level Data Link Control (HDLC) procedure specified by the International Organization for Standardization (ISO).

2.1.3 The transmission facility is duplex.

2.1.4 DCE compatibility of operation with the ISO balanced class of procedure (Class BA, options 2,8) is achieved using the provisions found under the headings annotated as "applicable to LAPB" in this Recommendation.

DTE manufacturers and implementors must be aware that the procedure hereunder described as LAPB will be the only one available in all networks.

Likewise, a DTE may continue to use the provisions found under the heading annotated as "applicable to LAP" in this Recommendation (in those networks supporting such a procedure), but for new DTE implementations, LAPB should be preferred.

Note: Other possible applications for further study are, for example:

- two-way alternate, asynchronous response mode
- two-way simultaneous, normal response mode
- two-way alternate, normal response mode

2.2 Frame Structure

2.2.1 All transmissions are in frames conforming to one of the formats of Table 2.1/X.25. The flag preceding the address field is defined as the opening flag.

TABLE 2.1/X.25 - Frame formats

Bit order of transmission	12345678	12345678	12345678	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	FCS 16-bits	F 01111110

FCS=frame checking sequence

Bit order of transmission	12345678	12345678	12345678		16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	I N-bits	FCS 16-bits	F 01111110

FCS=frame checking sequence

2.2.2 Flag Sequence

All frames shall start and end with the flag sequence consisting of one 0 followed by six contiguous 1s and one 0. A single flag may be used as both the closing flag for one frame and the opening flag for the next frame.

2.2.3 Address Field

The address field shall consist of one octet. The coding of the address field is described in 2.4.2 below.

2.2.4 Control Field

The control field shall consist of one octet. The content of this field is described in 2.3.2 below.

Note: The use of the extended control field is a subject for further study.

2.2.5 Information Field

The information field of a frame is unrestricted with respect to code or grouping of bits except for the packet formats specified in 3 below.

See 2.3.4.10 and 2.4.11.3 below with regard to the maximum information field length.

2.2.6 Transparency

The DTE or DCE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS sequences and shall insert a 0 bit after all sequences of 5 contiguous 1 bits (including the last 5 bits of the FCS) to ensure that a flag sequence is not simulated. The DTE or DCE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows 5 contiguous 1 bits.

2.2.7 Frame Checking Sequence (FCS)

The FCS shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

1. The remainder of $x^k(x^{15} + x^{14} + x^{13} + \ldots + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, and

2. the remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the content of the frame, existing between but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation, at the transmitter, the initial remainder of the division is preset to all ones and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16 bit FCS sequence.

At the receiver, the initial remainder is preset to all ones, and the serial incoming protected bits and the FCS when divided by the generator polynomial will result in a remainder of 0001110100001111 (x15 through x0, respectively) in the absence of transmission errors.

2.2.8 Order of Bit Transmission

Addresses, commands, responses and sequence numbers shall be transmitted with the low order bit first (for example the first bit of the sequence number that is transmitted shall have the weight 2^0).

The order of transmitting bits within the information field is not specified under 2 of this Recommendation. The FCS shall be transmitted to the line commencing with the coefficient of the highest term.

Note: The low order bit is defined as bit 1, as depicted in Tables 2.1/X.25 to 2.4/X.25.

2.2.9 Invalid Frames

A frame not properly bounded by two flags, or having fewer than 32 bits between flags, is an invalid frame.

2.2.10 Frame Abortion

Aborting a frame is performed by transmitting at least seven contiguous 1s (with no inserted 0s).

2.2.11 Interframe Time Fill

Interframe time fill is accomplished by transmitting contiguous flags between frames.

2.2.12 Link Channel States

2.2.12.1 Active Channel State

A channel is in an active condition when the DTE or DCE is actively transmitting a frame, an abortion sequence or interframe time fill.

2.2.12.2 Idle Channel State

A channel is defined to be in an idle condition when a contiguous 1s state is detected that persists for at least 15 bit times.

Note 1: The action to be taken upon detection of the idle channel state is a subject for further study.

Note 2: A link channel as defined here is the means of transmission for one direction.

2.3 Elements of Procedure

2.3.1 The elements of procedure are defined in terms of actions that occur on receipt of commands at a DTE or DCE.

The elements of procedure specified below contain a selection of commands and responses relevant to the link and system configuration described in 2.1 above.

A procedure is derived from these elements of procedure and is described in 2.4 below. Together 2.2 and 2.3 form the general requirements for the proper management of the access link.

2.3.2 Control Field Formats and State Variables

2.3.2.1 Control Field Formats

The control field contains a command or a response, and sequence numbers where applicable.

Three types of control field formats (see Table 2.2/X.25) are used to perform numbered information transfer (I frames), numbered supervisory functions (S frames) and unnumbered control functions (U frames).

TABLE 2.2/X.25 - Control field formats

Control field bits	1	2	3	4	5	6	7	8
I frame	0		N(S)		P/F		N(R)	
S frame	1	0	S	S	P/F		N(R)	
U frame	1	1	M	M	P/F	M	M	M

N(S) = transmitter send sequence number (bit 2 = low order bit)
N(R) = transmitter receive sequence number (bit 6 = low order bit)
S = supervisory function bit
M = modifier function bit
P/F = poll bit when issued as a command, final bit when issued as a response (1 = Poll/Final)

Information transfer format - I

The I format is used to perform an information transfer. The functions of N(S), N(R) and P/F are independent; i.e., each I frame has an N(S), an N(R) which may or may not acknowledge additional frames received by the DTE or DCE, and a P/F bit.

Supervisory format - S

The S format is used to perform link supervisory control functions such as acknowledge I frames, request retransmission of I frames, and to request a temporary suspension of transmission of I frames.

Unnumbered format - U

The U format is used to provide additional link control functions. This format contains no sequence numbers. The encoding of the unnumbered commands is as defined in Table 2.3/X.25.

2.3.2.2 Control Field Parameters

The various parameters associated with the control field formats are described below.

2.3.2.3 Modulus

Each I frame is sequentially numbered and may have the value 0 through modulus minus one (where "modulus" is the modulus of the sequence numbers). The modulus equals 8 and the sequence numbers cycle through the entire range.

2.3.2.4 Frame Variables and Sequence Numbers

2.3.2.4.1 Send State Variable V(S)

The send state variable denotes the sequence number of the next in-sequence I frame to be transmitted. The send state variable can take on the value 0 through modulus minus one. The value of the send state variable is incremented by one with each successive I frame transmission, but at the DCE cannot exceed N(R) of the last received I or S frame by more than the maximum number of outstanding I frames (k). The value of k is defined in 2.4.11.4 below.

2.3.2.4.2 Send Sequence Number N(S)

Only I frames contain N(S), the send sequence number of transmitted frames. Prior to transmission of an in-sequence I frame, the value of N(S) is updated to equal the value of the send state variable.

2.3.2.4.3 Receive State Variable V(R)

The receive state variable denotes the sequence number of the next in-sequence I frame to be received. This receive state variable can take on the values 0 through modulus minus one. The value of the receive state variable is incremented by the receipt of an error free, in-sequence I frame whose send sequence number N(S) equals the receive state variable.

2.3.2.4.4 Receive Sequence Number N(R)

All I frames and S frames contain N(R), the expected sequence number of the next received I frame. Prior to transmission of a frame of the above types, the value of N(R) is updated to equal the current value of the receive state variable. N(R) indicates that the DTE or DCE transmitting the N(R) has correctly received all I frames numbered up to and including N(R) - 1.

2.3.3 Functions of the Poll/Final Bit

The poll/final (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit.

The use of the P/F bit is described in 2.4.3 below.

2.3.4 Commands and Responses

The following commands and responses will be used by either the DTE or DCE and are represented in Table 2.3/X.25.

TABLE 2.3/X.25 - Commands and responses

Format	Commands	Responses	Encoding 1	2	3	4	5	6	7	8
Information transfer	I (information)		0	N(S)			P	N(R)		
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	P/F	N(R)		
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	P/F	N(R)		
	REJ (reject)	REJ (reject)	1	0	0	1	P/F	N(R)		
Unnumbered	SARM (set asynchronous response mode)	DM (disconnected mode)	1	1	1	1	P/F	0	0	0
	SABM (set asynchronous balanced mode)		1	1	1	1	P	1	0	0
	DISC (disconnect)		1	1	0	0	P	0	1	0
		UA (unnumbered acknowledgement)	1	1	0	0	F	1	1	0
		CMDR (command reject) FRMR (frame reject)	1	1	1	0	F	0	0	1

Note 1: The need for, and use of, additional commands and responses are for further study.

Note 2: DTEs do not have to implement both SARM and SABM; furthermore DM and SABM need not be used if SARM only is used.

Note 3: RR, RNR and REJ supervisory command frames are not used by the DCE when SARM is used (LAP).

The commands and responses are as follows:

2.3.4.1 <u>Information (I) Command</u>

The function of the information (I) command is to transfer across a data link sequentially numbered frames containing an information field.

2.3.4.2 <u>Receive Ready (RR) Command and Response</u>

The receive ready (RR) supervisory frame is used by the DTE or DCE to:

1) indicate it is ready to receive an I frame;

2) acknowledge previously received I frames numbered up to and including N(R) - 1.

RR may be used to clear a busy condition that was initiated by the transmission of RNR. The RR command with the P bit set to 1 may be used by the DTE or DCE to ask for the status of the DCE, or DTE, respectively.

2.3.4.3 <u>Reject (REJ) Command and Response</u>

The reject (REJ) supervisory frame is used by the DTE or DCE to request retransmission of I frames starting with the frame numbered N(R). I frames numbered N(R) - 1 and below are acknowledged. Additional I frames pending initial transmission may be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer may be established at any time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) equal to the N(R) of the REJ. The REJ command with the P bit set to 1 may be used by the DTE or DCE to ask for the status of the DCE or DTE, respectively.

2.3.4.4 <u>Receive Not Ready (RNR) Command and Response</u>

The receive not ready (RNR) supervisory frame is used by the DTE or DCE to indicate a busy condition; i.e., temporary inability to accept additional incoming I frames. I frames numbered up to and including N(R) - 1 are acknowledged. I frame N(R) and subsequent I frames received, if any, are not acknowledged; the acceptance status of these I frames will be indicated in subsequent exchanges.

An indication that the busy condition has cleared is communicated by the transmission of a UA, RR, REJ or SABM. The RNR command with the P bit set to 1 may be used by the DTE or DCE to ask for the status of the DCE or DTE, respectively.

2.3.4.5 Set Asynchronous Response Mode (SARM) Command

The SARM unnumbered command is used to place the addressed DTE or DCE in the asynchronous response mode (ARM) information transfer phase.

No information field is permitted with the SARM command. A DTE or DCE confirms acceptance of SARM by the transmission at the first opportunity of a UA response. Upon acceptance of this command the DTE or DCE receive state variable V(R) is set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.6 Set Asynchronous Balanced Mode (SABM) Command

The SABM unnumbered command is used to place the addressed DTE or DCE in the asynchronous balanced mode (ABM) information transfer phase.

No information field is permitted with the SABM command. A DTE or DCE confirms acceptance of SABM by the transmission at the first opportunity of a UA response. Upon acceptance of this command the DTE or DCE send state variable V(S) and receive state variable V(R) are set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.7 Disconnect (DISC) Command

The DISC unnumbered command is used to terminate the mode previously set. It is used to inform the DTE or DCE receiving the DISC that the DTE or DCE sending the DISC is suspending operation. No information field is permitted with the DISC command. Prior to actioning the command, the DTE or DCE receiving the DISC confirms the acceptance of DISC by the transmission of a UA response. The DTE or DCE sending the DISC enters the disconnected phase when it receives the acknowledging UA response.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.8 Unnumbered Acknowledge (UA) Response

The UA unnumbered response is used by the DTE or DCE to acknowledge the receipt and acceptance of the U format commands. Received U format commands are not actioned until the UA response is transmitted. The UA response is transmitted as directed by the received U format command. No information field is permitted with the UA response.

2.3.4.9 Disconnected Mode (DM) Response

The DM response is used to report a status where the DTE or DCE is logically disconnected from the link, and is in the disconnected phase. The DM response is sent in this phase to request a set mode command, or, if sent in response to the reception of a set mode command, to inform the DTE or DCE that the DCE or DTE, respectively, is still in disconnected phase and cannot action the set mode command. No information field is permitted with the DM response.

A DTE or DCE in a disconnected phase will monitor received commands, and will react to SABM as outlined in 2.4.5 below and will respond DM to any other command received with the P bit set to 1.

2.3.4.10 Command Reject (CMDR) Response
Frame Reject (FRMR) Response

The CMDR (FRMR) response is used by the DTE or DCE to report an error condition not recoverable by retransmission of the identical frame; i.e., one of the following conditions, which results from the receipt of a frame without FCS error:

1. the receipt of a command or response that is invalid or not implemented;

2. the receipt of an I frame with an information field which exceeds the maximum established length;

3. the receipt of an invalid N(R). (In the case of LAP, see 2.4.8.1)

4. the receipt of a frame with an information field which is not permitted or the receipt of an S or U frame with incorrect length.

An invalid N(R) is defined as one which points to an I frame which has previously been transmitted and acknowledged or to an I frame which has not been transmitted and is not the next sequential I frame pending transmission.

An information field which immediately follows the control field, and consists of 3 octets, is returned with this response and provides the reason for the CMDR (FRMR) response. This format is given in Table 2.4/X.25.

TABLE 2.4/X.25 - CMDR (FRMR) information field format

Information field bits

1 2 3 4 5 6 7 8	9	10 11 12	13	14 15 16	17	18	19	20	21	22	23	24
Rejected frame control field	0	V(S)	see Note	V(R)	W	X	Y	Z	0	0	0	0

- Rejected frame control field is the control field of the received frame which caused the command (frame) reject.

- V(S) is the current send state variable value at the DTE or DCE reporting the rejection condition (bit 10 = low order bit).

- V(R) is the current receive state variable value at the DTE or DCE reporting the rejection condition (bit 14 = low order bit).

- W set to 1 indicates that the control field received and returned in bits 1 through 8 was invalid or not implemented.

- X set to 1 indicates that the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted or is an S or U frame with incorrect length. Bit W must be set to 1 in conjunction with this bit.

- Y set to 1 indicates that the information field received exceeded the maximum established capacity of the DTE or DCE reporting the rejection condition.

- Z set to 1 indicates that the control field received and returned in bits 1 through 8 contained an invalid N(R).

<u>Note</u>: Bits 9, 13, 21 to 24 shall be set to 0 for CMDR. For FRMR, bits 9, 21 to 24 shall be set to 0. Bit 13 shall be set to 1 if the frame rejected was a response, and set to 0 if the frame rejected was a command.

2.3.5 Exception Condition Reporting and Recovery

The error recovery procedures which are available to effect recovery following the detection/occurrence of an exception condition at the link level are described below. Exception conditions described are those situations which may occur as the result of transmission errors, DTE or DCE malfunction or operational situations.

2.3.5.1 Busy Condition

The busy condition results when a DTE or DCE is temporarily unable to continue to receive I frames due to internal constraints, e.g., receive buffering limitations. In this case an RNR frame is transmitted from the busy DCE or DTE. I frames pending transmission may be transmitted from the busy DTE or DCE prior to or following the RNR. Clearing of the busy condition is indicated as described in 2.3.4.4 above.

2.3.5.2 N(S) Sequence Error

The information field of all I frames whose N(S) does not equal the receive state variable V(R) will be discarded.

An N(S) sequence exception condition occurs in the receiver when an I frame received error-free (no FCS error) contains an N(S) which is not equal to the receive state variable at the receiver. The receiver does not acknowledge (increment its receive state variable) the I frame causing the sequence error, or any I frame which may follow, until an I frame with the correct N(S) is received.

A DTE or DCE which receives one or more I frames having sequence errors but otherwise error-free shall accept the control information contained in the N(R) field and the P bit to perform link control functions; e.g., to receive acknowledgement of previously transmitted I frames and to cause the DTE or DCE to respond (P bit set to 1). Therefore, the retransmitted I frame may contain an N(R) field and P bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frame.

2.3.5.3 REJ Recovery

The REJ is used to initiate an exception recovery (retransmission) following the detection of a sequence error.

Only one "sent REJ" exception condition from a DTE or DCE is established at a time. A sent REJ exception condition is cleared when the requested I frame is received.

A DTE or DCE receiving REJ initiates sequential (re-)transmission of I frames starting with the I frame indicated by the N(R) obtained in the REJ frame.

2.3.5.4 Time-out Recovery

If a DTE or DCE, due to a transmission error, does not receive (or receives and discards) a single I frame or the last I frame in a sequence of I frames, it will not detect an out-of-sequence exception condition and therefore will not transmit REJ. The DTE or DCE which transmitted the unacknowledged I frame(s) shall, following the completion of a system specified time-out period (see 2.4.11.1 below), take appropriate recovery action to determine at which I frame retransmission must begin.

2.3.5.5 FCS Error and Invalid Frame

Any frame received with an FCS error or which is invalid (see 2.2.9 above) will be discarded and no action is taken as the result of that frame.

2.3.5.6 Rejection Condition

A rejection condition is established upon the receipt of an error free frame which contains an invalid command/response in the control field, an invalid frame format, an invalid N(R) (however see 2.4.8.1 below for LAP application) or an information field which exceeds the maximum information field length which can be accommodated.

At the DTE or DCE, this exception is reported by a CMDR (FRMR) response for appropriate DCE or DTE action, respectively. Once a DCE has established a CMDR (FRMR) exception, no additional I frames are accepted, until the condition is reset by the DTE, except for examination of the P bit (LAPB) or examination of the P bit and N(R) (LAP). The CMDR (FRMR) response may be repeated at each opportunity until recovery is effected by the DTE, or until the DCE initiates its own recovery.

2.4 Description of the Procedure

2.4.1 Procedure to Set the Mode Variable B (Applicable if Both LAP and LAPB are Implemented)

The DCE will maintain an internal mode variable B, which it will set as follows:

- to 1, upon acceptance of an SABM command from the DTE

- to 0, upon acceptance of an SARM command from the DTE.

Changes to the mode variable B by the DTE should occur only when the link has been disconnected as described in 2.4.4.3 or 2.4.5.3 below.

Should a DCE malfunction occur, the internal mode variable B will upon restoration of operation, but prior to link set-up by the DTE, be initially set to 1.

Whenever B is 1, the DCE will use the LAPB link set-up and disconnection procedure and is said to be in the LAPB (balanced) mode.

Whenever B is 0, the DCE will use the LAP link set-up and disconnection procedure, and is said to be in the LAP mode.

The following are applicable to both LAP and LAPB modes: 2.4.2, 2.4.3, 2.4.6, 2.4.11.

The following are applicable only to the LAP mode: 2.4.4, 2.4.7, 2.4.8.

The following are applicable only to the LAPB mode: 2.4.5, 2.4.9, 2.4.10.

2.4.2 Procedure for Addressing (Applicable to Both LAP and LAPB)

Frames containing commands transferred from the DCE to the DTE will contain the address A.

Frames containing responses transferred from the DTE to the DCE shall contain the address A.

Frames containing commands transferred from the DTE to the DCE shall contain the address B.

Frames containing responses transferred from the DCE to the DTE will contain the address B.

A and B addresses are coded as follows:

Address	1	2	3	4	5	6	7	8
A	1	1	0	0	0	0	0	0
B	1	0	0	0	0	0	0	0

Note: The DCE will discard all frames receive with an address other than A or B; the DTE should do the same.

2.4.3 Procedure for the Use of the P/F Bit (Applicable to Both LAP and LAPB)

The DTE or DCE receiving a SARM, SABM, DISC, supervisory command or an I frame with the P bit set to 1, will set the F bit to 1 in the next response frame it transmits.

The response frame returned by the DCE to a SARM, SABM or DISC command with the P bit set to 1 will be a UA (or DM) response with the F bit set to 1. The response frame returned by the DCE to an I frame with the P bit set to 1 will be an RR, REJ or RNR or CMDR or FRMR response format with the F bit set to 1.

The response frame returned by the DCE to a supervisory command frame with the P bit set to 1 will be an RR, RNR or CMDR or FRMR response with the F bit set to 1.

The P bit may be used by the DCE in conjunction with the timer recovery condition (see 2.4.6.8 below).

<u>Note</u> Other use of the P bit by the DCE is a subject for further study.

2.4.4 <u>Procedure for Link Set-up and Disconnection (Applicable to LAP)</u>

2.4.4.1 <u>Link Set-up</u>

The DCE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

The DTE shall indicate a request for setting up the link by transmitting a SARM command to the DCE.

Whenever receiving a SARM command, the DCE will return a UA response to the DTE and set its receive state variable V(R) to 0.

Should the DCE wish to indicate a request for setting up the link, or after transmission of a UA response to a first SARM command from the DTE as a request for setting up the link, the DCE will transmit a SARM command to the DTE and start Timer T1 (see 2.4.11.1 below). The DTE will confirm the reception of the SARM command by transmitting a UA response.

When receiving the UA response the DCE will set its send state variable to 0 and stop its Timer T1. If Timer T1 runs out before the UA response is received by the DCE, the DCE will retransmit a SARM command and restart Timer T1.

After transmission of SARM N2 times by the DCE, appropriate recovery action will be initiated.

The value of N2 is defined in 2.4.11.2 below.

2.4.4.2 <u>Information Transfer Phase</u>

After having both received a UA response to a SARM command transmitted to the DTE and transmitted a UA response to a SARM command received from the DTE, the DCE will accept and transmit I and S frames according to the procedures described in 2.4.6

below.

When receiving a SARM command, the DCE will conform to the resetting procedure described in 2.4.7 below. The DTE may also receive a SARM command according to this resetting procedure.

2.4.4.3 Link Disconnection

During the information transfer phase the DTE shall indicate a request for disconnecting the link by transmitting a DISC command to the DCE.

Whenever receiving a DISC command, the DCE will return a UA response to the DTE.

During an information transfer phase, should the DCE wish to indicate a request for disconnecting the link, or when receiving from the DTE a first DISC command as a request for disconnecting the link, the DCE will transmit a DISC command to the DTE and start Timer T1 (2.4.11.1 below). The DTE will confirm reception of the DISC command by returning a UA response. After transmitting a SARM command, the DCE will not transmit a DISC command until a UA response is received for this SARM command or until Timer T1 runs out.

When receiving a UA response to the DISC command, the DCE will stop its Timer T1. If Timer T1 runs out before a UA response is received by the DCE, the DCE will transmit a DISC command and restart Timer T1. After transmission of DISC N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5 Procedures for Link Set-up and Disconnection (Applicable to LAPB)

2.4.5.1 Link Set-up

The DCE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

Whenever receiving an SABM command, the DCE will return a UA response to the DTE and set both its send and receive state variables V(S) and V(R) to 0.

Should the DCE wish to set-up the link, it will send the SABM command and start Timer T1 (see 2.4.11.1 below). Upon reception of the UA response from the DTE the DCE resets both its send and receive state variables V(S) and V(R) to 0 and stops its Timer T1.

Should T1 expire before reception of the UA response from the DTE, the DCE will retransmit the SABM command and restart Timer T1. After transmission of the SABM command N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5.2 Information Transfer Phase

After having transmitted the UA response to an SABM command or having received the UA response to a transmitted SABM command, the DCE will accept and transmit I and S frames according to the procedures described in 2.4.6 below.

When receiving an SABM command while in the information transfer phase, the DCE will conform to the resetting procedure described in 2.4.9 below.

2.4.5.3 Link Disconnection

During the information transfer phase, the DTE shall indicate disconnecting of the link by transmitting a DISC command to the DCE.

When receiving a DISC command, the DCE will return a UA response to the DTE and enter the disconnected phase.

Should the DCE wish to disconnect the link, it will send the DISC command and start Timer T1 (see 2.4.11.1 below). Upon reception of the UA response from the DTE, the DCE will stop its Timer T1.

Should Timer T1 expire before reception of the UA response from the DTE, the DCE will retransmit the DISC command and restart Timer T1. After transmission of the DISC command N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5.4 Disconnected Phase

2.4.5.4.1 After having received a DISC command from the DTE and returned a UA response to the DTE, or having received the UA response to a transmitted DISC command, the DCE will enter the disconnected phase.

In the disconnected phase, the DCE may initiate link set-up. In the disconnected phase, the DCE will react to the receipt of an SABM command as described in 2.4.5.1 above and will transmit a DM response in answer to a received DISC command.

When receiving any other command frame with the P bit set to 1, the DCE will transmit a DM response with the F bit set to 1.

Other frames received in the disconnected phase will be ignored by the DCE.

2.4.5.4.2 When the DCE enters the disconnected phase after detecting error conditions as listed in 2.4.10 below, or exceptionally after recovery from an internal temporary malfunction it may also indicate this by sending a DM response rather than a DISC command. In these cases, the DCE will transmit DM and start its Timer T1 (see 2.4.11.1 below). If Timer T1 runs out before the reception of an SABM or DISC command from the DTE, the DCE will retransmit the DM response and restart Timer T1.

After transmission of the DM response N2 times, the DCE will remain in the disconnected phase and appropriate recovery actions will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5.5 Collision of Unnumbered Commands

Collision situations shall be resolved in the following way.

2.4.5.5.1 If the sent and received U commands are the same, the DTE and DCE shall send the UA response at the earliest possible opportunity. The DCE shall enter the indicated phase after receiving the UA response.

2.4.5.5.2 If the sent and received U commands are different, the DTE and DCE shall enter the disconnected phase and issue a DM response at the earliest possible opportunity.

2.4.5.6 Collision of DM Response with SABM or DISC Command

When a DM response is issued by the DCE as an unsolicited response to request the DTE to issue a mode-setting command as described in 2.4.5.4.2, a collision between a SABM or DISC command issued by the DTE and the unsolicited DM response issued by the DCE may occur. In order to avoid misinterpretation of the DM received, it is suggested that the DTE always will send its SABM or DISC command with the P bit set to 1.

2.4.6 Procedures for Information Transfer (Applicable to Both LAP and LAPB)

The procedures which apply to the transmission of I frames in each direction during the information transfer phase are described below.

In the following, "number one higher" is in reference to a continuously repeated sequence series, i.e., 7 is one higher than 6 and 0 is one higher than 7 for modulo eight series.

2.4.6.1 Sending I Frames

When the DCE has an I frame to transmit (i.e., an I frame not already transmitted, or having to be retransmitted as described in 2.4.6.5 below), it will transmit it with an N(S) equal to its current send state variable V(S), and an N(R) equal to its current receive state variable V(R). At the end of the transmission of the I frame, it will increment its send state variable V(S) by one.

If the Timer T1 is not running at the instant of transmission of an I frame, it will be started.

If the send state variable V(S) is equal to the last value of N(R) received plus k (where k is the maximum number of outstanding I frames - see 2.4.11.4 below) the DCE will not transmit any new I frames, but may retransmit an I frame as described in 2.4.6.5 or 2.4.6.8 below.

Note: In order to ensure security of information transfer, the DTE should not transmit any I frame if its send state variable V(S) is equal to the last value of N(R) it has received from the DCE plus 7.

When the DCE is in the busy condition it may still transmit I frames, provided that the DTE is not busy itself. When the DCE is in the command rejection condition (LAP), it may still transmit I frames. When the DCE is in the frame rejection condition (LAPB), it will stop transmitting I frames.

2.4.6.2 Receiving an I Frame

2.4.6.2.1 When the DCE is not in a busy condition and receives with the correct FCS an I frame whose send sequence number is equal to the DCE receive state variable V(R), the DCE will accept the information field of this frame, increment by one its receive state variable V(R), and act as follows:

i) If an I frame is available for transmission by the DCE, it may act as in 2.4.6.1 above and acknowledge the received I frame by setting N(R) in the control field of the next transmitted I frame to the value of the DCE receive state variable V(R). The DCE may also acknowledge the received I frame by transmitting an RR with the N(R) equal to the value of the DCE receive state variable V(R).

ii) If no I frame is available for transmission by the DCE, it will transmit an RR with the N(R) equal to the value of the DCE receive state variable V(R).

2.4.6.2.2 When the DCE is in a busy condition, it may ignore the information field contained in any received I frame.

Note: Zero length information fields shall not be passed to the Packet Level and this situation should be indicated to the Packet Level.

2.4.6.3 Reception of Incorrect Frames

When the DCE receives a frame with an incorrect FCS or receives an invalid frame (see 2.2.9), this frame will be discarded.

When the DCE receives an I frame whose FCS is correct, but whose send sequence number is incorrect, i.e., not equal to the current DCE receive state variable V(R), it will discard the information field of the frame and transmit an REJ response with the N(R) set to one higher than the N(S) of the last correctly received I frame. The DCE will then discard the information field of all I frames until the expected I frame is correctly received. When receiving the expected I frame, the DCE will then acknowledge the frame as described in 2.4.6.2 above. The DCE will use the N(R) and P bit indications in the discarded I frames.

2.4.6.4 Receiving Acknowledgement

When correctly receiving an I or S frame (RR, RNR or REJ), even in the busy or command rejection condition, the DCE will consider the N(R) contained in this frame as an acknowledgement for all the I frames it has transmitted with an N(S) up to and including the received N(R) minus one. The DCE will reset the Timer T1 when it correctly receives an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some I frames).

If the timer has been reset, and if there are outstanding I frames still unacknowledged, it will restart the Timer T1. If the timer then runs out, the DCE will follow the retransmission procedure (in 2.4.6.5 and 2.4.6.8 below) with respect to the unacknowledged I frames.

2.4.6.5 Receiving Reject

When receiving an REJ, and DCE will set its send state variable V(S) to the N(R) received in the REJ control field. It will transmit the corresponding I frame as soon as it is available or retransmit it. (Re)transmission will conform to the following:

i) If the DCE is transmitting a supervisory or unnumbered command or response when it receives the REJ, it will complete that transmission before commencing transmission of the requested I frame.

ii) If the DCE is transmitting an I frame when the REJ is received, it may abort the I frame and commence transmission of the requested I frame immediately after abortion.

iii) If the DCE is not transmitting any frame when the REJ is received, it will commence transmission of the requested I frame immediately.

In all cases, if other unacknowledged I frames had already been transmitted following the one indicated in the REJ, then those I frames will be retransmitted by the DCE following the retransmission of the requested I frame.

If the REJ frame was received from the DTE as a command with the P bit set to 1, the DCE will transmit an RR or RNR response with the F bit set to 1 before transmitting or retransmitting the corresponding I frame.

2.4.6.6 Receiving RNR

After receiving an RNR, the DCE may transmit or retransmit the I frame with the send sequence number equal to the N(R) indicated in the RNR. If the Timer T1 runs out after the reception of RNR, the DCE will follow the procedure described in 2.4.6.8 below. In any case the DCE will not transmit any other I frames before receiving an RR or REJ.

2.4.6.7 DCE Busy Condition

When the DCE enters a busy condition, it will transmit an RNR response at the earliest opportunity. While in the busy condition, the DCE will accept and process S frames and return an RNR response with the F bit set to 1 if it receives an S or I command frame with the P bit set to 1. To clear the busy condition, the DCE will transmit either an REJ response or an RR response with N(R) set to the current receive state variable V(R) depending on whether or not it discarded information fields of correctly received I frames.

Note: The DTE when encountering a DCE busy condition, may send supervisory command frames with the P bit set to 1. In the event that the DTE has not implemented supervisory commands, it may follow the procedures of the DCE (see 2.4.6.6) (applicable to LAPB).

2.4.6.8 Waiting Acknowledgement

The DCE maintains an internal retransmission count variable which is set to 0 when the DCE receives a UA or RNR, or when the DCE correctly receives an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some outstanding I frames).

If the Timer T1 runs out, the DCE will (re-)enter the timer recovery condition, add one to its retransmission count variable and set an internal variable X to the current value of its send state variable.

The DCE will restart Timer T1, set its send state variable to the last N(R) received from the DTE and retransmit the corresponding I frame with the P bit set to 1 (LAP or LAPB) or transmit an appropriate supervisory command with the P bit set to 1 (LAPB only).

The timer recovery condition is cleared when the DCE receives a valid S frame from the DTE, with the F bit set to 1.

If, while in the timer recovery condition, the DCE correctly receives a supervisory frame with the F bit set to 1 and with the N(R) within the range from its current send state variable to X included, it will clear the timer recovery condition and set its send state variable to the received N(R).

If, while in the timer recovery condition, the DCE correctly receives a supervisory frame with the F bit set to 0 and with an N(R) within the range from its current send state variable to X included, it will not clear the timer recovery condition. The received N(R) may be used to update the send state variable. However, the DCE may decide to keep the last transmitted I frame in store (even if it is acknowledged) in order to be able to retransmit it with the P bit set to 1 when Timer T1 expires at a later time.

If the retransmission count variable is equal to N2, the DCE initiates a resetting procedure for the direction of transmission from the DCE as described in 2.4.7.3, 2.4.9.2 or 2.4.9.3 below. N2 is a system parameter (see 2.4.11.2 below).

Note: Although the DCE will implement the internal variable X, other mechanisms do exist that achieve the identical functions. Therefore, the internal variable X is not necessarily implemented in the DTE.

2.4.7 Procedures for Resetting (Applicable to LAP)

2.4.7.1 The resetting procedure is used to reinitialize one direction of information transmission, according to the procedure described below. The resetting procedure only applies during the information transfer phase.

2.4.7.2 The DTE will indicate a resetting of the information transmission from the DTE by transmitting an SARM command to the DCE. When receiving an SARM command, the DCE will return, at the earliest opportunity, a UA response to the DTE and set its receive state variable V(R) to 0. This also indicates a clearance of the DCE busy condition, if present.

2.4.7.3 The DCE will indicate a resetting of the information transmission from the DCE by transmitting an SARM command to the DTE and will start Timer T1 (see 2.4.11.1 below). The DTE will confirm reception of the SARM command by returning a UA response to the DCE. When receiving this UA response to the SARM command, the DCE will set its send state variable to 0 and stop its Timer T1. If Timer T1 runs out before the UA response is received by the DCE, the DCE will retransmit an SARM command and restart Timer T1. After transmission of SARM N2 times, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

The DCE will not act on any received response frame which arrives before the UA response to the SARM command. The value of N(R) contained in any correctly received I command frames arriving before the UA response will also be ignored.

2.4.7.4 When receiving a CMDR response from the DTE, the DCE will initiate a resetting of the information transmission from the DCE as described in 2.4.7.3 above.

2.4.7.5 If the DCE transmits a CMDR response, it enters the command rejection condition. This command rejection condition is cleared when the DCE receives an SARM or DISC command. Any other command received while in the command rejection condition will cause the DCE to retransmit this CMDR response. The coding of the CMDR response will be as described in 2.3.4.10 above.

2.4.8 Rejection Conditions (Applicable to LAP)

2.4.8.1 Rejection Conditions Causing a Resetting of the Transmission of Information from the DCE

The DCE will initiate a resetting procedure as described in 2.4.7.3 above when receiving a frame with the correct FCS, with the address A (coded 1 1 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the responses used;

- the information field is invalid;

- the N(R) contained in the control field is invalid;

- the response contains an F bit set to 1 except during a timer recovery condition as described in 2.4.6.8 above.

The DCE will also initiate a resetting procedure as described in 2.4.7.3 above when receiving an I frame with correct FCS, with the address B (coded 1 0 0 0 0 0 0 0) and with an invalid N(R) contained in the control field.

A valid N(R) must be within the range from the lowest send sequence number N(S) of the still unacknowledged frame(s) to the current DCE send state variable included, even if the DCE is in a rejection condition, but not if the DCE is in the timer recovery condition (see 2.4.6.8 above).

2.4.8.2 Rejection Conditions Causing the DCE to Request a Resetting of the Transmission of Information from the DTE

The DCE will enter the command rejection condition as described in 2.4.7.5 above when receiving a frame with the correct FCS, with the address B (coded 1 0 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the commands used;

- the information field is invalid.

2.4.9 Procedures for Resetting (Applicable to LAPB)

2.4.9.1 The resetting procedures are used to initialize both directions of information transmission according to the procedure described below. The resetting procedures only apply during the information transfer phase.

2.4.9.2 The DTE or DCE shall indicate a resetting by transmitting an SABM command. After receiving an SABM command, the DCE or DTE, respectively, will return, at the earliest opportunity, a UA response to the DTE or DCE, respectively, and reset its send and receive state variables V(S) and V(R) to 0. This also clears a DCE and/or DTE busy condition, if present. Prior to initiating this link resetting procedure, the DTE or DCE may initiate a disconnect procedure as described in 2.4.5.3 above.

2.4.9.3 Under certain rejection conditions listed in 2.4.6.8 above and 2.4.10.2 below, the DCE may ask the DTE to reset the link by transmitting a DM response.

After transmitting a DM response, the DCE will enter the disconnected phase as described in 2.4.5.4.2 above.

2.4.9.4 Under certain rejection conditions listed in 2.4.10.1 below, the DCE may ask the DTE to reset the link by transmitting a FRMR response.

After transmitting a FRMR response, the DCE will enter the frame rejection condition. The frame rejection condition is cleared when the DCE receives an SABM or DISC command or DM response. Any other command received while in the frame rejection condition will cause the DCE to retransmit the FRMR response with the same information field as originally transmitted.

The DCE may start a Timer T1 on transmission of the FRMR response. If Timer T1 runs out before the reception of an SABM or DISC command from the DTE, the DCE may retransmit the FRMR response and restart Timer T1. After transmission of the FRMR response N2 times the DCE may reset the link as described in 2.4.9.2 above. The value of N2 is defined in 2.4.11.2 below.

2.4.10 Rejection Conditions (Applicable to LAPB)

2.4.10.1 The DCE will initiate a resetting procedure as described in 2.4.9.4 above, when receiving, during the information transfer phase, a frame with the correct FCS, with the address A or B, and with one of the following conditions:

- the frame is unknown as a command or as a response;
- the information field is invalid;
- the N(R) contained in the control field is invalid as described in 2.4.8.1 above.

The coding of the information field of the FRMR response which is transmitted is given in 2.3.4.10 above. Bit 13 of this information field is set to 0 if the address of the rejected frame is B. It is set to 1 if the address is A.

2.4.10.2 The DCE will initiate a resetting procedure as described in 2.4.9.2 or 2.4.9.3 above when receiving during the information transfer phase a DM response or a FRMR response.

The DCE may initiate a resetting procedure as described in 2.4.9.2 or 2.4.9.3 above when receiving during the information transfer phase a UA response or an unsolicited response with the F bit set to 1.

2.4.11 List of System Parameters (Applicable to Both LAP and LAPB)

The system parameters are as follows:

2.4.11.1 Timer T1

The period of the Timer T1 will take into account whether the timer is started at the beginning or the end of the frame in the DCE.

The period of the Timer T1, at the end of which retransmission of a frame may be initiated according to the procedures described in 2.4.4 to 2.4.6 above, is a system parameter agreed for a period of time with the Administration.

The proper operation of the procedure requires that Timer T1 be greater than the maximum time between transmission of frames (SARM, SABM, DM, DISC, FRMR, I or supervisory commands) and the reception of the corresponding frame returned as an answer to this frame (UA, DM or acknowledging frame). Therefore, the DTE should not delay the response or acknowledging frame returned to the above frames by more than a value T2 less than T1, where T2 is a system parameter.

The DCE will not delay the response or acknowledging frame returned to a command by more than T2.

2.4.11.2 Maximum Number of Transmissions N2

The value of the maximum number N2 of transmission and retransmissions of a frame following the running out of Timer T1 is a system parameter agreed for a period of time with the Administration.

2.4.11.3 Maximum Number of Bits in an I Frame N1

The maximum number of bits in an I frame is a system parameter which depends upon the maximum length of the information fields transferred across the DTE/DCE interface.

2.4.11.4 Maximum Number of Outstanding I Frames k

The maximum number (k) of sequentially numbered I frames that the DTE or DCE may have outstanding (i.e., unacknowledged) at any given time is a system parameter which can never exceed seven. It shall be agreed for a period of time with the Administration.

Note: As a result of the further study proposed in 2.2.4 above, the permissible maximum number of outstanding I frames may be increased.

3. DESCRIPTION OF THE PACKET LEVEL DTE/DCE INTERFACE

This and subsequent sections of the recommendation relate to the transfer of packets at the DTE/DCE interface. The procedures apply to packets which are successfully transferred across the DTE/DCE interface.

Each packet to be transferred across the DTE/DCE interface shall be contained within the link level information field which will delimit its length, and only one packet shall be contained in the information field.

Note 1: Possible insertion of more than one packet in the link level information field is for further study.

Note 2: At present, some networks require the data fields of packets to contain an integral number of octets. The transmission by the DTE of data fields not containing an integral number of octets to the network may cause a loss of data integrity.

Under urgent study are further considerations regarding the trends of future requirements and implementations toward either bit-orientation (any number of bits) or octet-orientation (an integral number of octets) for data fields in X.25 packets.

DTEs wishing universal operation on all networks should transmit all packets with data fields containing only an integral number of octets. Full data integrity can only be assured by exchange of octet-oriented data fields in both directions of transmission.

This section covers a description of the packet level interface for virtual call, permanent virtual circuit and datagram services. As designated in Recommendation X.2, virtual call and permanent virtual circuit services are essential (E) services to be provided by all networks. Datagram service is designated as an additional (A) service which may be provided by some networks.

Note: Under study are considerations regarding the amount of possible duplication between datagram, fast select and possible additional virtual call enhancements with the objective to minimize the variety of interfaces.

Procedures for virtual circuit service (i.e., virtual call and permanent virtual circuit services) are specified in section 4. Procedures for the datagram service are specified in section 5. Packet formats for all services are specified in section 6. Procedures and formats for optional user facilities are specified in section 7.

3.1 Logical Channels

To enable simultaneous virtual calls and/or permanent virtual circuits and/or datagrams, logical channels are used. Each virtual call, permanent virtual circuit, and datagram channel is assigned a Logical Channel Group Number (less than or equal to 15) and a Logical Channel Number (less than or equal to 255). For virtual calls, a Logical Channel Group Number and a Logical Channel Number are assigned during the call set-up phase. The range of logical channels used for virtual calls is agreed with the Administration at the time of subscription to the service (see Annex 1). For permanent virtual circuits and datagram channels, Logical Channel Group Numbers and Logical Channel Numbers are assigned in agreement with the Administration at the time of subscription to the service (see Annex 1).

3.2 Basic Structure of Packets

Every packet transferred across the DTE/DCE interface consists of at least 3 octets. These three octets contain a general format identifier, a logical channel identifier and a packet type identifier. Other packet fields are appended as required (see section 6).

Packet types and their use in association with various services are given in Table 3.1/X.25.

TABLE 3.1/X.25

PACKET TYPES AND THEIR USE IN VARIOUS SERVICES

PACKET TYPE		SERVICE		
FROM DCE TO DTE	FROM DTE TO DCE	VC	PVC	DG*
CALL SET-UP AND CLEARING (Note 1)				
INCOMING CALL	CALL REQUEST	X		
CALL CONNECTED	CALL ACCEPTED	X		
CLEAR INDICATION	CLEAR REQUEST	X		
DCE CLEAR CONFIRMATION	DTE CLEAR CONFIRMATION	X		
DATA AND INTERRUPT (Note 2)				
DCE DATA	DTE DATA	X	X	
DCE INTERRUPT	DTE INTERRUPT	X	X	
DCE INTERRUPT CONFIRMATION	DTE INTERRUPT CONFIRMATION	X	X	
DATAGRAM (Note 3)				
DCE DATAGRAM	DTE DATAGRAM			X
DATAGRAM SERVICE SIGNAL				X
FLOW CONTROL AND RESET (Note 4)				
DCE RR	DTE RR	X	X	X
DCE RNR	DTE RNR	X	X	X
	DTE REJ*	X	X	X
RESET INDICATION	RESET REQUEST	X	X	X
DCE RESET CONFIRMATION	DTE RESET CONFIRMATION	X	X	X
RESTART (Note 5)				
RESTART INDICATION	RESTART REQUEST	X	X	X
DCE RESTART CONFIRMATION	DTE RESTART CONFIRMATION	X	X	X
DIAGNOSTIC (Note 6)				
DIAGNOSTIC*		X	X	X

* Not necessarily available on all networks.

VC = Virtual call
PVC = Permanent virtual circuit
DG = Datagram

Note 1: See sections 4.1 and 7.2.4 for procedures and sections 6.2 and 6.8.2 for formats.

Note 2: See section 4.3 for procedures and section 6.3 for formats.

Note 3: See section 5.1 for procedures and section 6.4 for formats.

Note 4: See sections 4.4, 5.2 and 7.1.4 for procedures and section 6.5 and 6.8.1 for formats.

Note 5: See section 3.3 for procedures and section 6.6 for formats.

Note 6: See section 3.4 for procedures and section 6.7 for formats.

3.3 Procedure for Restart

The restart procedure is used to initialize or re-initialize the packet level DTE/DCE interface. The restart procedure simultaneously clears all the virtual calls and resets all the permanent virtual circuits and datagram channels at the DTE/DCE interface (see sections 4.5 and 5.3).

Annex 2, Figure A2.1/X.25 gives the state diagram which defines the logical relationships of events related to the restart procedure.

Annex 3, Table A3.2/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE for the restart procedure. Details of the action which should be taken by the DTE are for further study.

3.3.1 Restart by the DTE

The DTE may at any time request a restart by transferring across the DTE/DCE interface a RESTART REQUEST packet. The interface for each logical channel is then in the DTE RESTART REQUEST state (r2).

The DCE will confirm the restart by transferring a DCE RESTART CONFIRMATION packet placing the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1).

Note: States p1 and d1 are specified in sections 4 and 5.

The DCE RESTART CONFIRMATION packet can only be interpreted universally as having local significance. The time spent in the DTE RESTART REQUEST state (r2) will not exceed time-limit T20 (see Annex 4).

3.3.2 Restart by the DCE

The DCE may indicate a restart by transferring across the DTE/DCE interface a RESTART INDICATION packet. The interface for each logical channel is then in the DCE RESTART INDICATION state (r3). In this state of the DTE/DCE interface, the DCE will ignore all packets except for RESTART REQUEST and DTE RESTART CONFIRMATION.

The DTE will confirm the restart by transferring a DTE RESTART CONFIRMATION packet placing the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1).

The action taken by the DCE when the DTE does not confirm the restart within time-out T10 is given in Annex 4.

3.3.3 Restart Collision

Restart collision occurs when a DTE and a DCE simultaneously transfer a RESTART REQUEST and a RESTART INDICATION packet. Under this circumstance, the DCE will consider that the restart is completed. The DCE will not expect a DTE RESTART CONFIRMATION packet and will not transfer a DCE RESTART CONFIRMATION packet. This places the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1).

3.4 Error Handling

Table A3.1/X.25 specifies the reaction of the DCE when special error conditions are encountered. Other error conditions are discussed in sections 4 and 5.

3.4.1 Diagnostic Packet

The DIAGNOSTIC packet is used by some networks to indicate error conditions under circumstances when the usual methods of indication (i.e., reset, clear and restart with cause and diagnostic) are inappropriate (see Tables A3.1/X.25 and A4.1/X.25). The DIAGNOSTIC packet from the DCE supplies information on error situations which are considered unrecoverable at the packet level of X.25; the information provided permits an analysis of the error and recovery by higher levels at the DTE if desired or possible.

A DIAGNOSTIC packet is issued only once per particular instance of an error condition. No confirmation is required to be issued by the DTE on receipt of a DIAGNOSTIC packet. After issuance of a DIAGNOSTIC packet, the DCE maintains the logical channel(s) to

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which the DIAGNOSTIC packet is related in the same state as that when the DIAGNOSTIC packet was generated.

3.5 Effects of the Physical Level and the Link Level on the Packet Level

Changes of operational states of the physical level and the link level of the DTE/DCE interface do not implicitly change the state of each logical channel at the packet level. Such changes when they occur are explicitly indicated at the packet level by the use of restart, clear or reset procedures as appropriate.

A failure on the physical and/or link level is defined as a condition in which the DCE cannot transmit and receive any frames because of abnormal conditions caused by, for instance, a line fault between DTE and DCE.

When a failure on the physical and/or link level is detected, virtual calls will be cleared, permanent virtual circuits will be declared out of order and queued datagrams will be discarded. Further actions are specified in section 4.6 for virtual circuit services and in section 5.4 for the datagram service.

When the failure is recovered on physical and link levels, the DCE will send a RESTART INDICATION packet with the cause "Network operational" to the local DTE. Further actions are specified in section 4.6 for virtual circuit services and in section 5.4 for the datagram service.

In other out of order conditions on the physical and/or link level, including transmission of a DISC command by the DTE, the behavior of the DCE is for further study.

4. PROCEDURES FOR VIRTUAL CIRCUIT SERVICES

4.1 Procedures for Virtual Call Service

Annex 2, Figures A2.1/X.25, A2.2/X.25 and A2.3/X.25 show the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel used for virtual calls.

Annex 3 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 2. Details of the actions which should be taken by the DTE are for further study.

The call set-up and clearing procedures described in the following sections apply independently to each logical channel assigned to virtual call service at the DTE/DCE interface.

4.1.1 Ready State

If there is no call in existence, a logical channel is in the READY state (p1).

4.1.2 Call Request Packet

The calling DTE shall indicate a call request by transferring a CALL REQUEST packet across the DTE/DCE interface. The logical channel selected by the DTE is then in the DTE WAITING state (p2). The CALL REQUEST packet includes the called DTE address. The calling DTE address field may also be used.

Note 1: A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

Note 2: The CALL REQUEST packet should use the logical channel in the READY state with the highest number in the range which has been agreed with the Administration (see Annex 1). Thus the risk of call collision is minimized.

4.1.3 Incoming Call Packet

The DCE will indicate that there is an incoming call by transferring across the DTE/DCE interface an INCOMING CALL packet. This places the logical channel in the DCE WAITING state (p3).

The INCOMING CALL packet will use the logical channel in the READY state with the lowest number (see Annex 1). The INCOMING CALL packet includes the calling DTE address. The called DTE address field may also be used.

Note: A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

4.1.4 Call Accepted Packet

The called DTE shall indicate its acceptance of the call by transferring across the DTE/DCE interface a CALL ACCEPTED packet specifying the same logical channel as that of the INCOMING CALL packet. This places the specified logical channel in the DATA TRANSFER state (p4).

If the called DTE does not accept the call by a CALL ACCEPTED packet or does not reject it by a CLEAR REQUEST packet as described in section 4.1.7 within time-out T11 (see Annex 4), the DCE will consider it as a procedure error from the called DTE and will clear the virtual call according to the procedure described in section 4.1.8.

4.1.5 Call Connected Packet

The receipt of a CALL CONNECTED packet by the calling DTE specifying the same logical channel as that specified in the CALL REQUEST packet indicates that the call has been accepted by the called DTE by means of a CALL ACCEPTED packet. This places the specified logical channel in the DATA TRANSFER state (p4).

The time spent in the DTE WAITING state (p2) will not exceed time-limit T21 (see Annex 4).

4.1.6 Call Collision

Call collision occurs when a DTE and DCE simultaneously transfer a CALL REQUEST packet and an INCOMING CALL packet specifying the same logical channel. The DCE will proceed with the call request and cancel the incoming call.

4.1.7 Clearing by the DTE

At any time the DTE may indicate clearing by transferring across the DTE/DCE interface a CLEAR REQUEST packet (see section 4.5). The logical channel is then in the DTE CLEAR REQUEST state (p6). When the DCE is prepared to free the logical channel, the DCE will transfer across the DTE/DCE interface a DCE CLEAR CONFIRMATION packet specifying the logical channel. The logical channel is now in the READY state (p1).

The DCE CLEAR CONFIRMATION packet can only be interpreted universally as having local significance, however within some Administration's networks clear confirmation may have end to end significance. In all cases the time spent in the DTE CLEAR REQUEST state (p6) will not exceed time-limit T23 (see Annex 4).

It is possible that subsequent to transferring a CLEAR REQUEST packet the DTE will receive other types of packets, dependent on the state of the logical channel, before receiving a DCE CLEAR CONFIRMATION packet.

Note: The calling DTE may abort a call by clearing it before it has received a CALL CONNECTED or CLEAR INDICATION packet.

The called DTE may refuse an incoming call by clearing it as described in this section rather than transmitting a CALL ACCEPTED packet as described in section 4.1.4.

4.1.8 Clearing by the DCE

The DCE will indicate clearing by transferring across the DTE/DCE interface a CLEAR INDICATION packet (see section 4.5). The logical channel is then in the DCE CLEAR INDICATION state (p7). The DTE shall respond by transferring across the DTE/DCE interface a

DTE CLEAR CONFIRMATION packet. The logical channel is now in the READY state (p1).

The action taken by the DCE when the DTE does not confirm clearing within time-out T13 is given in Annex 4.

4.1.9 Clear Collision

Clear collision occurs when a DTE and a DCE simultaneously transfer a CLEAR REQUEST packet and a CLEAR INDICATION packet specifying the same logical channel. Under this circumstance the DCE will consider that the clearing is completed. The DCE will not expect a DTE CLEAR CONFIRMATION packet and will not transfer a DCE CLEAR CONFIRMATION packet. This places the logical channel in the READY state (p1).

4.1.10 Unsuccessful Call

If a call cannot be established, the DCE will transfer a CLEAR INDICATION packet specifying the logical channel indicated in the CALL REQUEST packet.

4.1.11 Call Progress Signals

The DCE will be capable of transferring to the DTE clearing call progress signals as specified in Recommendation X.96.

Clearing call progress signals will be carried in CLEAR INDICATION packets which will terminate the call to which the packet refers. The method of coding CLEAR INDICATION packets containing call progress signals is detailed in section 6.2.3.

4.1.12 Data Transfer State

The procedures for the control of packets between DTE and DCE while in the DATA TRANSFER state are contained in section 4.3.

4.2 Procedures for Permanent Virtual Circuit Service

Annex 2, Figures A2.1/X.25 and A2.3/X.25 show the state diagrams which give a definition of events at the packet level DTE/DCE interface for logical channels assigned for permanent virtual circuits.

Annex 3 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 2. Details of the action which should be taken by the DTE are for further study.

For permanent virtual circuits there is no call set-up or clearing. The procedures for the control of packets between DTE and DCE while in the DATA TRANSFER state are contained in section 4.3.

4.3 Procedures for Data and Interrupt Transfer

The data transfer and interrupt procedures described in the following subsections apply independently to each logical channel assigned for virtual calls or a permanent virtual circuit existing at the DTE/DCE interface.

Normal network operation dictates that user data in data and interrupt packets are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications. Order of bits in data packets is preserved. Packet sequences are delivered as complete packet sequences. DTE Diagnostic Codes are treated as described in sections 6.2.3, 6.5.3 and 6.6.1.

4.3.1 States for Data Transfer

A virtual call logical channel is in the DATA TRANSFER state (p4) after completion of call establishment and prior to a clearing or a restart procedure. A permanent virtual circuit logical channel is continually in the DATA TRANSFER state (p4) except during the restart procedure. Data, interrupt, flow control and reset packets may be transmitted and received by a DTE in the DATA TRANSFER state of a logical channel at the DTE/DCE interface. In this state, the flow control and reset procedures described in section 4.4 apply to data transmission on that logical channel to and from the DTE.

When a virtual call is cleared, data and interrupt packets may be discarded by the network (see section 4.5). In addition data, interrupt, flow control and reset packets transmitted by a DTE will be ignored by the DCE when the logical channel is in the DCE CLEAR INDICATION state (p7). Hence it is left to the DTE to define DTE to DTE protocols able to cope with the various possible situations that may occur.

4.3.2 User Data Field Length of Data Packets

The standard maximum User Data field length is 128 octets.

In addition, other maximum User Data field lengths may be offered by Administrations from the following list: 16, 32, 64, 256, 512 and 1024 octets. An optional maximum User Data field length may be selected for a period of time as the default maximum User Data field length common to all virtual calls at the DTE/DCE interface (see section 7.2.1). A value other than the default may be selected for a period of time for each permanent virtual circuit (see section 7.2.1). Negotiation of maximum User Data field lengths on a per call basis may be made with the Flow Control Parameter Negotiation facility (see section 7.2.2).

The User Data field of data packets transmitted by a DTE or DCE may contain any number of bits up to the agreed maximum.

Note: At present, some networks require the User Data field to contain an integral number of octets (see section 3, Note 2).

If the User Data field in a data packet exceeds the locally permitted maximum User Data field length, then the DCE will reset the virtual call or permanent virtual circuit with the resetting cause "Local procedure error".

4.3.3 Delivery Confirmation Bit

The setting of the Delivery Confirmation bit (D bit) is used to indicate whether or not the DTE wishes to receive an end-to-end acknowledgment of delivery, for data it is transmitting, by means of the packet receive sequence number P(R) (see section 4.4).

Note 1: The use of the D bit procedure does not obviate the need for a higher level protocol agreed between the communicating DTEs which may be used with or without the D bit procedure to recover from user or network generated resets and clearings.

Note 2: After January 1982, the D bit procedure should be considered an integral part of this Recommendation. In the interim period, the D bit procedure will be available on some Public Data Networks and between some pairs of Public Data Networks on a bilateral basis.

During the interim period, Administrations of networks which do not provide the D bit procedure should be consulted to determine whether the significance of P(R) is a local updating of the window across the packet level DTE/DCE interface or conveys an end-to-end acknowledgement of delivery of data.

In order to facilitate the orderly introduction of the D bit procedures in DTEs and DCEs, the following mechanisms are provided.

The calling DTE can ascertain during call establishment that the D bit procedure can be used for the call by setting bit 7 in the General Format Identifier of the CALL REQUEST packet to 1 (see section 6.1.1). Every network or part of international network where the D bit procedure is available will pass this bit transparently. If the remote DTE is able to handle the D bit procedure, it should not regard this bit being set to 1 in the INCOMING CALL packet as invalid.

Likewise, the called DTE can set bit 7 in the General Format Identifier of the CALL ACCEPTED packet to 1. Every network or part of international network where the D bit is available will pass this bit transparently. If the calling DTE is able to handle the D bit procedure, it should not regard this bit being set to 1 in the CALL CONNECTED packet as invalid.

If any network along the path does not support the D bit procedure, this would be indicated by call clearing by the DCE with a cause indicating "Incompatible destination" and the diagnostic "Invalid general format identifier" or by any other means to indicate an invalid general format identifier at a DTE/DCE interface (see Table A3.1/X.25).

The use by the DTEs of the above mechanism in the CALL REQUEST and CALL ACCEPTED packets is recommended but is not mandatory for using the D bit procedure during the virtual call.

If a D bit is set to 1 in a data packet on a virtual call or permanent virtual circuit where the D bit is not available, this will be indicated to both DTEs by a RESET INDICATION packet with the cause "Incompatible destination" and the diagnostic "Invalid general format identifier", or by any other means to indicate an invalid general format identifier at a DTE/DCE interface (see Table A3.1/X.25).

4.3.4 More Data Mark

If a DTE or DCE wishes to indicate a sequence of more than one packet, it uses a More Data mark (M bit) as defined below.

The M bit can be set to 1 in any data packet. When it is set to 1 in a full data packet or in a partially full data packet also carrying the D bit set to 1, it indicates that more data is to follow. Recombination with the following data packet may be only performed within the network when the M bit is set to 1 in a full data packet which also has the D bit set to 0.

A sequence of data packets with every M bit set to 1 except for the last one will be delivered as a sequence of data packets with the M bit set to 1 except for the last one when the original packets having the M bit set to 1 are either full (irrespective of the setting of the D bit) or partially full but have the D bit set to 1.

Two categories of data packets, A and B, have been defined as shown in Table 4.1/X.25. Table 4.1/X.25 also illustrates the network's treatment of the M and D bits at both ends of a virtual call or permanent virtual circuit.

TABLE 4.1/X.25

DEFINITION OF TWO CATEGORIES OF DATA PACKETS
AND NETWORK TREATMENT OF THE M and D BITS

Data Packet Sent by Source DTE				Combining with Subsequent Packet(s) is Performed by the Network when Possible	Data Packet* Received by Destination DTE	
Category	M	D	Full		M	D
B	0 or 1	0	No	No	0	0
B	0	1	No	No	0	1
B	1	1	No	No	1	1
B	0	0	Yes	No	0	0
B	0	1	Yes	No	0	1
A	1	0	Yes	Yes (see Note)	1	0
B	1	1	Yes	No	1	1

* Refers to the delivered data packet whose last bit of user data corresponds to the last bit of user data, if any, that was present in the data packet sent by the source DTE.

Note: If the data packet sent by the source DTE is combined with other packets, up to and including a category B packet, the M and D bit settings in the data packet received by the destination DTE will be according to that given in the two right hand columns for the last data packet sent by the source DTE that was part of the combination.

4.3.5 Complete Packet Sequence

A complete packet sequence is defined as being composed of a single category B packet and all contiguous preceeding category A packets (if any). Category A packets have the exact maximum User Data field length with the M bit set to 1 and the D bit set to 0. All other data packets are category B packets.

When transmitted by a source DTE, a complete packet sequence is always delivered to the destination DTE as a single complete packet sequence.

Thus, if the receiving end has a larger maximum data field length than the transmitting end, then packets within a complete packet sequence will be combined within the network. They will be delivered in a complete packet sequence where each packet, except the last one, has the exact maximum data field length, the M bit set to 1, and the D bit set to 0. The User Data field of the last packet of the sequence may have less than the maximum length and the M and D bits are set as described in Table 4.1/X.25.

If the maximum data field length is the same at both ends, then data fields of data packets are delivered to the receiving DTE exactly as they have been received by the network, except as follows. If a full packet with the M bit set to 1 and the D bit set to 0 is followed by an empty packet, then the two packets may be merged so as to become a single category B full packet. If the last packet of a complete packet sequence transmitted by the source DTE has a User Data field less than the maximum length with the M bit set to 1 and the D bit set to 0, then the last packet of the complete packet sequence delivered to the receiving DTE will have the M bit set to 0.

If the receiving end has a smaller maximum data field length than the transmitting end, then packets will be segmented within the network, and the M and D bits set by the network as described to maintain complete packet sequences.

4.3.6 Qualifier Bit

A complete packet sequence may be on one of two levels. If a DTE wishes to transmit data on more than one level, it uses an indicator called the Qualifier bit (Q bit).

When only one level of data is being transmitted on a logical channel, the Qualifier bit is always set to 0. If two levels of data are being transmitted, the transmitting DTE should set the Qualifier bit in all data packets of a complete packet sequence to the same value, either 0 or 1. A complete packet sequence, which is transmitted with the Qualifier bit set to the same value in all packets, is delivered by the network as a complete packet sequence with the Qualifier bit set in all packets to the value assigned by the transmitting DTE.

The action of the network when the Qualifier bit is not set to the same value by the transmitting DTE within a complete packet sequence is left for further study.

Recommendation X.29 gives an example of the procedures to be used when the Qualifier bit is set to 1.

Packets are numbered consecutively (see section 4.4.1.1) regardless of their data level.

4.3.7 Interrupt Procedure

The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to data packets (see section 4.4). The interrupt procedure can only apply in the FLOW CONTROL READY state (d1) within the DATA TRANSFER state (p4).

The interrupt procedure has no effect on the transfer and flow control procedures applying to the data packets on the virtual call or permanent virtual circuit.

To transmit an interrupt, a DTE transfers across the DTE/DCE interface a DTE INTERRUPT packet. The DTE should not transmit a second DTE INTERRUPT packet until the first one is confirmed with a DCE INTERRUPT CONFIRMATION packet (see Note 2 to Table A3.4/X.25). The DCE, after the interrupt procedure is completed at the remote end, will confirm the receipt of the interrupt by transferring a DCE INTERRUPT CONFIRMATION packet. The receipt of a DCE INTERRUPT CONFIRMATION packet indicates that the interrupt has been confirmed by the remote DTE by means of a DTE INTERRUPT CONFIRMATION packet.

The DCE indicates an interrupt from the remote DTE by transferring across the DTE/DCE interface a DCE INTERRUPT packet containing the same data field as in the DTE INTERRUPT packet transmitted by the remote DTE. A DCE INTERRUPT packet is delivered at or before the point in the stream of data packets at which the DTE INTERRUPT packet was generated. The DTE will confirm the receipt of the DCE INTERRUPT packet by transferring a DTE INTERRUPT CONFIRMATION packet.

4.4 Procedures for Flow Control

This subsection only applies to the DATA TRANSFER state (p4) and specifies the procedures covering flow control of data packets and reset on each logical channel used for a virtual call or a permanent virtual circuit.

4.4.1 Flow Control

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit, the transmission of data packets is controlled separately for each direction and is based on authorizations from the receiver.

On a virtual call or permanent virtual circuit, flow control also allows a DTE to limit the rate at which the remote DTE can transmit data packets. This is achieved by the receiving DTE controlling the rate at which it accepts packets across the DTE/DCE interface, noting that there is a network-dependent limit on the number of data packets which may be in the network on the virtual call or permanent virtual circuit.

4.4.1.1 Numbering of Data Packets

Each data packet transmitted at the DTE/DCE interface for each direction of transmission in a virtual call or permanent virtual circuit is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo 8. The packet sequence numbers cycle through the entire range 0 to 7. Some Administrations will provide the Extended Packet Sequence Numbering facility (see section 7.1.1) which, if selected, provides a sequence numbering scheme for packets being performed modulo 128. In this case, packet sequence numbers cycle through the entire range 0 to 127. The packet sequence numbering scheme, modulo 8 or 128, is the same for both directions of transmission and is common for all logical channels at the DTE/DCE interface.

Only data packets contain this sequence number called the packet send sequence number P(S).

The first data packet to be transmitted across the DTE/DCE interface for a given direction of data transmission, when the logical channel has just entered the FLOW CONTROL READY state (d1), has a packet send sequence number equal to 0.

4.4.1.2 Window Description

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit and for each direction of data transmission, a window is defined as the ordered set of W consecutive packet send sequence numbers of the data packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. When a virtual call or permanent virtual circuit at the DTE/DCE interface has just entered the FLOW CONTROL READY state (d1), the window related to each direction of data transmission has a lower window edge equal to 0.

The packet send sequence number of the first data packet not authorized to cross the interface is the value of the lower window edge plus W (modulo 8, or 128 when extended).

The standard window size W is 2 for each direction of data transmission at the DTE/DCE interface. In addition, other window sizes may be offered by Administrations. An optional window size may be selected for a period of time as the default window size common to all virtual calls at the DTE/DCE interface (see section 7.1.2). A value other than the default may be selected for a period of time for each permanent virtual circuit (see section 7.1.2). Negotiation of window sizes on a per call basis may be made with the Flow Control Parameter Negotiation facility (see section 7.2.2).

4.4.1.3 Flow Control Principles

When the sequence number P(S) of the next packet to be transmitted by the DCE is within the window, the DCE is authorized to transmit this data packet to the DTE. When the sequence number P(S) of the next data packet to be transmitted by the DCE is outside of the window, the DCE shall not transmit a data packet to the DTE. The DTE should follow the same procedure.

When the sequence number P(S) of the data packet received by the DCE is the next in sequence and is within the window, the DCE will accept this data packet. A received data packet containing a P(S) that is out of sequence (i.e., there is a duplicate or a gap in the P(S) numbering), outside the window, or not equal to 0 for the first data packet after entering the FLOW CONTROL READY state (dl) is considered by the DCE as a local procedure error. The DCE will reset the virtual call or permanent virtual circuit (see section 4.4.3). The DTE should follow the same procedure.

Some networks do not invoke the error procedure on receipt of a data packet containing a P(S) that is out of sequence but is within the window. These networks may pass on such packets to the remote DTE in order to make it possible for the local DTE to retransmit packets on virtual calls or permanent virtual circuits (within the national network).

A number (modulo 8, or 128 when extended), referred to as a packet receive sequence number P(R), conveys across the DTE/DCE interface information from the receiver for the transmission of data packets. When transmitted across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional data packets may be authorized by the receiver to cross the DTE/DCE interface.

The packet receive sequence number, P(R), is conveyed in data, receive ready (RR) and receive not ready (RNR) packets.

The value of a P(R) received by the DCE must be within the range from the last P(R) received by the DCE up to and including the packet send sequence number of the next data packet to be transmitted by the DCE. Otherwise, the DCE will consider the receipt of this P(R) as a procedure error and will reset the virtual call or permanent virtual circuit. The DTE should follow the same procedure.

The receive sequence number P(R) is less than or equal to the sequence number of the next expected data packet and implies that the DTE or DCE transmitting P(R) has accepted <u>at least</u> all data packets numbered up to and including P(R)-1.

4.4.1.4 Delivery Confirmation

When the D bit is set to 0 in a data packet having P(S) = p, the significance of the returned P(R) corresponding to that data packet [i.e., P(R) $\geq$ p+1] is a local updating of the window across the packet level interface so that the achievable throughput is not constrained by the DTE-to-DTE round trip delay across the network(s).

When the D bit is set to 1 in a data packet having P(S) = p, the significance of the returned P(R) corresponding to that data packet [i.e., P(R) $\geq$ p+1] is an indication that a P(R) has been received fr[illegible] the remote DTE for all data bits in the data packet in which the D bit had originally been set to 1.

Note 1: A DTE, on receiving a data packet with the D bit set to 1, should transmit the corresponding P(R) as soon as possible in order to avoid the possibility of deadlocks (e.g., without waiting for further data packets). A data, RR or RNR packet may be used to convey the P(R) (see Note to section 4.4.1.6). Likewise, the DCE is required to send P(R) to the DTE as soon as possible from when the P(R) is received from the remote DTE.

Note 2: In the case where a P(R) for a data packet with the D bit set to 1 is outstanding, local updating of the window will be deferred for subsequent data packets with the D bit set to 0. Some networks may also defer updating the window for previous data packets (within the window) with the D bit set to 0 until the corresponding P(R) for the packet with the outstanding D bit set to 1 is transmitted to the DTE.

Note 3: P(R) values corresponding to the data contained in data packets with the D bit set to 1 need not be the same at the DTE/DCE interfaces at each end of a virtual call or a permanent virtual circuit.

4.4.1.5 DTE and DCE Receive Ready (RR) Packets

RR packets are used by the DTE or DCE to indicate that it is ready to receive the W data packets within the window starting with P(R), where P(R) is indicated in the RR packet.

4.4.1.6 DTE and DCE Receive Not Ready (RNR) Packets

RNR packets are used by the DTE or DCE to indicate a temporary inability to accept additional data packets for a given virtual call or permanent virtual circuit. A DTE or DCE receiving an RNR packet shall stop transmitting data packets on the indicated logical channel, but the window is updated by the P(R) value of the RNR packet. The receive not ready situation indicated by the transmission of an RNR packet is cleared by the transmission in the same direction of an RR packet or by a reset procedure being initiated.

The transmission of an RR packet after an RNR packet at the packet level is not to be taken as a demand for retransmission of packets which have already been transmitted.

Note: The RNR packet may be used to convey across the DTE/DCE interface the P(R) value corresponding to a data packet which had the D bit set to 1 in the case that additional data packets cannot be accepted.

4.4.2 Throughput Characteristics and Throughput Classes

The attainable throughput on virtual calls and permanent virtual circuits carried at the DTE/DCE interface may vary due to the statistical sharing of transmission and switch resources and is constrained by:

(i) the access line characteristics, local window size and traffic characteristics of other logical channels at the local DTE/DCE interface,

(ii) the access line characteristics, local window size and traffic characteristics of other logical channels at the remote DTE/DCE interface, and

(iii) the throughput achievable on the virtual call or permanent virtual circuit through the network(s) independent of interface characteristics including number of active logical channels. This throughput may be dependent on network service characteristics such as window rotation mechanisms and/or optional user facilities requested on national/international calls.

The attainable throughput will also be affected by:

(i) the receiving DTE flow controlling the DCE,

(ii) the transmitting DTE not sending data packets which have the maximum data field length,

(iii) the local DTE/DCE window and/or packet sizes, and

(iv) the use of the D bit.

A throughput class for one direction of transmission is an inherent characteristic of the virtual call or permanent virtual circuit related to the amount of resources allocated to this virtual call or permanent virtual circuit. This characteristic is meaningful when the D bit is set to 0 in data packets. It is a measure of the throughput that is not normally exceeded on the virtual call or permanent virtual circuit. However, due to the statistical sharing of transmission and switching resources, it is not guaranteed that the throughput class can be reached 100% of the time.

Depending on the network and the applicable conditions at the considered moment, the effective throughput may exceed the throughput class.

Note: The definition of throughput class as a grade of service parameter is for further study. The grade of service might be specified when the D bit is set to 0 or over a time period between the completion and initiation of successive D bit procedures.

The throughput class may only be reached if the following conditions are met:

(a) the access data links of both ends of a virtual call or permanent virtual circuit are engineered for the throughput class;

(b) the receiving DTE is not flow controlling the DCE such that the throughput class is not reachable;

(c) the transmitting DTE is sending data packets which have the maximum data field length; and

(d) all data packets transmitted on the virtual call or permanent virtual circuit have the D bit set to 0.

The throughput class is expressed in bits per second. At a DTE/DCE interface, the maximum data field length is specified for a virtual call or permanent virtual circuit, and thus the throughput class can be interpreted by the DTE as the number of full data packets/second that the DTE does not have a need to exceed.

In the absence of the Default Throughput Class Assignment faciltiy (see section 7.1.3), the default throughput classes for both directions of transmission correspond to the user class of service of the DTE (see section 7.4.2.6) but do not exceed the maximum throughput class supported by the network. Negotiation of throughput classes on a per call basis may be made with the Throughput Class Negotiation facility (see section 7.2.3).

Note: The summation of throughput classes of all virtual calls, permanent virtual circuits and datagram logical channels supported at a DTE/DCE interface may be greater than the data transmission rate of the access line.

4.4.3 Procedure for Reset

The reset procedure is used to re-initialize the virtual call or permanent virtual circuit and in so doing removes in each direction all data and interrupt packets which may be in the network (see section 4.5). When a virtual call or permanent virtual circuit at the DTE/DCE interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent data packets to cross the DTE/DCE interface for each direction of data transmission shall start from 0.

The reset procedure can only apply in the DATA TRANSFER state (p4) of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned. For example, when a clearing or restarting procedure is initiated, RESET REQUEST and RESET INDICATION packets can be left unconfirmed.

For flow control, there are three states d1, d2 and d3 within the DATA TRANSFER state (p4). They are FLOW CONTROL READY (d1), DTE RESET REQUEST (d2), and DCE RESET INDICATION (d3) as shown in the state diagram in Annex 2, Figure A2.3/X.25. When entering state p4, the logical channel is placed in state d1. Annex 3, Table A3.4/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

4.4.3.1 Reset Request Packet

The DTE shall indicate a request for reset by transmitting a RESET REQUEST packet specifying the logical channel. This places the logical channel in the DTE RESET REQUEST state (d2).

4.4.3.2 Reset Indication Packet

The DCE shall indicate a reset by transmitting to the DTE a RESET INDICATION packet specifying the logical channel and the reason for the resetting. This places the logical channel in the DCE RESET INDICATION state (d3). In this state, the DCE will ignore data, interrupt, RR and RNR packets.

4.4.3.3 Reset Collision

Reset collision occurs when a DTE and a DCE simultaneously transmit a RESET REQUEST packet and a RESET INDICATION packet specifying the same logical channel. Under this circumstance the DCE will consider that the reset is completed. The DCE will not expect a DTE RESET CONFIRMATION packet and will not transfer a DCE RESET CONFIRMATION packet. This places the logical channel in the FLOW CONTROL READY state (d1).

4.4.3.4 Reset Confirmation Packets

When the logical channel is in the DTE RESET REQUEST state (d2), the DCE will confirm reset by transmitting to the DTE a DCE RESET CONFIRMATION packet. This places the logical channel in the FLOW CONTROL READY state (d1).

The DCE RESET CONFIRMATION packet can only be interpreted universally as having local significance, however within some Administration's networks reset confirmation may have end to end significance. In all cases the time spent in the DTE RESET REQUEST state (d2) will not exceed time-limit T22 (see Annex 4).

When the logical channel is in the DCE RESET INDICATION state (d3), the DTE will confirm reset by transmitting to the DCE a DTE RESET CONFIRMATION packet. This places the logical channel in the FLOW CONTROL READY state (d1). The action taken by the DCE when the DTE does not confirm the reset within time-out T12 is given in Annex 4.

4.5 Effects of Clear, Reset and Restart Procedures on the Transfer of Packets

All data and interrupt packets generated by a DTE (or the network) before initiation by the DTE or the DCE of a clear, reset or restart procedure at the local interface will either be delivered to the remote DTE before the DCE transmits the corresponding indication on the remote interface, or be discarded by the network.

No data or interrupt packets generated by a DTE (or the network) after the completion of a reset (or for permanent virtual circuits also a restart) procedure at the local interface will be delivered to the remote DTE before the completion of the corresponding reset procedure at the remote interface.

When a DTE initiates a clear, reset or restart procedure on its local interface, all data and interrupt packets which were generated by the remote DTE (or the network) before the corresponding indication is transmitted to the remote DTE will be either delivered to the initiating DTE before DCE confirmation of the initial clear, reset or restart request, or be discarded by the network.

Note: The maximum number of packets which may be discarded is a function of network end-to-end delay and throughput characteristics and, in general, has no relation to the local window size. Provision of more precise information is for further study. For virtual calls and permanent virtual circuits on which all data packets are transferred with the D bit set to 1, the maximum number of packets which may be discarded in one direction of transmission is not larger than the window size of the direction of transmission.

4.6 Effects of Physical and Link Level Failures

When a failure on the physical and/or link level is detected, the DCE will transmit to the remote end:

(1) a reset with the cause "Out of order" for each permanent virtual circuit and

(2) a clear with the cause "Out of order" for each existing virtual call.

During the failure, the DCE will clear any incoming virtual calls.

When the failure is recovered on the physical and link levels, the restart procedure will be actioned (see section 3.5) and a reset with the cause "Remote DTE operational" will be transmitted to the remote end of each permanent virtual circuit.

5. PROCEDURES FOR DATAGRAM SERVICE

Annex 2 shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel. Figures A2.1/X.25 and A2.3/X.25 apply to datagram logical channels.

Annex 3 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 2. Details of actions which should be taken by the DTE are for further study.

There is no call set-up or clearing for datagrams.

A DTE DATAGRAM packet includes the destination DTE address; the source DTE address may also be used.

A DCE DATAGRAM packet includes the source DTE address; the destination DTE address may also be used.

Note: A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

5.1 Procedures for Datagram Transfer

The data transfer procedure applies independently to each datagram logical channel existing at the DTE/DCE interface.

Normal network operation dictates that user data in datagram packets are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications.

Order of bits of user data is preserved within a datagram.

5.1.1 States for Data Transfer

Datagram logical channels are continually in the DATA TRANSFER state (p4) except during the restart procedure. Datagram, datagram service signal, flow control, and reset packets may be transmitted and received by a DTE in the DATA TRANSFER state of a datagram logical channel at the DTE/DCE interface. In this state, the flow control and reset procedures described in section 5.2 apply to data transmission on that datagram logical channel to and from the DTE.

5.1.2 User Data Field Length

The maximum User Data field length for datagrams is 128 octets.

The data field of datagram packets transmitted by a DTE or DCE may contain any number of bits up to the maximum.

Note: At present, some networks require the data field to contain an integral number of octets (see section 3, Note 2).

5.1.3 Datagram Identification

Each datagram transmitted at the DTE/DCE interface for each direction of transmission may be uniquely numbered with a datagram identification number. Assignment of the values to the datagram identification is a DTE responsibility and may be assigned according to any algorithm. The network will not operate on the datagram identification except to return the information in the appropriate network generated datagram service signal packet.

5.1.4 Datagram Service Signals

The DCE will be capable of transferring to the DTE service signals as specified in Recommendation X.96. The datagram service signals will be carried in datagram service signal packets. Datagram service signals are of two types - specific and general.

5.1.4.1 Datagram Service Signal - Specific

This is a service signal generated by the network relative to a specific datagram issued by the DTE. There are three classes for this type of service signal:

(a) Datagram rejected - datagram discarded by network; a correction, based on the received cause, is required before trying again.

(b) Datagram non-delivery indication - datagram discarded by network; try again later based on the received cause, next time may be successful.

<u>Note</u>: This class of service signal is only issued by the network when the non-delivery indication facility (see section 7.3.4) has been requested.

(c) <u>Datagram delivery confirmation</u> - datagram has been accepted by the destination DTE.

<u>Note</u>: This class of service signal is only issued by the network when the delivery confirmation facility (see section 7.3.5) has been requested.

Datagram service signal - specific packets will include the address information, if valid, and the datagram identification associated with the original datagram for which the service signal applies. The original destination address is provided in the datagram service signal packet as the source address while the original source address is shown as the destination address, when present.

5.1.4.2 <u>Datagram Service Signal - General</u>

This is a service signal generated by the network relative to datagram operation but not to any specific datagram issued by the DTE.

5.2 <u>Procedures for Flow Control</u>

This subsection only applies to the DATA TRANSFER state (p4) and specifies the procedures covering flow control of datagram and datagram service signal packets and reset on each datagram logical channel.

5.2.1 <u>Flow Control</u>

At the DTE/DCE interface of a datagram logical channel, the transmission of datagram and datagram service signal packets is controlled separately for each direction and is based on authorizations from the receiver. Datagram and datagram service signal packets are referred to below as flow controlled packets.

5.2.1.1 <u>Numbering of Packets</u>

Each datagram and datagram service signal packet transmitted at the DTE/DCE interface for each direction of transmission on a given datagram logical channel is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo 8. The packet sequence numbers cycle through the entire range 0 to 7. Some Administrations will provide the Extended Packet Sequence Numbering facility (see section 7.1.1) which, if selected, provides a sequence numbering scheme for packets being performed modulo 128. In this case, packet sequence numbers cycle through the entire range 0 to 127. The packet sequence numbering scheme, modulo 8 or 128, is the same for both directions of transmission and is common for all logical channels at the DTE/DCE interface.

For datagram service, only datagram and datagram service signal packets contain this sequence number called the packet send sequence number P(S).

The first datagram or datagram service signal packet to be transmitted across the DTE/DCE interface for a given direction of data transmission, when the datagram logical channel has just entered the FLOW CONTROL READY state (d1), has a packet send sequence number equal to 0.

5.2.1.2 Window Description

At the DTE/DCE interface of a datagram logical channel, and for each direction of data transmission, a window is defined as the ordered set of W consecutive packet send sequence numbers of the flow controlled packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. When the datagram logical channel has just entered the FLOW CONTROL READY state (d1), the window related to each direction of data transmission has a lower window edge equal to 0.

The packet send sequence number of the first flow controlled packet not authorized to cross the interface is the value of the lower window edge plus W (modulo 8, or 128 when extended).

The standard window size W is 2 for each direction of data transmission at a DTE/DCE interface. In addition, other window sizes may be offered by Administrations and may be selected for a period of time for each datagram logical channel (see section 7.1.2).

5.2.1.3 Flow Control Principles

When the sequence number of the next flow controlled packet to be transmitted by the DCE is within the window, the DCE is authorized to transmit this flow controlled packet to the DTE. When the sequence number P(S) of the next flow controlled packet to be transmitted by the DCE is outside of the window, the DCE shall not transmit a flow controlled packet to the DTE. The DTE should follow the same procedure.

When the sequence number P(S) of the flow controlled packet received by the DCE is the next in sequence and is within the window, the DCE will accept this flow controlled packet. A received flow controlled packet containing a P(S) that is out of sequence (i.e., there is a duplicate or a gap in the P(S) numbering), outside the window, or not equal to zero for the first flow controlled packet after entering the FLOW CONTROL READY state (d1) is considered by the DCE as a local procedure error. The DCE will reset the datagram logical channel (see section 5.2.3). The DTE should follow the same procedure.

A number (modulo 8, or 128 when extended), referred to as a packet receive sequence number P(R), conveys across the DTE/DCE interface information from the receiver for the transmission of flow controlled packets. When transmitted across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional flow controlled packets may be authorized by the receiver to cross the DTE/DCE interface.

The packet receive sequence number, P(R), is conveyed in datagram, datagram service signal, receive ready (RR) and receive not ready (RNR) packets.

The value of a P(R) received by the DCE must be within the range from the last P(R) received by the DCE up to and including the packet send sequence number of the next flow controlled packet to be transmitted by the DCE. Otherwise, the DCE will consider the receipt of this P(R) as a procedure error and will reset the logical channel. The DTE should follow the same procedure.

The receive sequence number P(R) is less than or equal to the sequence number of the next expected flow controlled packet and implies that the DTE or DCE transmitting P(R) has accepted <u>at least</u> all flow controlled packets numbered up to and including P(R)-1.

The only significance of a P(R) value is a local updating of the window across the packet level interface.

5.2.1.4 Datagram Queue

The network maintains a datagram queue for each datagram logical channel at destination DCE. The maximum length of the queue for each datagram logical channel is agreed for a period of time between the DTE and the Administration (see section 7.3.2).

Datagram service signal packets have priority over other datagram packets and are inserted at the beginning of the queue. This may lead to the DCE discarding the last datagram packet of the queue if the maximum queue length is exceeded. When the queue is full, additional arriving datagrams are discarded.

By agreement for a period of time between the DTE and the Administration (see section 7.3.3), a special datagram logical channel may be assigned for the transmission of datagram service signals. In this case, the maximum length of the queues for datagrams and datagram service signals are independently agreed between the DTE and the Administration.

If the DTE flow controls the receipt of datagram service signal packets, the DCE cannot guarantee to store an indefinite number of service signals. Therefore, there is a possibility of loss of service signal packets at the DCE. A possible coupling mechanism to allow the DCE to regulate the number of datagrams generated by the DTE in relation to the capacity of the DCE to store the datagram service signals will be studied to determine whether such losses at the DCE should be prevented.

5.2.1.5 DTE and DCE Receive Ready (RR) Packets

RR packets are used by the DTE or DCE to indicate that it is ready to receive the W flow controlled packets within the window starting with P(R), where P(R) is indicated in the RR packet.

5.2.1.6 DTE and DCE Receive Not Ready (RNR) Packets

RNR packets are used by the DTE or DCE to indicate a temporary inability to accept additional flow controlled packets for a given datagram logical channel. A DTE or DCE receiving an RNR packet shall stop transmitting flow controlled packets on the indicated datagram logical channel, but the window is updated by the P(R) value of the RNR packet. The receive not ready situation indicated by the transmission of RNR packet is cleared by the transmission in the same direction of an RR packet or by a reset procedure being initiated.

The transmission of an RR after an RNR at the packet level is not to be taken as a demand for retransmission of packets which have already been transmitted.

5.2.2 Throughput Characteristics

Throughput is the effective data transfer rate measured in bits per second.

For each datagram logical channel, a throughput class for each direction of data transmission at the DTE/DCE interface is agreed for a period of time between the DTE and the Administration (see section 7.1.3).

Relating to datagram operation, the following has been identified for further study:

(a) The attainment of throughput on a given datagram logical channel.

(b) The necessity for discriminating between throughput on datagram logical channels compared with logical channels used for virtual calls and permanent virtual circuits.

5.2.3 Procedure for Reset

The reset procedure is used to re-initialize the datagram logical channel. When a datagram logical channel at the DTE/DCE interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent flow controlled packets to cross the DTE/DCE interface for each direction of data transmission shall start from 0.

For datagram logical channels, the reset procedure causes datagrams and datagram service signals to be purged from the DCE queue associated with that datagram logical channel. A datagram service signal with the cause "Remote procedure error" will be issued to the remote end for each datagram requesting the non-delivery indication facility.

The reset procedure can only apply in the DATA TRANSFER state (p4) of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned. For example, when a restarting procedure is initiated, RESET REQUEST and RESET INDICATION packets can be left unconfirmed.

For flow control, there are three states d1, d2, and d3 within the DATA TRANSFER state (p4). They are FLOW CONTROL READY (d1), DTE RESET REQUEST (d2), and DCE RESET INDICATION (d3) as shown in the state diagram in Annex 2, Figure A2.3/X.25. When entering state p4, the datagram logical channel is placed in state d1. Annex 3, Table A3.4/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

5.2.3.1 Reset Request Packet

The DTE shall indicate a request for reset by transmitting a RESET REQUEST packet specifying the datagram logical channel. This places the datagram logical channel in the DTE RESET REQUEST state (d2).

5.2.3.2 Reset Indication Packet

The DCE shall indicate a reset by transmitting to the DTE a RESET INDICATION packet specifying the datagram logical channel and the reason for the resetting. This places the datagram logical channel in the DCE RESET INDICATION state (d3). In this state, the DCE will ignore datagram, RR and RNR packets.

5.2.3.3 Reset Collision

Reset collision occurs when a DTE and a DCE simultaneously transmit a RESET REQUEST packet and a RESET INDICATION packet specifying the same datagram logical channel. Under this circumstance, the DCE will consider the reset completed. The DCE will not expect a DTE RESET CONFIRMATION packet and will not transfer a DCE RESET CONFIRMATION packet. This places the datagram logical channel in the FLOW CONTROL READY state (d1).

5.2.3.4 Reset Confirmation Packets

When the datagram logical channel is in the DTE RESET REQUEST state (d2), the DCE will confirm reset by transmitting to the DTE a DCE RESET CONFIRMATION packet. This places the datagram logical channel in the FLOW CONTROL READY state (d1).

The DCE RESET CONFIRMATION packet has local significance. The time spent in the DTE RESET REQUEST state (d2) will not exceed time-limit T22 (see Annex 4).

When the datagram logical channel is in the DCE RESET INDICATION state, the DTE will confirm reset by transmitting to the DCE a DTE RESET CONFIRMATION packet. This places the datagram logical channel in the FLOW CONTROL READY state (d1). The action taken by the DCE when the DTE does not confirm the reset within time-out T12 is given in Annex 4.

5.3 Effects of Reset and Restart Procedures on the Transfer of Packets

For datagram logical channels, the reset and restart procedures cause datagrams and datagram service signals to be purged from the DCE queue. A datagram service signal with the cause "Remote procedure error" will be issued to the remote end for each datagram requesting the non-delivery indication facility.

5.4 Effects of Physical and Link Level Failures

When a failure on physical and/or link level is detected, the DCE will purge datagrams and datagram service signals from the DCE queue associated with each datagram logical channel and, for each datagram requesting the non-delivery indication facility, transmit to the remote end a datagram service signal with the cause "Out of order".

During the failure, the DCE will discard any incoming datagrams and datagram service signals. A datagram service signal with the cause "Out of order" will be sent to the remote end for each datagram requesting the non-delivery indication facility.

When the failure is recovered on the physical and link levels, the restart procedure will be actioned (see section 3.5). Upon completion of this procedure, incoming datagrams and datagram service signals will be handled in the normal manner.

6. PACKET FORMATS

6.1 General

The possible extension of packet formats by the addition of new fields is for further study.

Note: Any such field:

(a) would only be provided as an addition following all previously defined fields, and not as an insertion between any of the previously defined fields.

(b) would be transmitted to a DTE only when either the DCE has been informed that the DTE is able to interpret this field and act upon it, or when the DTE can ignore the field without adversely affecting the operation of the DCE.

(c) would not contain any information pertaining to a user facility to which the DTE has not subscribed.

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of a packet are consecutively numbered starting from 1 and are transmitted in this order.

6.1.1 General Format Identifier

The General Format Identifier field is a four bit binary coded field which is provided to indicate the general format of the rest of the header. The General Format Identifier field is located in bit positions 8, 7, 6 and 5 of octet 1, and bit 5 is the low order bit (see Table 6.1/X.25).

TABLE 6.1/X.25

GENERAL FORMAT IDENTIFIER

GENERAL FORMAT IDENTIFIER		Octet 1 bits 8 7 6 5
Call set-up packets	Sequence numbering scheme modulo 8	0 X 0 1
	Sequence numbering scheme modulo 128	0 X 1 0
Clearing, datagram, flow control, interrupt, reset, restart and diagnostic packets	Sequence numbering scheme modulo 8	0 0 0 1
	Sequence numbering scheme modulo 128	0 0 1 0
Data packets	Sequence numbering scheme modulo 8	X X 0 1
	Sequence numbering scheme modulo 128	X X 1 0
Datagram service signal packets	Sequence numbering scheme modulo 8	1 0 0 1
	Sequence numbering scheme modulo 128	1 0 1 0
General Format Identifier extension		* * 1 1

*Undefined

Note: A bit which is indicated as "X" may be set to either "0" or "1" as discussed in subsequent sections.

Bit 8 of the General Format Identifier is used for the Qualifier bit in data packets. It is set to 1 in datagram service signal packets and is set to 0 in all other packets.

Bit 7 of the General Format Identifier is used for the delivery confirmation procedure in data and call set-up packets and is set to 0 in all other packets.

Bits 6 and 5 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo 8 sequence numbering from packets using modulo 128 sequence numbering. The third code is used to indicate an extension to an expanded format for a family of General Format Identifier codes which are a subject of further study. The fourth code is unassigned.

Note 1: In the absence of the Extended Packet Sequence Numbering facility (see section 7.1.1), the sequence numbering scheme is performed modulo 8.

Note 2: It is envisaged that other General Format Identifier codes could identify alternative packet formats.

6.1.2 Logical Channel Group Number

The Logical Channel Group Number appears in every packet except restart packets and diagnostic packets in bit positions 4, 3, 2 and 1 of octet 1. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the Logical Channel Group Number. In restart and diagnostic packets, this field is coded all zeros.

6.1.3 Logical Channel Number

The Logical Channel Number appears in every packet except restart packets and diagnostic packets in all bit positions of octet 2. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the Logical Channel Number. In restart and diagnostic packets, this field is coded all zeros.

6.1.4 Packet Type Identifier

Each packet shall be identified in octet 3 of the packet according to Table 6.2/X.25.

TABLE 6.2/X.25

PACKET TYPE IDENTIFIER

PACKET TYPE		OCTET 3 BITS							
FROM DCE TO DTE	FROM DTE TO DCE	8	7	6	5	4	3	2	1
CALL SET-UP AND CLEARING									
INCOMING CALL	CALL REQUEST	0	0	0	0	1	0	1	1
CALL CONNECTED	CALL ACCEPTED	0	0	0	0	1	1	1	1
CLEAR INDICATION	CLEAR REQUEST	0	0	0	1	0	0	1	1
DCE CLEAR CONFIRMATION	DTE CLEAR CONFIRMATION	0	0	0	1	0	1	1	1
DATA AND INTERRUPT									
DCE DATA	DTE DATA	X	X	X	X	X	X	X	0
DCE INTERRUPT	DTE INTERRUPT	0	0	1	0	0	0	1	1
DCE INTERRUPT CONFIRMATION	DTE INTERRUPT CONFIRMATION	0	0	1	0	0	1	1	1
DATAGRAM*									
DCE DATAGRAM	DTE DATAGRAM	X	X	X	X	X	X	X	0
DATAGRAM SERVICE SIGNAL		X	X	X	X	X	X	X	0
FLOW CONTROL AND RESET									
DCE RR (MODULO 8)	DTE RR (MODULE 8)	X	X	X	0	0	0	0	1
DCE RR (MODULO 128)*	DTE RR (MODULO 128)*	0	0	0	0	0	0	0	1
DCE RNR (MODULO 8)	DTE RNR (MODULO 8)	X	X	X	0	0	1	0	1
DCE RNR (MODULO 128)*	DTE RNR (MODULO 128)*	0	0	0	0	0	1	0	1
	DTE REJ (MODULO 8)*	X	X	X	0	1	0	0	1
	DTE REJ (MODULO 128)*	0	0	0	0	1	0	0	1
RESET INDICATION	RESET REQUEST	0	0	0	1	1	0	1	1
DCE RESET CONFIRMATION	DTE RESET CONFIRMATION	0	0	0	1	1	1	1	1
RESTART									
RESTART INDICATION	RESTART REQUEST	1	1	1	1	1	0	1	1
DCE RESTART CONFIRMATION	DTE RESTART CONFIRMATION	1	1	1	1	1	1	1	1
DIAGNOSTIC									
DIAGNOSTIC*		1	1	1	1	0	0	0	1

* Not necessarily available on every network.

<u>Note</u>: A bit which is indicated as "X" may be set to either "0" or "1" as discussed in subsequent sections.

6.2 Call Set-Up and Clearing Packets

6.2.1 Call Request and Incoming Call Packets

Figure 6.1/X.25 illustrates the format of CALL REQUEST and INCOMING CALL packets.

General Format Identifier

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in section 4.3.3 is used.

Address Lengths Field

Octet 4 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Address Field

Octet 5 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Note: This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	0	1	0	1	1
4	Calling DTE address length				Called DTE address length			
	DTE Address (See Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Call User Data (See Notes 3 and 4)							

Note 1: Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2: The figure is drawn assuming a single address is present consisting of an odd number of digits.

Note 3: Bits 8 and 7 of the first octet of the Call User Data field may have particular significance (see section 6.2.1).

Note 4: Maximum length of the Call User Data field is 16 octets.

Figure 6.1/X.25 - Call request and incoming call packet format

Facility Field

The Facility field is present only when the DTE is using an optional user facility requiring some indication in the CALL REQUEST and INCOMING CALL packets.

The coding of the Facility field is defined in section 7.

The Facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 63 octets.

Call User Data Field

Following the Facility field, the Call User Data field may be present and has a maximum length of 16 octets.

Note: At present, some networks require the Call User Data field to contain an integral number of octets (see section 3, Note 2).

If the Call User Data field is present, the use and format of this field is determined by bits 8 and 7 of the first octet of this field (see Note).

If bits 8 and 7 of the first octet of the Call User Data field are 00, a portion of the Call User Data field is used for protocol identification in accordance with other CCITT Recommendations such as Recommendation X.29.

If bits 8 and 7 of the first octet of the Call User Data field are 01, a portion of the Call User Data field may be used for protocol identification in accordance with specifications of Administrations.

If bits 8 and 7 of the first octet of the Call User Data field are 10, a portion of the Call User Data field may be used for protocol identification in accordance with specifications of international user bodies.

If bits 8 and 7 of the first octet of the Call User Data field are 11, no constraints are placed on the use by the DTE of the remainder of the Call User Data field.

Users are cautioned that if bits 8 and 7 of the first octet of the Call User Data field have any value other than 11, a protocol may be identified that is implemented within public data networks.

Note: When a virtual call is being established between two packet mode DTEs, the network does not act on any part of the Call User Data field, unless required to do otherwise by an appropriate request for an optional user facility on a per call basis. Such a facility is for further study.

6.2.2 Call Accepted and Call Connected Packets

Figure 6.2/X.25 illustrates the format of CALL ACCEPTED and CALL CONNECTED packets.

General Format Identifier

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in section 4.3.3 is used.

Address Lengths Field

Octet 4 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

The use of the Address Lengths field in CALL ACCEPTED packets is only mandatory when the Address field or the Facility Length field is present.

Address Field

Octet 5 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Note: This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

	Bits 8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	1	1	1	1
4	Calling DTE address length*				Called DTE address length*			
	DTE Address (See Note 2)*							
					0	0	0	0
	0	0	Facility length*					
	Facilities*							

Note 1: Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2: The figure is drawn assuming a single address is present consisting of an odd number of digits.

* These fields are not mandatory in CALL ACCEPTED packets (see section 6.2.2).

Figure 6.2/X.25 - Call accepted and call connected packet format

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

The use of the Facility Length field in CALL ACCEPTED packets is only mandatory when the Facility field is present.

Facility Field

The Facility field is present only when the DTE is using an optional user facility requiring some indication in the CALL ACCEPTED and CALL CONNECTED packets.

The coding of the Facility field is defined in section 7.

The Facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 63 octets.

6.2.3 Clear Request and Clear Indication Packets

Figure 6.3/X.25 illustrates the format of CLEAR REQUEST and CLEAR INDICATION packets.

Clearing Cause Field

Octet 4 is the Clearing Cause field and contains the reason for the clearing of the call.

The bits of the Clearing Cause field in CLEAR REQUEST packets should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

The coding of the Clearing Cause field in CLEAR INDICATION packets is given in Table 6.3/X.25.

Octet	Bits 8	7	6	5	4	3	2	1
1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	1	0	0	1	1
4	Clearing Cause							
5	Diagnostic Code*							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

* This field is not mandatory in CLEAR REQUEST packets.

Figure 6.3/X.25 - Clear request and clear indication packet format

Octet	Bits 8	7	6	5	4	3	2	1
1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	1	0	1	1	1

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.4/X.25- DTE and DCE clear confirmation packet format

TABLE 6.3/X.25

CODING OF CLEARING CAUSE FIELD IN CLEAR INDICATION PACKET

	8	7	6	5	4	3	2	1
DTE originated	0	0	0	0	0	0	0	0
Number busy	0	0	0	0	0	0	0	1
Out of order	0	0	0	0	1	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Reverse charging acceptance not subscribed*	0	0	0	1	1	0	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Fast select acceptance not subscribed*	0	0	1	0	1	0	0	1
Invalid facility request	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Local procedure error	0	0	0	1	0	0	1	1
Network congestion	0	0	0	0	0	1	0	1
Not obtainable	0	0	0	0	1	1	0	1
RPOA out of order*	0	0	0	1	0	1	0	1

* May be received only if the corresponding optional user facility is used.

Diagnostic Code

Octet 5 is the Diagnostic Code and contains additional information on the reason for the clearing of the call.

In a CLEAR REQUEST packet, the Diagnostic Code is not mandatory.

In a CLEAR INDICATION packet, if the Clearing Cause field indicates "DTE originated," the Diagnostic Code is passed unchanged from the clearing DTE. If the clearing DTE has not provided a Diagnostic Code in its CLEAR REQUEST packet, then the bits of the Diagnostic Code in the resulting CLEAR INDICATION packet will all be zero.

When a CLEAR INDICATION packet results from a RESTART REQUEST packet, the value of the Diagnostic Code will be that specified in the RESTART REQUEST packet, or all zeros in the case where no Diagnostic Code has been specified in RESTART REQUEST.

When the Clearing Cause field does not indicate "DTE originated," the Diagnostic Code in a CLEAR INDICATION packet is network generated. Annex 5 lists the codings for network generated diagnostics. The bits of the Diagnostic Code are all set to 0 when no specific additional information for the clearing is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

6.2.4 DTE and DCE Clear Confirmation Packets

Figure 6.4/X.25 illustrates the format of the DTE and DCE CLEAR CONFIRMATION packets.

6.3 Data and Interrupt Packets

6.3.1 DTE and DCE Data Packets

Figure 6.5/X.25 illustrates the format of the DTE and DCE DATA packets.

Qualifier Bit

Bit 8 of octet 1 is the Qualifier bit.

Delivery Confirmation Bit

Bit 7 of octet 1 is the Delivery Confirmation bit.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3 or bits 8 through 2 of octet 4, when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

More Data Bit

Bit 5 in octet 3, or bit 1 in octet 4 when extended, is used for the More Data mark: 0 for no more data and 1 for more data.

Packet Send Sequence Number

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier Q	D	0	1	Logical Channel Group Number			
2	Logical Channel Number							
3	P(R)			M	P(S)			0
	User Data							

(Modulo 8)

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier Q	D	1	0	Logical Channel Group Number			
2	Logical Channel Number							
3	P(S)							0
4	P(R)							M
	User Data							

(When extended to modulo 128)

D = Delivery Confirmation bit

M = More Data bit

Q = Qualifier bit

Figure 6.5/X.25 - DTE and DCE data packet format

User Data Field

Bits following octet 3, or octet 4 when extended, contain user data.

Note: At present, some networks require the User Data field to contain an integral number of octets (see section 3, Note 2).

6.3.2 DTE and DCE Interrupt Packets

Figure 6.6/X.25 illustrates the format of the DTE and DCE INTERRUPT packets.

Interrupt User Data Field

Octet 4 contains user data.

6.3.3 DTE and DCE Interrupt Confirmation Packets

Figure 6.7/X.25 illustrates the format of the DTE and DCE INTERRUPT CONFIRMATION packets.

6.4 Datagram and Datagram Service Signal Packets

6.4.1 DTE and DCE Datagram Packets

Figure 6.8/X.25 illustrates the format of DTE and DCE DATAGRAM packets.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

Packet Send Sequence Number

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Address Lengths Field

The octet following the sequence numbers consists of field length indicators for the destination and source DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the destination DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the source DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Octet	Bits 8	7	6	5	4	3	2	1
1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	1	0	0	0	1	1
4	Interrupt User Data							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.6/X.25 - DTE and DCE interrupt packet format

Octet	Bits 8	7	6	5	4	3	2	1
1	General Format Identifier See note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	1	0	0	1	1	1

Note: coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.7/X.25 - DTE and DCE interrupt confirmation packet format

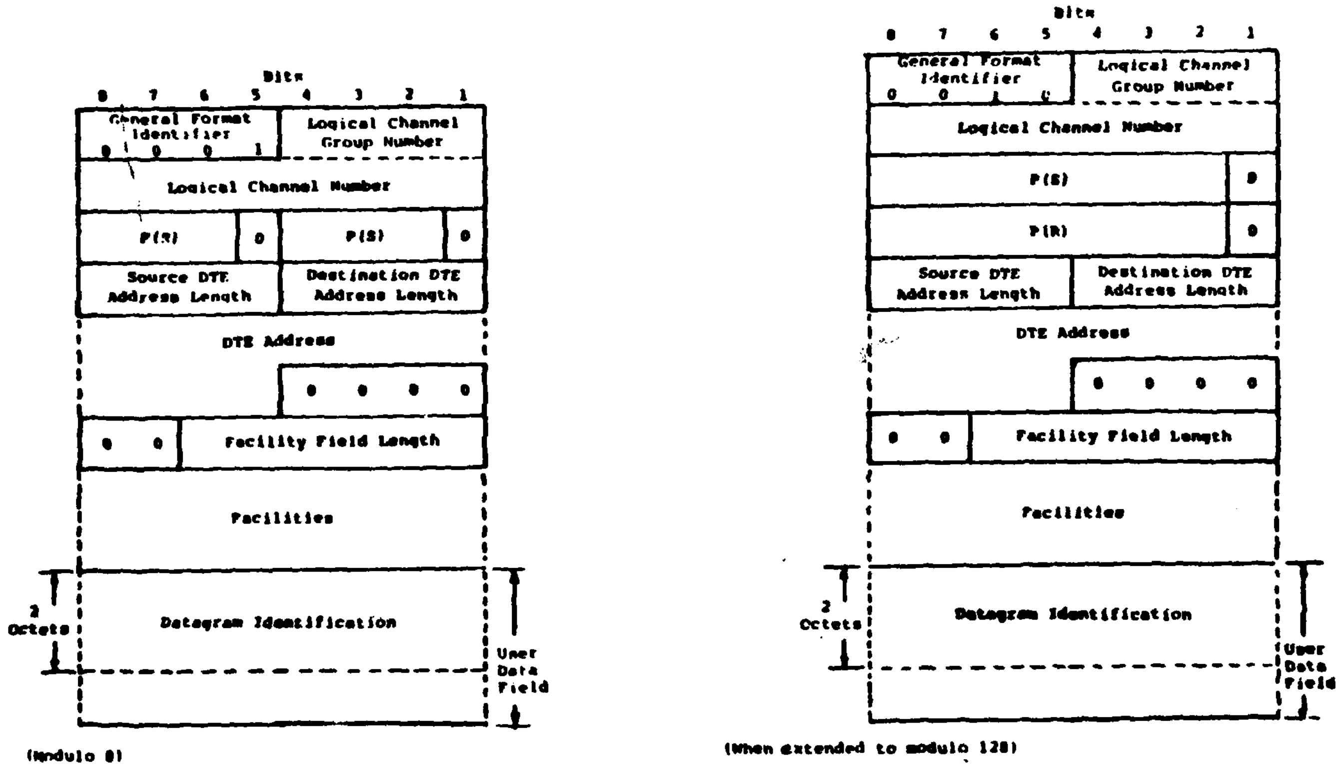


Figure 6.8/X.25 - DTE and DCE datagram packet format

Address Field

The octets following the Address Length field consist of the destination DTE address when present, then the source DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Note: This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

Facility Field

The Facility field is present only when the DTE is using an optional user facility requiring some indication in the datagram packet.

The coding of this Facility field is defined in section 7.

The Facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However this maximum does not exceed 63 octets.

User Data Field

Following the Facility field, the User Data field may be present and has a maximum length of 128 octets. The first two octets of the User Data field are called the datagram identification.

Note: At present, some networks require the User Data field to contain an integral number of octets (see section 3, Note 2).

6.4.2 Datagram Service Signal Packets

Figure 6.9/X.25 illustrates the format of DATAGRAM SERVICE SIGNAL packets.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

Packet Send Sequence Number

Bit 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Address Lengths Field

The octet following the sequence numbers consists of field length indicators for the destination and source DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the destination DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the source DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

The source DTE address length indicator is coded all zeros for datagram service signal - general packets.

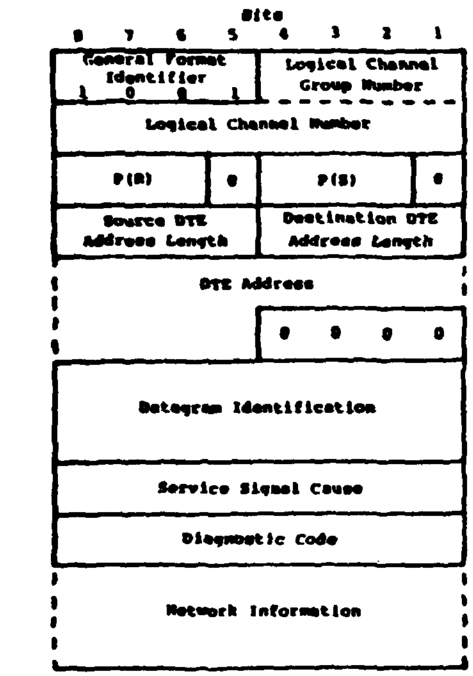
Address Field

The octets following the Address Length field consist of the destination DTE address when present, then the source DTE address when present (see section 5.1.4.1).

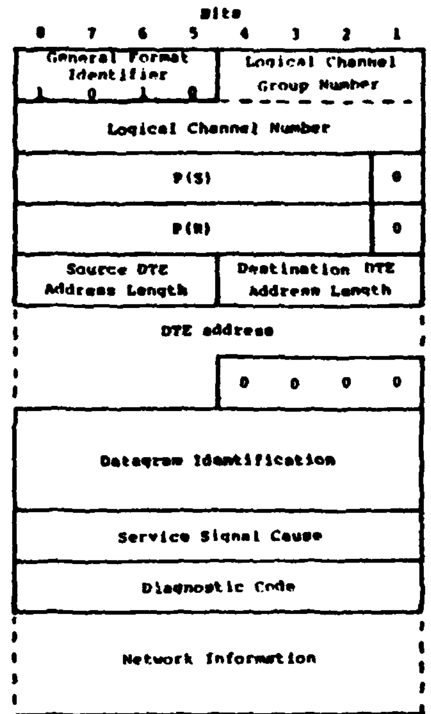
Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.



(Modulo 8)



(When extended to modulo 128)

Figure 6.9/X.25 - Datagram service signal packet format

Datagram Identification Field

The Datagram Identification field of datagram service signal - specific packets contains the first two octets of the User Data field from the original datagram to which the datagram service signal packet applies. If the User Data field of the original datagram is less than two octets, the Datagram Identification field in the datagram service signal packet will be padded out to two octets by inserting the appropriate number of 0 bits.

The Datagram Identification field of datagram service signal - general packets is coded with all zeros.

Cause Field

The octet immediately following the Datagram Identification field is the Cause field and contains the reason for the datagram service signal.

The coding of the Cause field is given in Table 6.4/X.25.

TABLE 6.4/X.25

CODING OF CAUSE FIELD IN DATAGRAM SERVICE SIGNAL PACKET

	8 7 6 5 4 3 2 1
Datagram Service Signal - Specific	
Datagram Rejected	
Local procedure error	0 0 0 1 0 0 1 1
Invalid facility request	0 0 0 0 0 0 1 1
Access barred	0 0 0 0 1 0 1 1
Not obtainable	0 0 0 0 1 1 0 1
Incompatible destination	0 0 1 0 0 0 0 1
Reverse charging acceptance not subscribed	0 0 0 1 1 0 0 1
Datagram Non-Delivery Indication (Note 1)	
Network congestion	0 0 0 0 0 1 0 1
Out of order	0 0 0 0 1 0 0 1
Number busy (destination queue full)	0 0 0 0 0 0 0 1
Remote procedure error	0 0 0 1 0 0 0 1
Datagram Delivery Confirmation (Note 2)	
Delivery confirmation	0 0 1 1 0 0 0 1
Datagram Service Signal - General	
Local DCE queue overflow (Note 3)	0 1 1 1 1 1 1 1
Network congestion	0 1 0 0 0 1 1 1
Network operational	0 1 0 0 1 1 1 1

Note 1: Issued only when the Non-delivery Indication facility (see section 7.3.4) has been requested.

Note 2: Issued only when the Delivery Confirmation facility (see section 7.3.5) has been requested.

Note 3: For further study.

Diagnostic Code

The octet immediately following the Cause field contains additional information on the reason for the datagram service signal.

The coding of the Diagnostic Code field is given in Annex 5. Assigned Diagnostic Codes applicable to datagram service signal packets include decimal 33, 38, 39, 40, 65, 66, 67 and 68. The bits of the Diagnostic Code in a datagram service signal packet are all set to zero when no specific additional information for the service signal is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

Network Information Field

Following the Diagnostic Code field, the Network Information field may be present and has a maximum length of 16 octets.

If the Diagnostic Code field designates Facility Code Not Allowed or Facility Parameter Not Allowed, then the Network Information field will contain the octets associated with the facility code and its associated parameter field. If the Diagnostic Code field designates Invalid Address, then the Network Information Field will contain the octets associated with the two Address Length fields and the octets associated with the Address field.

The information content of this field for other Diagnostic Codes is for further study.

6.5 Flow Control and Reset Packets

6.5.1 DTE and DCE Receive Ready (RR) Packets

Figure 6.10/X.25 illustrates the format of the DTE and DCE RR packets.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

6.5.2 DTE and DCE Receive Not Ready (RNR) Packets

Figure 6.11/X.25 illustrates the format of the DTE and DCE RNR packets.

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier 0	0	0	1	Logical Channel Group Number			
2	Logical Channel Number							
3	P(R)			Packet Type Identifier 0	0	0	0	1

(Modulo 8)

Bits

Octet	8	7	6	5	4	3	2	1
1	General Format Identifier 0	0	1	0	Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	0	0	0	1
4	P(R)							0

(when extended to Modulo 128)

Figure 6.10/X.25 - DTE and DCE RR packet format

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier 0	0	0	1	Logical Channel Group Number			
2	Logical Channel Number							
3	P(R)			Packet Type Identifier 0	0	1	0	1

(Modulo 8)

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier 0	0	1	0	Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	0	1	0	1
4	P(R)							0

(when extended to Modulo 128)

Figure 6.11/X.25 - DTE and DCE RNR packet format

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

6.5.3 Reset Request and Reset Indication Packets

Figure 6.12/X.25 illustrates the format of the RESET REQUEST and RESET INDICATION packets.

Resetting Cause Field

Octet 4 is the Resetting Cause field and contains the reason for the reset.

The bits of the Resetting Cause field in a RESET REQUEST packet should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

The coding of the Resetting Cause field in a RESET INDICATION packet is given in Table 6.5/X.25.

TABLE 6.5/X.25

CODING OF RESETTING CAUSE FIELD IN RESET INDICATION PACKET

	8	7	6	5	4	3	2	1
DTE originated**	0	0	0	0	0	0	0	0
Out of order*	0	0	0	0	0	0	0	1
Remote procedure error**	0	0	0	0	0	0	1	1
Local procedure error	0	0	0	0	0	1	0	1
Network congestion	0	0	0	0	0	1	1	1
Remote DTE operational*	0	0	0	0	1	0	0	1
Network operational***	0	0	0	0	1	1	1	1
Incompatible destination**	0	0	0	1	0	0	0	1

* Applicable to permanent virtual circuits only.

** Applicable to virtual calls and permanent virtual circuits only.

*** Applicable to permanent virtual circuits and datagram logical channels only.

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	1	1	0	1	1
4	Resetting Cause							
5	Diagnostic Code*							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

* This field is not mandatory in RESET REQUEST packets.

Figure 6.12/X.25 - Reset request and reset indication packet format

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See Note				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	1	1	1	1	1

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.13/X.25 - DTE and DCE reset confirmation packet format

Diagnostic Code

Octet 5 is the Diagnostic Code and contains additional information on the reason for the reset.

In a RESET REQUEST packet the Diagnostic code is not mandatory.

In a RESET INDICATION packet, if the Resetting Cause field indicates "DTE originated," the Diagnostic Code has been passed unchanged from the resetting DTE. If the DTE requesting a reset has not provided a Diagnostic Code in its RESET REQUEST packet, then the bits of the Diagnostic Code in the resulting RESET INDICATION packet will all be zeros.

If a RESET INDICATION packet results from a RESTART REQUEST packet, the value of the Diagnostic Code will be that specified in the RESTART REQUEST, or all zeros in the case where no Diagnostic Code has been specified in RESTART REQUEST.

If the Resetting Cause field does not indicate "DTE originated", the Diagnostic Code in a RESET INDICATION packet is network generated. Annex 5 lists the codings for network generated diagnostics. The bits of the Diagnostic Code are all set to 0 when no specific additional information for the reset is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

6.5.4 DTE and DCE Reset Confirmation Packets

Figure 6.13/X.25 illustrates the format of the DTE and DCE RESET CONFIRMATION packets.

6.6 Restart Packets

6.6.1 Restart Request and Restart Indication Packets

Figure 6.14/X.25 illustrates the format of the RESTART REQUEST and RESTART INDICATION packets.

Restarting Cause Field

Octet 4 is the Restarting Cause field and contains the reason for the restart.

The bits of the Restarting Cause field in RESTART REQUEST packets should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See Note				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet Type Identifier							
	1	1	1	1	1	0	1	1
4	Restarting Cause							
5	Diagnostic Code*							

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

* This field is not mandatory in RESTART REQUEST packets

Figure 6.14/X.25 - Restart request and restart indication packet format

	Bits							
	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier See Note				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet Type Identifier							
	1	1	[illegible]	1	1	1	1	1

Note: Coded 0001 (modulo 8) or 0010 (modulo 128)

Figure 6.15/X.25 - DTE and DCE restart confirmation packet format

The coding of the Restarting Cause field in the RESTART INDICATION packets is given in Table 6.6/X.25.

TABLE 6.6/X.25

CODING OF RESTARTING CAUSE FIELD IN RESTART INDICATION PACKETS

	8 7 6 5 4 3 2 1
Local procedure error	0 0 0 0 0 0 0 1
Network congestion	0 0 0 0 0 0 1 1
Network operational	0 0 0 0 0 1 1 1

Diagnostic Code

Octet 5 is the Diagnostic Code and contains additional information on the reason for the restart.

In a RESTART REQUEST packet, the Diagnostic Code is not mandatory. The Diagnostic Code, if specified, is passed to the corresponding DTEs as the Diagnostic Code of a RESET INDICATION packet for permanent virtual circuits or a CLEAR INDICATION packet for virtual calls.

The coding of Diagnostic Code field in a RESTART INDICATION packet is given in Annex 5. The bits of the Diagnostic Code are all set to zero when no specific additional information for the restart is supplied.

Note: The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic Code field. Unspecified code combinations in the Diagnostic Code field shall not cause the DTE to not accept the Cause field.

6.6.2 DTE and DCE Restart Confirmation Packets

Figure 6.15/X.25 illustrates the format of the DTE and DCE RESTART CONFIRMATION packets.

6.7 Diagnostic Packet

Figure 6.16/X.25 illustrates the format of the DIAGNOSTIC packet.

	Bits 8	7	6	5	4	3	2	1
Octet 1	General Format Identifier (See Note 1)				0	0	0	0
2	0	0	0	0	0	0	0	0
3	1	1	1	1	0	0	0	1
	Packet Type Identifier							
4	Diagnostic Code							
5	Diagnostic Explanation (See Note 2)							

Note 1: Coded 0001 (modulo 8) or 0010 (modulo 128)

Note 2: The figure is drawn assuming the Diagnostic Explanation field is an integral number of octets in length.

Figure 6.16/X.25 - Diagnostic packet format

Diagnostic Code Field

Octet 4 is the diagnostic code and contains information on the error condition which resulted in the transmission of the DIAGNOSTIC packet. The coding of the Diagnostic Code field is given in Annex 5.

Diagnostic Explanation Field

When the DIAGNOSTIC packet is issued as a result of the reception of an erroneous packet from the DTE (see Table A3.1/X.25), this field contains the first three octets of header information from the erroneous DTE packet. If the packet contains less than 3 octets, this field contains whatever bits were received.

When the DIAGNOSTIC packet is issued as a result of a DCE timeout (see Table A4.1/X.25), the Diagnostic Explanation field contains 2 octets coded as follows:

- Bits 8, 7, 6 and 5 of the first octet contains the General Format Identifier for the interface.
- Bits 4 to 1 of the first octet and bits 8 to 1 of the second octet are all 0 for expiration of time-out T10 and give the number of the logical channel on which the time-out occurred for expiration of time-out T12 or T13.

6.8 Packets Required for Optional User Facilities

6.8.1 DTE Reject (REJ) Packet For The Packet Retransmission Facility

Figure 6.17/X.25 illustrates the format of the DTE REJ packets, used in conjunction with the Packet Retransmission facility described in section 7.1.4.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

6.8.2 Call Set-up and Clearing Packets For The Fast Select Facility and Fast Select Acceptance Facility

6.8.2.1 Call Request and Incoming Call Packets

Figure 6.18/X.25 illustrates the format of CALL REQUEST and INCOMING CALL packets used in conjunction with the Fast Select facility and Fast Select Acceptance facility described in sections 7.2.4 and 7.2.5.

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier				Logical Channel Group Number			
	0	0	0	1				
2	Logical Channel Number							
3	P(R)			Packet Type Identifier				
				0	1	0	0	1

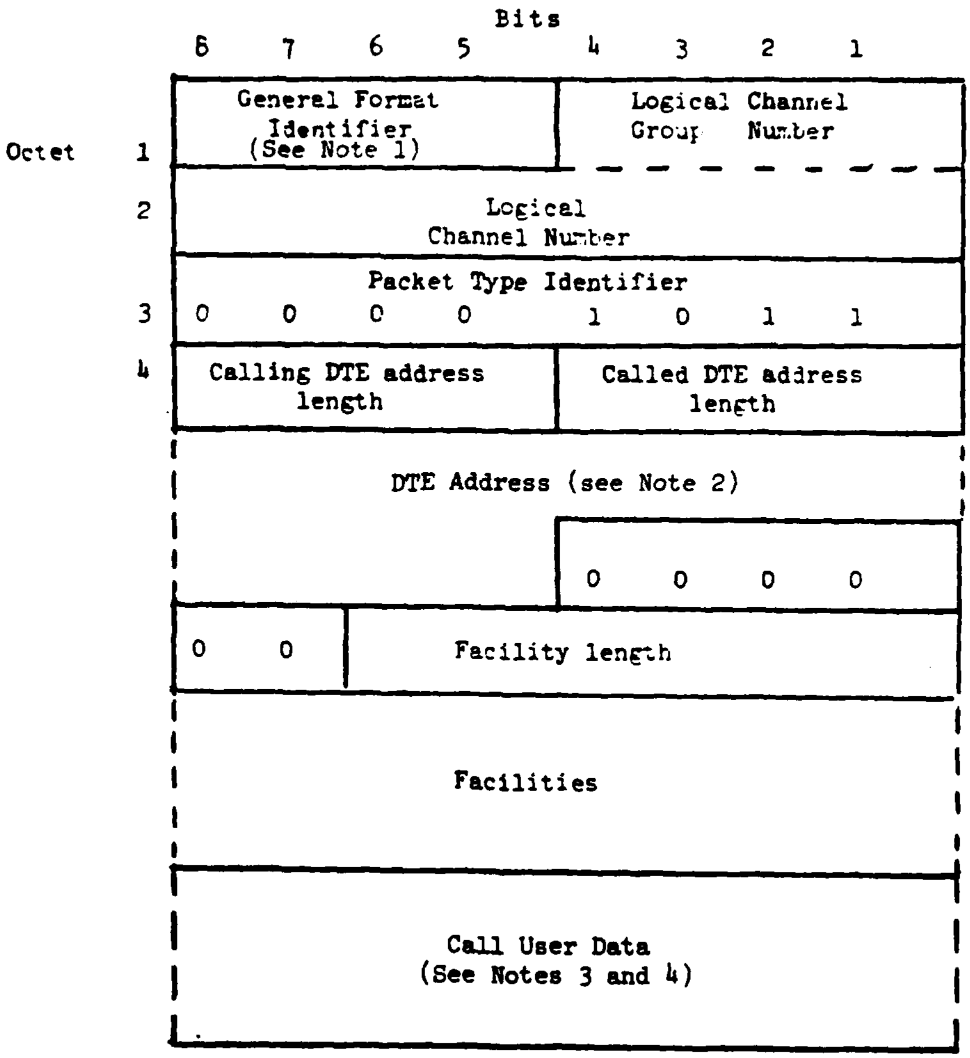
(Modulo 8)

Bits

	8	7	6	5	4	3	2	1
Octet 1	General Format Identifier				Logical Channel Group Number			
	0	0	1	0				
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	0	1	0	0	1
4	P(R)							0

(When extended to modulo 128)

Figure 6.17/X.25 - DTE REJ packet format



Note 1: Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2: The figure is drawn assuming a single address is present consisting of an odd number of digits.

Note 3: Bits 8 and 7 of the first octet of the Call User Data field may have particular significance (see section 6.2.1).

Note 4: Maximum length of the Call User Data field is 128 octets.

Figure 6.18/X.25 - Call request and incoming call packet format for the Fast Select facility

Description of section 6.2.1 is applied to this section except the length of the Call User Data field has a maximum length of 128 octets.

Note: At present, some networks require the Call User Data field to contain an integral number of octets (see section 3, Note 2).

6.8.2.2 Call Accepted and Call Connected Packets

Figure 6.19/X.25 illustrates the format of CALL ACCEPTED and CALL CONNECTED packets used in conjunction with the Fast Select facility and Fast Select Acceptance facility described in sections 7.2.4 and 7.2.5.

Description of section 6.2.2 is applied to this section and, in addition, the Called User Data field may be present and has a maximum length of 128 octets. The Address Lengths field and Facility Length field are mandatory.

Note: At present, some networks require the Called User Data field to contain an integral number of octets (see section 3, Note 2).

If the Called User Data field is present, the use and format of this field is determined by bits 8 and 7 of the first octet of this field (see Note).

If bits 8 and 7 of the first octet of the Called User Data field are 00, a portion of the Called User Data field is used for protocol identification in accordance with other CCITT Recommendations.

If bits 8 and 7 of the first octet of the Called User Data field are 01, a portion of the Called User Data field may be used for protocol identification in accordance with specifications of Administrations.

If bits 8 and 7 of the first octet of the Called User Data field are 10, a portion of the Called User Data field may be used for protocol identification in accordance with specifications of International user bodies.

If bits 8 and 7 of the first octet of the Called User Data field are 11, no constraints are placed on the use by the DTE of the remainder of the Called User Data field.

Users are cautioned that if bits 8 and 7 of the first octet of the Called User Data field have any value other than 11, a protocol may be identified that is implemented within public data networks.

Octet	Bits 8	7	6	5	4	3	2	1
1	General Format Identifier (See Note 1)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier 0	0	0	0	1	1	1	1
4	Calling DTE address length				Called DTE address length			
	DTE Address (See Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Called User Data (See Notes 3 and 4)							

Note 1: Coded 0X01 (modulo 8) or 0X10 (modulo 128).
Note 2: The figure is drawn assuming a single address is present consisting of an odd number of digits.
Note 3: Bits 8 and 7 of the first octet of the Called User Data field may have particular significance (see section 6.8.2.2).
Note 4: Maximum length of the Called User Data field is 128 octets.

Figure 6.19/X.25 - Call accepted and call connected packet format for the Fast Select facility

Note: When a virtual call is being established between two packet mode DTEs, the network does not act on any part of the Called User Data field, unless required to do otherwise by an appropriate request for an optional user facility on a per call basis. Such a facility is for further study.

6.8.2.3 Clear Request and Clear Indication Packets

Figure 6.20/X.25 illustrates the format of CLEAR REQUEST and CLEAR INDICATION packets used in conjunction with the Fast Select facility and Fast Select Acceptance facility described in sections 7.2.4 and 7.2.5.

Description of the Clearing Cause field and the Diagnostic Code field in section 6.2.3 is applied to this section. In addition the following fields may follow the Diagnostic Code field and in such cases the use of the Diagnostic Code field is mandatory.

Address Lengths Field

Octet 6 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE addresses in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Note: This field is coded with all 0s. Other codings are for further study.

Address Field

Note: Pending the further study indicated above, this field is not present.

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address field indicate the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

Note: This field is coded with all 0s. Other codings are for further study.

<table>
<tr><th></th><th colspan="8">Bits</th></tr>
<tr><th></th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td>Octet 1</td><td colspan="4">General Format Identifier (See Note 1)</td><td colspan="4">Logical Channel Group Number</td></tr>
<tr><td>2</td><td colspan="8">Logical Channel Number</td></tr>
<tr><td>3</td><td colspan="8">Packet Type Identifier</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>4</td><td colspan="8">Clearing Cause</td></tr>
<tr><td>5</td><td colspan="8">Diagnostic Code</td></tr>
<tr><td>6</td><td colspan="4">Calling DTE address length</td><td colspan="4">Called DTE address length</td></tr>
<tr><td></td><td colspan="8">DTE Address (See Note 2)</td></tr>
<tr><td></td><td colspan="4"></td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td></td><td>0</td><td>0</td><td colspan="6">Facility length</td></tr>
<tr><td></td><td colspan="8">Facilities</td></tr>
<tr><td></td><td colspan="8">Clear User Data (See Note 3)</td></tr>
</table>

<u>Note 1</u>: Coded 0001 (modulo 8) or 0010 (modulo 128).

<u>Note 2</u>: The figure is drawn assuming a single address is present consisting of an odd number of digits.

<u>Note 3</u>: Maximum length of the Clear User Data field is 128 octets.

Figure 6.20/X.25 - Clear request and clear indication packet format for the Fast Select facility

Facility Field

Note: Pending the further study indicated above, this field is not present.

Clear User Data Field

Following the Facility field, the Clear User Data field may be present and has a maximum length of 128 octets.

Note: At present, some networks require the Clear User Data field to contain an integral number of octets (see section 3, Note 2).

7. PROCEDURES AND FORMATS FOR OPTIONAL USER FACILITIES

7.1 Procedures for Optional User Facilities Associated with Virtual Circuit and Datagram Services

7.1.1 Extended Packet Sequence Numbering

Extended Packet Sequence Numbering is an optional user facility agreed for a period of time. It applies in common to all logical channels at the DTE/DCE interface.

This user facility, if subscribed to, provides sequence numbering of packets performed modulo 128. In the absence of this facility, the sequence numbering of packets is performed modulo 8.

7.1.2 Nonstandard Default Window Sizes

Nonstandard Default Window Sizes is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default window sizes from the list of window sizes supported by the Administration. Some networks may constrain the default window sizes to be the same for each direction of transmission across the DTE/DCE interface. In the absence of this facility, the default window sizes are 2.

Values other than the default window sizes may be negotiated for a virtual call by means of the Flow Control Parameter Negotiation facility (see section 7.2.2). Values other than the default window sizes may be agreed for a period of time for each permanent virtual circuit and each datagram logical channel.

7.1.3 Default Throughput Classes Assignment

Default Throughput Classes Assignment is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default throughput classes from the list of throughput classes supported by the Administration. Some networks may constrain the default throughput classes to be the sane for each direction of data transmission. In the absence of this facility, the ' fault throughput classes correspond to the user class of service of the DTE (see section 7.4.2.6) but do not exceed the maximum throughput class supported by the network.

The default throughput classes are the maximum throughput classes which may be associated with any virtual call at the DTE/DCE interface. Values other than the default throughput classes may be negotiated for a virtual call by means of the Throughput Class Negotiation facility (see section 7.2.3). Values other than the default throughput classes may be agreed for a period of time for each permanent virtual circuit and each datagram logical channel.

7.1.4 Packet Retransmission

Packet Retransmission is an optional user facility agreed for a period of time. It applies in common to all logical channels at the DTE/DCE interface.

Note: In this section, the term "flow controlled packet" refers to the DCE DATA packet for virtual call and permanent virtual circuit logical channels and refers to the DCE DATAGRAM and DATAGRAM SERVICE SIGNAL packets for datagram logical channels.

This user facility, if subscribed to, allows a DTE to request retransmission of one or several consecutive flow controlled packets from the DCE by transferring across the DTE/DCE interface a DTE REJECT packet specifying a logical channel number and a sequence number P(R). The value of this P(R) should be within the range from the last P(R) received by the DCE up to, but not including, the P(S) of the next flow controlled packet to be transmitted by the DCE. If the P(R) is outside this range, the DCE will initiate the reset procedure with the cause "Local procedure error" and diagnostic #2.

When receiving a DTE REJECT packet, the DCE initiates on the specified logical channel retransmission of the flow controlled packets; the Packet Send Sequence Numbers of which are starting from P(R) where P(R) is indicated in the DTE REJECT packet. Until the DCE transfers across the DTE/DCE interface a flow controlled packet with a Packet Send Sequence Number equal to the P(R) indicated in the DTE REJECT packet, the DCE will consider the receipt of another DTE REJECT packet as a procedure error and reset the logical channel.

Additional flow controlled packets pending initial transmission may follow the retransmitted packet(s).

A DTE receive not ready situation indicated by the transmission of RNR packet is cleared by the transmission of a DTE REJECT packet.

The conditions under which the DCE ignores a DTE REJECT packet, or considers it as a procedure error, are those described for flow control packets (see Annex 3).

7.1.5 Incoming Calls Barred

Incoming Calls Barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface for virtual calls and datagrams.

This user facility, if subscribed to, prevents incoming virtual calls and datagrams from being presented to the DTE. The DTE may originate outgoing virtual calls and datagrams.

Note: Logical channels used for virtual calls retain their full duplex capability. Logical channels used for datagrams and datagram service signals retain their capability to convey datagram service signals.

7.1.6 Outgoing Calls Barred

Outgoing Calls Barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface for virtual calls and datagrams.

This user facility, if subscribed to, prevents the DCE from accepting outgoing virtual calls and datagrams from the DTE. The DTE may receive incoming virtual calls and datagrams.

Note: Logical channels used for virtual calls retain their full duplex capability.

7.1.7 One-way Logical Channel Outgoing

One-way Logical Channel Outgoing is an optional user facility agreed for a period of time. This user facility, if subscribed to, restricts the logical channel use to originating outgoing virtual calls or datagrams only.

Note: A logical channel used for virtual calls retains its full duplex capability. A logical channel used for datagrams and datagram service signals retains its capability to convey datagram service signals.

The rules according to which Logical Channel Group Numbers and Logical Channel Numbers can be assigned to one-way outgoing logical channels for virtual calls are given in Annex 1.

Note: If all the logical channels for virtual calls and datagrams are one-way outgoing at a DTE/DCE interface, the effect is equivalent to the Incoming Calls Barred facility (see section 7.1.5).

7.1.8 One-way Logical Channel Incoming

One-way Logical Channel Incoming is an optional user facility agreed for a period of time. This user facility, if subscribed to, restricts the logical channel use to receiving incoming virtual calls or datagrams only.

Note: A logical channel used for virtual calls retains its full duplex capability.

The rules according to which Logical Channel Group Numbers and Logical Channel Numbers can be assigned to one-way incoming logical channels for virtual calls are given in Annex 1.

Note: If all the logical channels for virtual calls and datagrams are one-way incoming at a DTE/DCE interface, the effect is equivalent to the Outgoing Calls Barred facility (see section 7.1.6).

7.1.9 Closed User Group

Closed User Group is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more closed user groups. A closed user group permits the DTEs belonging to the group to communicate with each other, but precludes communication with all other DTEs.

The calling/source DTE should specify the closed user group selected for a virtual call or datagram using the optional user facility parameters (see section 7.4.2.1) in the CALL REQUEST or DTE DATAGRAM packet.

The closed user group selected for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters (see section 7.4.2.1) in the INCOMING CALL or DCE DATAGRAM packet.

When a DTE only belongs to one closed user group or when the virtual call or datagram is associated with the DTE's preferential closed user group, this indication may not be present in the CALL REQUEST, INCOMING CALL, DTE DATAGRAM or DCE DATAGRAM packet.

7.1.10 Closed User Group with Outgoing Access

Closed User Group with Outgoing Access is an optional user facility agreed for a period of time for virtual calls or datagrams. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in section 7.1.9) and to originate virtual calls or datagrams to DTEs in the open part of the network and to DTEs having the incoming access capability.

The procedures for using this facility are the same as those given in section 7.1.9. However, the optional user facility parameters may not be present when originating virtual calls or datagrams to DTEs in the open part of the network or to DTEs having the incoming access capability.

7.1.11 Closed User Group with Incoming Access

Closed User Group with Incoming Access is an optional user facility agreed for a period of time for virtual calls or datagrams. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in section 7.1.9) and to receive incoming calls or datagrams from DTEs in the open part of the network and from DTEs having the outgoing access capability.

The procedures for using this facility are the same as those given in section 7.1.9. However, the optional user facility parameters may not be present when receiving incoming calls or datagrams from DTEs in the open part of the network or from DTEs having the outgoing access capability.

7.1.12 Incoming Calls Barred within a Closed User Group

Incoming Calls Barred within a Closed User Group is an optional user facility agreed for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to originate virtual calls or datagrams to DTEs in this closed user group, but precludes the reception of incoming calls or datagrams from other DTEs in this closed user group.

The procedures for using this facility are the same as those given in sections 7.1.9, 7.1.10 and 7.1.11.

7.1.13 Outgoing Calls Barred within a Closed User Group

Outgoing Calls Barred within a Closed User Group is an optional user facility agreed for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to receive virtual calls or datagrams from other DTEs in this closed user group, but prevents the DTE from originating virtual calls or datagrams to other DTEs in this closed user group.

The procedures for using this facility are the same as those given in sections 7.1.9, 7.1.10 and 7.1.11.

7.1.14 Bilateral Closed User Group

Bilateral Closed User Group is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more bilateral closed user groups. A bilateral closed user group permits a pair of DTEs who bilaterally agree to communicate with each other to do so, but precludes communication with all other

DTEs.

The calling/source DTE should specify the bilateral closed user group selected for a virtual call or datagram using the optional user facility parameters (see section 7.4.2.2) in the CALL REQUEST or DTE DATAGRAM packet. The called/destination DTE address length shall be coded all zeros.

The bilateral closed user group for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters in the INCOMING CALL or DCE DATAGRAM packet.

7.1.15 Bilateral Closed User Group with Outgoing Access

Bilateral Closed User Group with Outgoing Access is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more bilateral closed user groups (as in section 7.1.14) and to originate virtual calls or datagrams to DTEs in the open part of the network.

The procedures for using this facility are the same as those given in section 7.1.14.

7.1.16 Reverse Charging

Reverse Charging is an optional user facility which can be requested by a DTE for a given virtual call or for a datagram (see section 7.4.2.3).

7.1.17 Reverse Charging Acceptance

Reverse Charging Acceptance is an optional user facility agreed for a period of time.

This user facility, if subscribed to, authorizes the DCE to transmit to the DTE incoming calls or datagrams which request the Reverse Charging facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls or datagrams which request the Reverse Charging facility.

7.1.18 RPOA Selection

RPOA Selection is an optional user facility which may be requested by a DTE for a given virtual call or for a datagram.

This user facility, when requested, provides for the user specification by the calling/source DTE of a particular RPOA transit network through which the call or datagram is to be routed internationally, when more than one RPOA transit network exists at an international gateway (see section 7.4.2.4).

7.2 Procedures for Optional User Facilities Only Available with Virtual Circuit Services

7.2.1 Nonstandard Default Packet Sizes

Nonstandard Default Packet Sizes is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default packet sizes from the list of packet sizes supported by the Administration. Some networks may constrain the packet sizes to be the same for each direction of data transmission across the DTE/DCE interface. In the absence of this facility, the default packet sizes are 128 octets.

Note: In this section, the term "packet sizes" refers to the maximum User Data field lengths of DCE DATA and DTE DATA packets.

Values other than the default packet sizes may be negotiated for a virtual call by means of the Flow Control Parameter Negotiation facility (see section 7.2.2). Values other than the default packet sizes may be agreed for a period of time for each permanent virtual circuit.

7.2.2 Flow Control Parameter Negotiation

Flow Control Parameter Negotiation is an optional user facility agreed for a period of time which can be used by a DTE for virtual calls. This facility, if subscribed to, permits negotiation on a per call basis of the flow control parameters. The flow control parameters considered are the packet and window sizes at the DTE/DCE interface for each direction of data transmission.

Note: In this section, the term "packet sizes" refers to the maximum User Data field lengths of DCE DATA and DTE DATA packets.

In the absence of the Flow Control Parameter Negotiation facility, the flow control parameters to be used at a particular DTE/DCE interface are the default packet sizes (see section 7.2.1) and the default window sizes (see section 7.1.2).

When the calling DTE has subscribed to the Flow Control Parameter Negotiation facility, it may separately request packet sizes and window sizes for each direction of data transmission (see section 7.4.2.5). If a particular window size is not explicitly requested in a CALL REQUEST packet, the DCE will assume that the default window size was requested. If a particular packet size is not explicitly requested, the DCE will assume that the default packet size was requested.

When a called DTE has subscribed to the Flow Control Parameter Negotiation facility, each INCOMING CALL packet will indicate the packet and window sizes from which DTE negotiation can start. No relationship needs to exist between the packet and window sizes requested in the CALL REQUEST packet and those indicated in the INCOMING CALL packet. The called DTE may request window and packet sizes with facilities in the CALL ACCEPTED packet. The only valid facility requests in the CALL ACCEPTED packet, as a function of the facility indications in the INCOMING CALL packet, are given in Table 7.1/X.25. If the facility request is not made in the CALL ACCEPTED packet, the DTE is assumed to have accepted the indicated values (regardless of the default values).

TABLE 7.1/X.25

VALID FACILITY REQUESTS IN CALL ACCEPTED PACKET IN RESPONSE TO FACILITY INDICATIONS IN INCOMING CALL PACKET

Facility Indication	Valid Facility Request
W(indicated) $\geq$ 2	W(indicated) $\geq$ W(requested) $\geq$ 2
W(indicated) = 1	W(requested) = 1 or 2
P(indicated) $\geq$ 128	P(indicated) $\geq$ P(requested) $\geq$ 128
P(indicated) < 128	128 $\geq$ P(requested) $\geq$ P(indicated)

When the calling DTE has subscribed to the Flow Control Parameter Negotiation facility, every CALL CONNECTED packet will indicate the packet and window sizes to be used at the DTE/DCE interface for the call. The only valid facility indications in the CALL CONNECTED packet, as a function of the facility requests in the CALL REQUEST packet, are given in Table 7.2/X.25.

TABLE 7.2/X.25

VALID FACILITY INDICATIONS IN CALL CONNECTED PACKET IN RESPONSE TO FACILITY REQUESTS IN CALL REQUEST PACKET

Facility Request	Valid Facility Indication
W(requested) $\geq$ 2	W(requested) $\geq$ W(indicated) $\geq$ 2
W(requested) = 1	W(indicated) = 1 or 2
P(requested) $\geq$ 128	P(requested) $\geq$ P(indicated) $\geq$ 128
P(requested) < 128	128 $\geq$ P(indicated) $\geq$ P(requested)

The network may have constraints requiring the flow control parameters used for a call to be modified before indicating them to the DTE in the INCOMING CALL packet or CALL CONNECTED packet; e.g., the ranges of parameter values available on various networks may differ.

Window and packet sizes need not be the same at each end of a virtual call.

The role of the DCE in negotiating the flow control parameters may be network dependent.

7.2.3 Throughput Class Negotiation

Throughput Class Negotiation is an optional user facility agreed for a period of time which can be used by a DTE for virtual calls. This facility, if subscribed to, permits negotiation on a per call basis of the throughput classes. The throughput classes are considered independently for each direction of data transmission.

Default values are agreed between the DTE and the Administration (see section 7.1.3). The default values correspond to the maximum throughput classes which may be associated with any virtual call at the DTE/DCE interface.

When the calling DTE has subscribed to the Throughput Class Negotiation facility, it may separately request the throughput classes of the virtual call in the CALL REQUEST packet (see section 7.4.2.6). If particular throughput classes are not requested, the DCE will assume the default values.

When a called DTE has subscribed to the Throughput Class Negotiation facility, each INCOMING CALL packet will indicate the throughput classes from which DTE negotiation may start. These throughput classes are lower or equal to the ones selected at the calling DTE/DCE interface, either explicitly, or by default if the calling DTE has not subscribed to the Throughput Class Negotiation facility or has not explicitly requested throughput class values in the CALL REQUEST packet. These throughput classes indicated to the called DTE will also not be higher than the default throughput classes, respectively for each direction of transmission, at the calling and the called DTE/DCE interfaces. They may be further constrained by internal limitations of the network.

The called DTE may request with a facility in the CALL ACCEPTED packet the throughput classes that should finally apply to the virtual call. The only valid throughput classes in the CALL ACCEPTED packet are lower than or equal to the ones (respectively) indicated in the INCOMING CALL packet. If the called DTE does not make any throughput class facility request in the CALL ACCEPTED packet, the throughput classes finally applying to the virtual call will be the ones indicated in the INCOMING CALL packet.

If the called DTE has not subscribed to the Throughput Class Negotiation facility, the throughput classes finally applying to the virtual call are less than or equal to the ones selected at the calling DTE/DCE interface, and less than or equal to the default values defined at the called DTE/DCE interface.

When the calling DTE has subscribed to the Throughput Class Negotiation facility, every CALL CONNECTED packet will indicate the throughput classes finally applying to the virtual call.

When neither the calling DTE nor the called DTE has subscribed to the Throughput Class Negotiation facility, the throughput classes applying to the virtual call will not be higher than the ones agreed as defaults at the calling and called DTE/DCE interfaces. They may be further constrained to lower values by the network, e.g., for international service.

Note 1: Since both Throughput Class Negotiation and Flow Control Parameter Negotiation (see section 7.2.2) facilities can be applied to a single call, the achievable throughput will depend on how users manipulate the D bit.

Note 2: Users are cautioned that the choice of too small a window and packet size of a DTE/DCE interface (made by use of the Flow Control Parameter Negotiation facility) may adversely affect the attainable throughput class of a virtual call. This is likewise true of flow control mechanisms adopted by the DTE to control data transmission from the DCE.

7.2.4 Fast Select

Fast Select is an optional user facility which may be requested by a DTE for a given virtual call.

DTEs can request the Fast Select facility on a per call basis by means of an appropriate facility request (see section 7.4.2.7) in a CALL REQUEST packet using any logical channel which has been assigned to virtual calls.

The Fast Select facility, if requested in the CALL REQUEST packet and if it indicates no restriction on response, allows this packet to contain a Call User Data field of up to 128 octets and authorizes the DCE to transmit to the DTE, during the DTE waiting state, a CALL CONNECTED packet with a Called User Data field of up to 128 octets or a CLEAR INDICATION packet with a Clear User Data field of up to 128 octets.

The Fast Select facility, if requested in the CALL REQUEST packet and if it indicates restriction on response, allows this packet to contain a Call User Data field of up to 128 octets and authorizes the DCE to transmit to the DTE, during the DTE waiting state, a CLEAR INDICATION packet with a Clear User Data field of up to 128 octets; the DCE would not be authorized to transmit a CALL CONNECTED packet.

Where a DTE requests the Fast Select facility in a CALL REQUEST packet, the INCOMING CALL packet should be only delivered to the called DTE if that DTE has subscribed to the Fast Select Acceptance facility (see section 7.2.5).

If the called DTE has subscribed to the Fast Select Acceptance facility, it will be advised that the Fast Select facility, and an indication of whether or not there is a restriction on the response, has been requested through the inclusion of the appropriate facility in the INCOMING CALL packet.

If the called DTE has not subscribed to the Fast Select Acceptance facility, an INCOMING CALL packet with the Fast Select facility requested will not be transmitted and a CLEAR INDICATION packet with the cause "Fast select acceptance not subscribed" will be returned to the calling DTE.

The presence of the Fast Select facility indicating no restriction on response in an INCOMING CALL packet permits the DTE to issue as a direct response to this packet a CALL ACCEPTED packet with a Called User Data field of up to 128 octets or a CLEAR REQUEST packet with a Clear User Data field of up to 128 octets.

The presence of the Fast Select facility indicating restriction on response in an INCOMING CALL packet permits the DTE to issue as a direct response to this packet a CLEAR REQUEST packet with a Clear User Data field of up to 128 octets; the DTE would not be authorized to send a CALL ACCEPTED packet.

The possibility to send a CLEAR REQUEST packet with a Clear User Data field up to 128 octets at any time instead of just in the DCE WAITING state (p3) is for further study.

Note: The Call User Data field, the Called User Data field and the Clear User Data field will not be fragmented for delivery across the DTE/DCE interface.

The significance of the CALL CONNECTED packet and the CLEAR INDICATION packet with the cause "DTE originated" as a direct response to the CALL REQUEST packet with the Fast Select facility is that the CALL REQUEST packet with the data field has been received by the called DTE.

All other procedures of a call in which the Fast Select facility has been requested are the same as those of a virtual call.

7.2.5 Fast Select Acceptance

Fast Select Acceptance is an optional user facility agreed for a period of time. This user facility, if subscribed to, authorizes the DCE to transmit to the DTE incoming calls which request the Fast Select facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls which request the Fast Select facility.

7.2.6 D Bit Modification

D Bit Modification is an optional user facility agreed for a period of time. This facility applies to all virtual calls and permanent virtual circuits at the DTE/DCE interface. This facility is only intended for use by those pre D bit DTEs which were designed for operation on Public Data Networks that support end-to-end P(R) significance. It allows these DTEs to continue to operate with end-to-end P(R) significance within a national network after the network supports the delivery confirmation (D bit) procedure.

This facility, when subscribed to, will for communications within the national network:

(a) change the value of the D bit from 0 to 1 in all CALL REQUEST, CALL ACCEPTED and DTE DATA packets received from the DTE, and

(b) set the D bit to 0 in all INCOMING CALL, CALL CONNECTED and DCE DATA packets transmitted to the DTE.

For international operation, conversion (b) above applies and conversion (a) above does not apply. Other conversion rules for international operation are for bilateral agreement between

Administrations.

7.3 Procedures for Optional User Facilities Only Available with Datagram Service

7.3.1 Abbreviated Address

Abbreviated Address an optional user facility agreed for a period of time. This facility permits encoding of addresses into shorter representations as agreed between the Administration and DTE. Initially this facility is restricted to a 1:1 mapping of single addresses, but 1:N mapping for multiple addresses is for further study.

7.3.2 Datagram Queue Length Selection

Datagram Queue Length Selection is an optional user facility agreed for a period of time for each datagram logical channel. This facility enables selection of the number of datagram and datagram service signal packets that will be stored in a queue by the destination DCE when the rate of arrival of packets at the destination DCE from other sources exceeds the rate of delivery of packets to the destination DTE.

7.3.3 Datagram Service Signal Logical Channel

Datagram Service Signal Logical Channel is an optional user facility agreed for a period of time. This facility provides a separate logical channel for the DTE to receive only datagram service signals. This enables the DTE to separately flow control datagram service signal packets from the datagram packets.

7.3.4 Datagram Non-delivery Indication

Datagram Non-delivery Indication is an optional user facility which may be agreed for a period of time or selected on a per-datagram basis (see section 7.4.2.8).

This user facility, when requested, provides for a non-delivery indication service signal generated by the network when a datagram cannot be delivered to the destination DTE.

7.3.5 Datagram Delivery Confirmation

Datagram Delivery Confirmation is an optional user facility which may be agreed for a period of time or selected on a per-datagram basis (see section 7.4.2.9).

This user facility, when requested, provides for a delivery confirmation service signal generated by the network after the datagram has been accepted by the destination DTE.

7.4 Formats for Optional User Facilities

7.4.1 General

The Facility field is present only when a DTE is using an optional user facility requiring some indication in the CALL REQUEST, INCOMING CALL, CALL ACCEPTED, CALL CONNECTED, CLEAR REQUEST, CLEAR INDICATION, DTE DATAGRAM or DCE DATAGRAM packet.

The Facility field contains one or more facility elements. The first octet of each facility element contains a facility code to indicate the facility or facilities requested.

Note: The action taken by the DCE when a facility code appears more than once is for further study.

The facility codes are divided into four classes, by making use of bits 8 and 7 of the facility code field, in order to specify facility parameters consisting of 1, 2, 3, or a variable number of octets. The general class coding of the facility code field is shown below.

bit	8 7 6 5 4 3 2 1	
CLASS A	0 0 X X X X X X	for single octet parameter field
CLASS B	0 1 X X X X X X	for double octet parameter field
CLASS C	1 0 X X X X X X	for triple octet parameter field
CLASS D	1 1 X X X X X X	for variable length parameter field

For class D the octet following the facility code indicates the length, in octets, of the facility parameter field. The facility parameter field length is binary coded and bit 1 is the low order bit of this indicator.

The formats for the four classes are shown below.

CLASS A

	8	7	6	5	4	3	2	1
0	0	0	X	X	X	X	X	X
1	Facility parameter field							

CLASS B

	8	7	6	5	4	3	2	1
0	0	1	X	X	X	X	X	X
1	Facility parameter							
2	field							

CLASS C

	8	7	6	5	4	3	2	1
0	1	0	X	X	X	X	X	X
1	Facility							
2	parameter							
3	field							

CLASS D

	8	7	6	5	4	3	2	1
0	1	1	X	X	X	X	X	X
1	Facility parameter field length							
2	Facility parameter field							

The facility code field is binary coded and, without extension, provides for a maximum of 64 facility codes for classes A, B and C and 63 facility codes for class D giving a total of 255 facility codes.

Facility code 11111111 is reserved for extension of the facility code. The octet following this octet indicates an extended facility code having the format A, B, C or D as defined above. Repetition of facility code 11111111 is permitted and thus additional extensions result.

The coding of the facility parameter field is dependent on the facility being requested.

A facility code may be assigned to identify a number of specific facilities, each having a bit in the parameter field indicating facility requested/facility not requested. In this situation, the parameter field is binary encoded with each bit position relating to a specific facility. A 0 indicates that the facility related to the particular bit is not requested and a 1 indicates that the facility related to the particular bit is requested. Parameter bit positions not assigned to a specific facility are set to zero. If none of the facilities represented by the facility code are requested for a virtual call or datagram, the facility code and its associated parameter field need not be present.

A Facility Marker, consisting of a single octet pair, is used to separate requests for X.25 facilities, as defined in this section, from requests for non-X.25 facilities that may also be offered by an Administration. The first octet is a facility code and is set to zero and the second octet is the facility parameter field.

The coding of the parameter field will be either all zeros or all ones depending on whether the facility requests following the marker refer to facilities offered by the calling/source or called/destination network, respectively. For intra-network virtual calls or datagrams, the parameter field should be all zeros.

Requests for non-X.25 facilities offered by the calling/source and called/destination networks may be simultaneously present within the facility field and in such cases two Facility Markers will be required with parameter fields coded as described above.

Within the facility field, requests for X.25 facilities will precede all requests for non-X.25 facilities and Facility Markers need only be included when requests for non-X.25 facilities are present.

7.4.2 Coding of Facility Field for Particular Facilities

7.4.2.1 Coding of Closed User Group Facility

The coding of the facility code field and the format of the facility parameter field for Closed User Group are the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Closed User Groups is:

bit:	8	7	6	5	4	3	2	1
code:	0	0	0	0	0	0	1	1

Facility Parameter Field

The index to the Closed User Group selected for the virtual call or datagram is in the form of two decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 being the low order bit of the first digit and bit 1 being the low order bit of the second digit.

Indexes to the same Closed User Group at different DTE/DCE interfaces may be different.

7.4.2.2 Coding of Bilaterial Closed User Group Facility

The coding of the facility code field and the format of the facility parameter field for Bilateral Closed User Group are the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Bilateral Closed User Group is:

bit: 8 7 6 5 4 3 2 1

code: 0 1 0 0 0 0 0 1

Facility Parameter Field

The index to the Bilateral Closed User Group selected for the virtual call or datagram is in the form of 4 decimal digits.

Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit, and bit 1 of the second octet being the low order bit of the fourth digit.

Indexes to the same Bilateral Closed User Group at different DTE/DCE interfaces may be different.

7.4.2.3 Coding of Reverse Charging Facility

The coding of the facility code and parameter fields for Reverse Charging is the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM, and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Reverse Charging is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 0 0 1

Facility Parameter Field

The coding of the facility parameter field is:

bit 1 = 0 for Reverse Charging not requested

bit 1 = 1 for Reverse Charging requested

Note: Bits 6, 5, 4, 3 and 2 may be used for other facilities; if not, they are set to 0. Use of bits 8 and 7 are described in section 7.4.2.7.

7.4.2.4 Coding of RPOA Selection Facility

The coding of the facility code and parameter fields for RPOA Selection is the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for RPOA Selection is:

bit: 8 7 6 5 4 3 2 1

code: 0 1 0 0 0 1 0 0

Facility Parameter Field

The parameter field contains the Data Network Identification Code for the requested RPOA transit network, and is in the form of 4 decimal digits.

Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit, and bit 1 of the second octet being the low order bit of the fourth digit.

7.4.2.5 Coding of the Flow Control Parameter Negotiation Facility

7.4.2.5.1 Coding for Packet Sizes

The coding of the facility code field and the format of the facility parameter field for packet sizes are the same in CALL REQUEST, INCOMING CALL, CALL ACCEPTED, and CALL CONNECTED packets.

Facility Code Field

The coding of the facility code field for packet sizes is:

bit: 8 7 6 5 4 3 2 1

code: 0 1 0 0 0 0 1 0

Facility Parameter Field

The packet size for the direction of transmission from the called DTE is indicated in bits 4, 3, 2, and 1 of the first octet. The packet size for the direction of transmission from the calling DTE is indicated in bits 4, 3, 2, and 1 of the second octet. Bits 5, 6, 7 and 8 of each octet must be zero.

The four bits indicating each packet size are binary coded and express the logarithm base 2 of the number of octets of the maximum packet size.

Networks may offer values from 4 to 10, corresponding to packet sizes of 16, 32, 64, 128, 256, 512, or 1024, or a subset of these values. All Administrations will provide a packet size of 128.

7.4.2.5.2 Coding for Window Sizes

The coding of the facility code field and the format of the facility parameter field for window sizes are the same in CALL REQUEST, INCOMING CALL, CALL ACCEPTED, and CALL CONNECTED packets.

Facility Code Field

The coding of the facility code field for window sizes is:

bit:	8	7	6	5	4	3	2	1
code:	0	1	0	0	0	0	1	1

Facility Parameter Field

The window size for the direction of transmission from the called DTE is indicated in bits 7 to 1 of the first octet. The window size for the direction of transmission from the calling DTE is indicated in bits 7 to 1 of the second octet. Bit 8 of each octet must be zero.

The bits indicating each window size are binary coded and express the size of the window. A value of zero is not allowed.

Window sizes of 8 to 127 are only valid for calls which employ extended numbering. The ranges of values allowed by a network for calls with normal numbering and extended numbering are network dependent. All Administrations will provide a window size of 2.

7.4.2.6 <u>Coding of Throughput Class Negotiation Facility</u>

The coding of the facility code field and the format of the facility parameter field for Throughput Class Negotiation are the same in CALL REQUEST, INCOMING CALL, CALL ACCEPTED and CALL CONNECTED packets.

Facility Code Field

The coding of the facility code field for Throughput Class Negotiation is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 0 1 0

Facility Parameter Field

The throughput class for transmission from the calling DTE is indicated in bits 4, 3, 2 and 1. The throughput class for transmission from the called DTE is indicated in bits 8, 7, 6 and 5.

The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated below.

bit: / or bit:	4 / 8	3 / 7	2 / 6	1 / 5	Throughput class (bits per second)
	0	0	0	0	Reserved
	0	0	0	1	Reserved
	0	0	1	0	Reserved
	0	0	1	1	75
	0	1	0	0	150
	0	1	0	1	300
	0	1	1	0	600
	0	1	1	1	1,200
	1	0	0	0	2,400
	1	0	0	1	4,800
	1	0	1	0	9,600
	1	0	1	1	19,200
	1	1	0	0	48,000
	1	1	0	1	Reserved
	1	1	1	0	Reserved
	1	1	1	1	Reserved

[illegible] <u>Coding of Fast Select Facility</u>

[illegible] of the facility code and parameter fields for Fast [illegible] the same in CALL REQUEST and INCOMING CALL packets.

Facility Code Field

The coding of the facility code field for Fast Select is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 0 0 1

Facility Parameter Field

The coding of the facility parameter field is:

bit 8 = 0 and bit 7 = 0 or 1 for Fast Select not requested

bit 8 = 1 and bit 7 = 0 for Fast Select requested with no restriction on response

bit 8 = 1 and bit 7 = 1 for Fast Select requested with restriction on response

Note: Bits 6, 5, 4, 3 and 2 may be used for other facilities; if not, they are set to 0. Use of bit 1 is described in section 7.4.2.3.

7.4.2.8 Coding of Datagram Non-delivery Indication Facility

The coding of the facility code and parameter fields is the same in the DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Datagram Non-delivery Indication is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 1 1 0

Facility Parameter Field

The coding of the facility parameter field is:

bit 2 = 0 for Datagram Non-delivery Indication not requested

bit 2 = 1 for Datagram Non-delivery Indication requested

Note: Bits 8, 7, 6, 5, 4, and 3 may be used for other facilities; if not, they are set to 0. Use of bit 1 is described in section 7.4.2.9.

7.4.2.9 Coding of Datagram Delivery Confirmation Facility

The coding of the facility code and parameter fields is the same in the DTE DATAGRAM and DCE DATAGRAM packets.

Facility Code Field

The coding of the facility code field for Datagram Delivery Confirmation is:

bit: 8 7 6 5 4 3 2 1

code: 0 0 0 0 0 1 1 0

Facility Parameter Field

The coding of the facility parameter field is:

bit 1 = 0 for Datagram Delivery Confirmation not requested

bit 1 = 1 for Datagram Delivery Confirmation requested

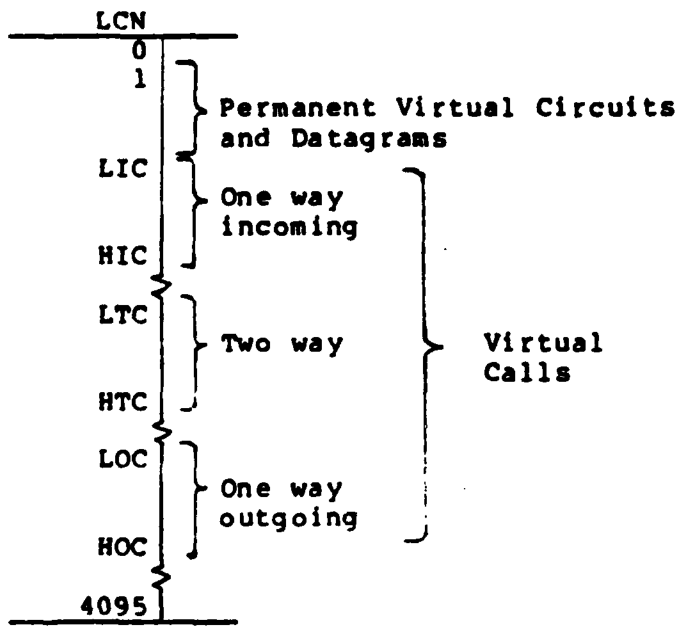
Note: Bits 8, 7, 6, 5, 4, and 3 may be used for other facilities; if not, they are set to 0. Use of bit 2 is described in section 7.4.2.8.

ANNEX 1
(to Recommendation X.25)

RANGE OF LOGICAL CHANNELS USED FOR VIRTUAL CALLS, PERMANENT VIRTUAL CIRCUITS AND DATAGRAMS

In the case of a single logical channel DTE, logical channel 1 will be used.

For each multiple logical channel DTE/DCE interface, a range of logical channels will be agreed upon with the Administration according to the following figure:



where:

Logical channels 1 to LIC-1: range of logical channels which may be assigned to permanent virtual circuits and datagrams.

Logical channels LIC to HIC: range of logical channels which are assigned to one-way incoming logical channels for virtual calls (see section 7.1.8).

Logical channels LTC to HTC: range of logical channels which are assigned to two-way logical channels for virtual calls.

Logical channels LOC to HOC: range of logical channels which are assigned to one-way outgoing logical channels for virtual calls (see section 7.1.7).

Logical channels HIC+1 to LTC-1, HTC+1 to LOC-1, and HOC+1 to 4095 are non-assigned logical channels.

<u>Note 1</u>: The reference to the numbers of logical channels is made according to a set of contiguous numbers from 0 (lowest) to 4095 (highest) using 12 bits made up of the 4 bits of the Logical Channel Group Number (see section 6.1.2) and the 8 bits of the Logical Channel Number (see section 6.1.3). The numbering is binary coded using bit positions 4 through 1 of octet 1 followed by bit positions 8 through 1 of octet 2 with bit 1 of octet 2 as the low order bit.

<u>Note 2</u>: All logical channel boundaries are agreed with the Administration for a period of time.

<u>Note 3</u>: In order to avoid frequent rearrangement of logical channels, not all logical channels within the range for permanent virtual circuits or datagrams are necessarily assigned.

<u>Note 4</u>: In the absence of permanent virtual circuits and datagram channels, logical channel 1 is available for LIC. In the absence of permanent virtual circuits, datagram channels and one-way incoming logical channels, logical channel 1 is available for LTC. In the absence of permanent virtual circuits, datagram channels, one way incoming logical channels and two-way logical channels, logical channel 1 is available for LOC.

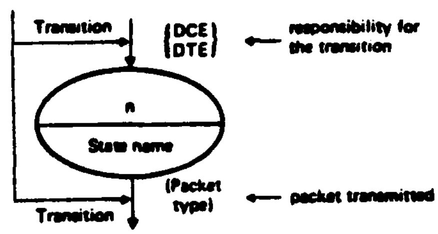
<u>Note 5</u>: DCE search algorithm for a logical channel for a new incoming call will be to use the lowest logical channel in the READY state in the range of LIC to HIC and LTC to HTC.

<u>Note 6</u>: In order to minimize the risk of call collision, the DTE search algorithm is suggested to start with the highest numbered logical channel in the READY state. The DTE could start with the two-way logical channel or one-way outgoing logical channel ranges.

ANNEX 2
(to Recommendation X.25)

PACKET LEVEL DTE/DCE INTERFACE STATE DIAGRAMS

Symbol definition of the state diagrams



Note 1: Each state is represented by an ellipse wherein the state name and number are indicated.

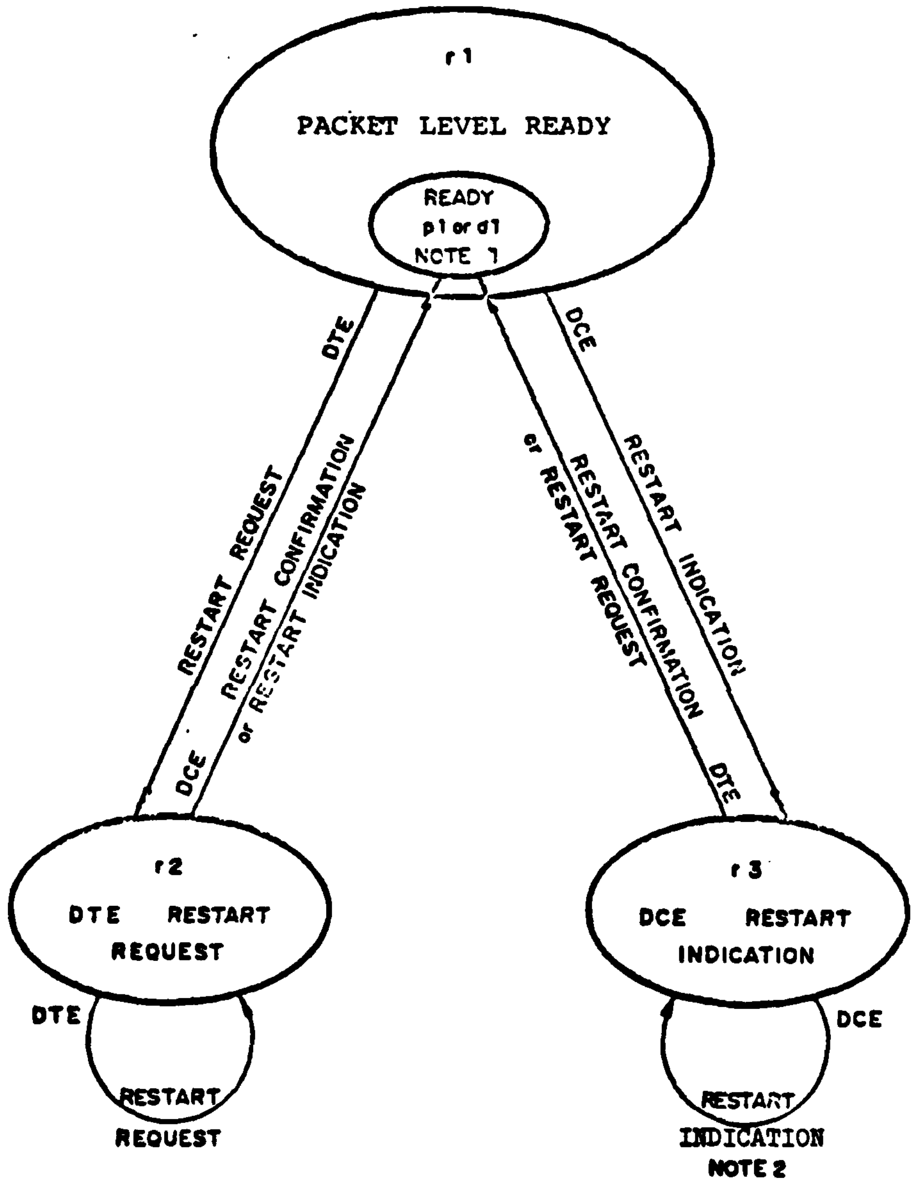
Note 2: Each state transition is represented by an arrow. The responsibility for the transition (DTE or DCE) and the packet that has been transferred are indicated beside that arrow.

Order definition of the state diagrams

For the sake of clarity, the normal procedure at the interface is described in a number of small state diagrams. In order to describe the normal procedure fully it is necessary to allocate a priority to the different figures and to relate a higher order diagram with a lower one. This has been done by the following means:

- The figures are arranged in order of priority with Figure A2.1/X.25 (Restart) having the highest priority and subsequent figures having lower priority. Priority means that when a packet belonging to a higher order diagram is transferred, that diagram is applicable and the lower order one is not.

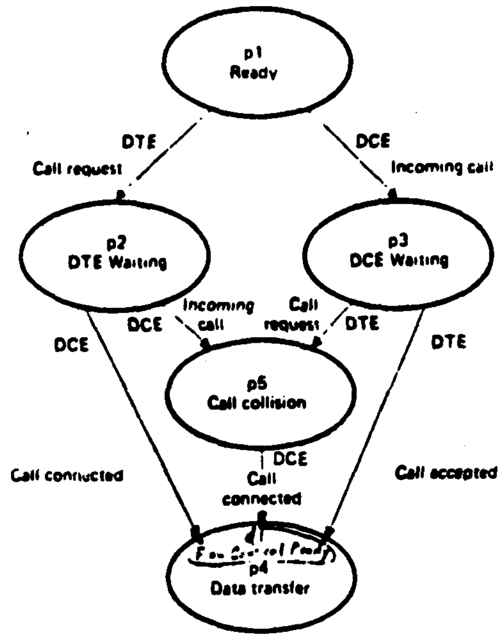
- The relation with a state in a lower order diagram is given by including that state inside an ellipse in the higher order diagram.



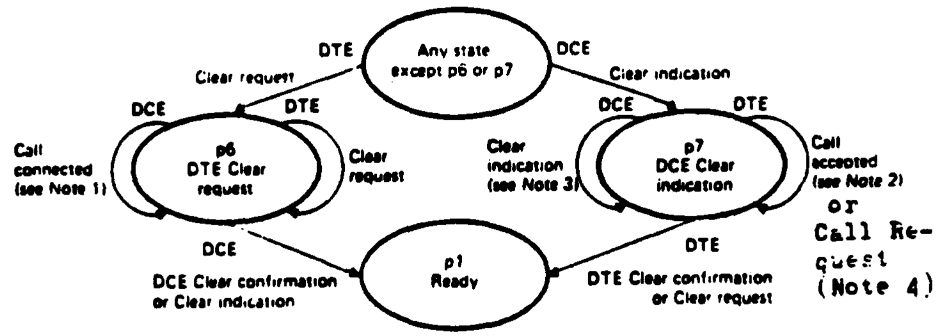
Note 1: State pl for virtual calls or state dl for permanent virtual circuits and datagram.

Note 2: This transition may take place after timeout T10.

Figure A2.1/X.25 - Diagram of states for the transfer of restart packets.



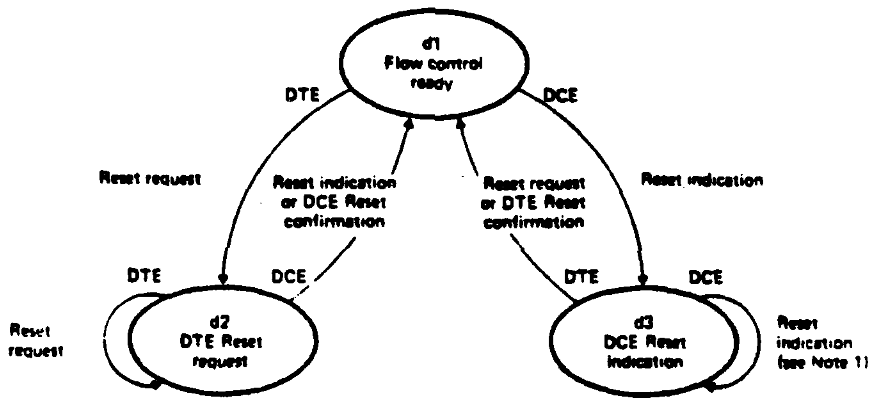
a) Call set-up phase



b) Call clearing phase

Note 1 - This transition is possible only if the previous state was *DTE Waiting* (p2).
Note 2 - This transition is possible only if the previous state was *DCE Waiting* (p3).
Note 3 - This transition may take place after time-out T13.
Note 4 - This transition is possible only if the previous state was Ready (p1) or DCE Waiting (p3).

Figure A2.2/X.25 - Diagram of states for the transfer of call set-up and call clearing packets within the packet level ready (r1) state



Note 1. – This transition may take place after time-out T12

Figure A2.3/X.25 - Diagram of states for the transfer of reset packets within the data transfer (p4) state

ANNEX 3
(to Recommendation X.25)

ACTIONS TAKEN BY THE DCE ON RECEIPT OF PACKETS IN A GIVEN STATE OF THE PACKET LEVEL DTE/DCE INTERFACE AS PERCEIVED BY THE DCE

TABLE A3.1/X.25

Special cases

The number following the # is the diagnostic code (see Annex 5).

Packet from the DTE	Any state
Any packet with packet length <2 octets	DIAG #38
Any packet with incorrect general format identifier	DIAG #40
Any packet with unassigned logical channel	DIAG #36
Any packet with correct GFI and assigned logical channel	SEE TABLE A3.2/X.25

DIAG: The DCE discards the received packet and, for networks which implement the diagnostic packet, transmits a DIAGNOSTIC packet to the DTE containing the indicated diagnostic code.

There may be more than one error associated with a packet. The network will stop normal processing of a packet when an error is encountered. Thus only one diagnostic code is indicated in the DIAGNOSTIC packet. The order of packet de-coding and checking on networks is not standardized.

TABLE A3.2/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: restart procedure for assigned logical channels

The figures in brackets are the new states to be entered.
The figure following the # is the diagnostic code (Note 1).

State of the interface as perceived by the DCE / Packet from the DTE with assigned logical channel	PACKET LEVEL READY r1	DTE RESTART REQUEST r2	DCE RESTART INDICATION r3
RESTART REQUEST	NORMAL (r2)	DISCARD (r2)	NORMAL (p1 or d1) Note 2
DTE RESTART CONFIRMATION	ERROR (r3) #17	ERROR (r3) #18	NORMAL (p1 or d1) Note 2
DATA, DATAGRAM, INTERRUPT, CALL SET-UP AND CLEARING, FLOW CONTROL OR RESET	SEE TABLE A3.3/X.25	ERROR (r3) #18	DISCARD (r3)
RESTART REQUEST OR DTE RESTART CONFIRMATION WITH BITS 1 TO 4 OF OCTET 1 OR BITS 1 TO 8 OF OCTET 2 ≠ 0	SEE TABLE A3.3/X.25	ERROR (r3) #41	DISCARD (r3)
PACKETS HAVING A PACKET TYPE IDENTIFIER WHICH IS SHORTER THAN 1 OCTET OR IS NOT SUPPORTED BY THE DCE	SEE TABLE A3.3/X.25	ERROR (r3) #38 #33	DISCARD (r3)

NOTES TO TABLE A3.2/X.25

NORMAL: The action taken by the DCE follows the procedures as defined in section 3. If a RESTART REQUEST packet or DTE RESTART CONFIRMATION packet received in state r3 exceeds the maximum permitted length, the DCE will invoke the ERROR procedure with diagnostic #39 and enter state r3. If a RESTART REQUEST packet received in state r1 exceeds the maximum permitted length, the action taken by the DCE is for further study.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a restarting by transmitting to the DTE a RESTART INDICATION packet, with the cause "Local procedure error" (diagnostic per Table A3.2/X.25). If connected through the virtual call, the distant DTE is also informed of the restarting by a CLEAR INDICATION packet, with the cause "Remote procedure error" (same diagnostic). In the case of a permanent virtual circuit, the distant DTE will be informed by a RESET INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

If a RESTART INDICATION is issued as a result of an error condition in state r2, the DCE should eventually consider the DTE/DCE interface to be in the PACKET LEVEL READY state (r1).

<u>Note 1</u>: There may be more than one error associated with a packet. The network will stop normal processing of a packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet de-coding and checking on networks is not standardized.

<u>Note 2</u>: p1 for logical channels assigned to virtual calls; d1 for logical channels assigned to permanent virtual circuits and datagrams.

TABLE A3.3/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: call setup and clearing on assigned logical channels

The figures in brackets are the new states to be entered. The figure following the # is the diagnostic code (Note 1).

State of the interface as perceived by the DCE / Packet from the DTE with assigned logical channel	PACKET LEVEL READY r1						
	READY p1	DTE WAITING p2 Note 3	DCE WAITING p3 Note 2	DATA TRANSFER p4	CALL COLLISION p5 Notes 2,3	DTE CLEAR REQUEST p6	DCE CLEAR INDICATION p7
CALL REQUEST	NORMAL (p2) Note 4	ERROR (p7) #21	NORMAL (p5) Note 4	ERROR (p7) Note 5 #23	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
CALL ACCEPTED	ERROR (p7) #20	ERROR (p7) #21	NORMAL (p4) Note 6 ERROR (p7) Note 7 #42	ERROR (p7) Note 5 #23	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
CLEAR REQUEST	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6) Note 5	NORMAL (p6)	DISCARD (p6)	NORMAL (p1)
DTE CLEAR CONFIRMATION	ERROR (p7) #20	ERROR (p7) #21	ERROR (p7) #22	ERROR (p7) Note 5 #23	ERROR (p7) #24	ERROR (p7) #25	NORMAL (p1)
DATA, DATAGRAM, INTERRUPT, RESET OR FLOW CONTROL	ERROR (p7) #20	ERROR (p7) #21	ERROR (p7) #22	SEE TABLE A3.4/X.25	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
RESTART REQUEST OR DTE RESTART CONFIRMATION WITH BITS 1 TO 4 OF OCTET 1 OR BITS 1 TO 8 OF OCTET 2 $\neq$ 0	ERROR (p7) #41	ERROR (p7) #41	ERROR (p7) #41	SEE TABLE A3.4/X.25	ERROR (p7) #41	ERROR (p7) #41	DISCARD (p7)
PACKETS HAVING A PACKET TYPE IDENTIFIER WHICH IS SHORTER THAN ONE OCTET OR IS NOT SUPPORTED BY THE DCE	ERROR (p7) #38 #33	ERROR (p7) #38 #33	ERROR (p7) #38 #33	SEE TABLE A3.4/X.25	ERROR (p7) #38 #33	ERROR (p7) #38 #33	DISCARD (p7)

NOTES TO TABLE A3.3/X.25

NORMAL: The action taken by the DCE follows the procedures as defined in section 4. If the packet exceeds the maximum permitted length the DCE will invoke the ERROR procedure with diagnostic #39 and enter state p7.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a clearing by transmitting to the DTE a CLEAR INDICATION packet, with the cause "Local procedure error" (diagnostic per Table A3.3/X.25). If connected through the virtual call, the distant DTE is also informed of the clearing by a CLEAR INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

It is required that in the absence of an appropriate DTE response to a CLEAR INDICATION packet issued as a result of an error condition in state p6, the DCE should eventually consider the DTE/DCE interface to be in the READY state (p1).

<u>Note 1</u>: There may be more than one error associated with a packet (e.g., packet too long and transmitted in a wrong state). The network will stop processing of the packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet de-coding and checking on networks is not standardized.

<u>Note 2</u>: This state does not exist in the case of an outgoing one-way logical channel (as perceived by the DTE).

<u>Note 3</u>: This state does not exist in the case of an incoming one-way logical channel (as perceived by the DTE).

<u>Note 4</u>: (a) In the case of an incoming one-way logical channel (as perceived by the DTE) the DCE will transmit a CLEAR INDICATION with the cause "Local procedure error" and diagnostic #34.

(b) The DCE will transmit a CLEAR INDICATION if the CALL REQUEST contains an improper address format or facility field; call progress signals and diagnostic codes are listed below:

AD-A099 489 DELTA INFORMATION SYSTEMS INC JENKINTOWN PA F/G 17/2
A PROJECTION OF THE CHARACTERISTICS OF GROUP 4 FACSIMILE EQUIPM--ETC(U)
FEB 81 R A SCHAPHORST DCA100-80-M-0200
UNCLASSIFIED NCS-TIB-81-2 NL

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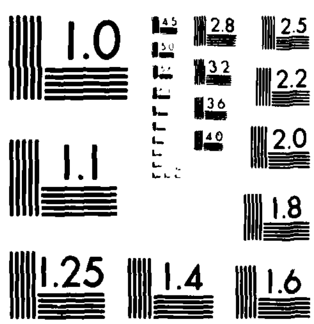


MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963 A

	Error Condition	Cause			Possible Diagnostics
1.	Address contains a non BCD digit	Local	Procedure	Error	#67,68
2.	Prefix digit not supported	"	"	"	"
3.	National address smaller than national address format permits	"	"	"	"
4.	National address larger than national address format permits	"	"	"	"
5.	DNIC less than four digits	"	"	"	"
6.	Facility length larger than 63	"	"	"	#64
7.	No combination of facilities could equal facility length	"	"	"	#64
8.	Facility length larger than remainder of packet	"	"	"	#38
9.	Facility values conflict (e.g., a particular combination not supported)	"	"	"	#66
10.	Facility code not allowed	Invalid	Facility	Request	#65
11.	Facility value not allowed	"	"	"	#66

(c) The DCE will transmit a CLEAR INDICATION if the remote DTE makes a procedure error, either for one of the above reasons associated with its call acceptance, or because of an expired timeout (diagnostic #49).

Note 5: In the case of an permanent virtual circuit, the DCE discards the received packet and indicates a reset by transmitting to the DTE a RESET INDICATION packet, with the cause "Local procedure error" (diagnostic #35). The distant DTE is also informed of the reset by a RESET INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

In the case of a datagram logical channel, the DCE discards the received packet and indicates a reset by transmitting to the DTE a RESET INDICATION packet, with the cause "Local procedure error".

Note 6: The ERROR procedure will be invoked by the DCE if the CALL ACCEPTED packet contains an improper address format or facility field. Examples are similar to those in Note 4 point (b) above.

Note 7: The presence of the Fast Select facility, indicating restriction on response in an INCOMING CALL packet prohibits the DTE from sending a CALL ACCEPTED packet.

TABLE A3.4/X.25

<u>**Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: data transfer (flow control and reset) on assigned logical channels**</u>

The figures in brackets are the new states to be entered. The figure following the # is the diagnostic code (Note 1).

State of the interface as perceived by the DCE / Packet from the DTE with assigned logical channel	DATA TRANSFER p4		
	FLOW CONTROL READY d1	DTE RESET REQUEST d2	DCE RESET INDICATION d3
RESET REQUEST	NORMAL (d2)	DISCARD (d2)	NORMAL (d1)
DTE RESET CONFIRMATION	ERROR (d3) #27	ERROR (d3) #28	NORMAL (d1)
DATA, DATAGRAM, INTERRUPT OR FLOW CONTROL	NORMAL (d1) Note 2	ERROR (d3) #28	DISCARD (d3)
RESTART REQUEST OR DTE RESTART CONFIRMATION WITH BITS 1 TO 4 OF OCTET 1 OR BITS 1 TO 8 OF OCTET 2 ≠ 0	ERROR (d3) #41	ERROR (d3) #41	DISCARD (d3)
PACKETS HAVING A PACKET TYPE IDENTIFIER WHICH IS SHORTER THAN ONE OCTET OR IS NOT SUPPORTED BY THE DCE	ERROR (d3) #27	ERROR (d3) #28	DISCARD (d3)
INVALID PACKET TYPE ON A PERMANENT VIRTUAL CIRCUIT	ERROR (d3) #35	ERROR (d3) #35	DISCARD (d3)
REJECT PACKET NOT SUBSCRIBED	ERROR (d3) #37	ERROR (d3) #37	DISCARD (d3)

NOTES TO TABLE A3.4/X.25

NORMAL: The action taken by the DCE follows the procedures as defined in sections 4 and 5. If the packet exceeds the maximum permitted length, the DCE will invoke the ERROR procedure using diagnostic code #39 and enter state d3.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a reset by transmitting to the DTE a RESET INDICATION packet, with the cause "Local procedure error" (diagnostic per Table A3.4/X.25). For virtual calls and permanent virtual circuits, the distant DTE is also informed of the reset by a RESET INDICATION packet, with the cause "Remote procedure error" (same diagnostic).

If a RESET INDICATION is issued as a result of an error condition in state d2 for permanent virtual circuits and datagram logical channels, the DCE should eventually consider the DTE/DCE interface to be in the FLOW CONTROL READY state (d1) In this case, the action to be taken on a virtual call is for further study.

Note 1: There may be more than one error associated with a packet (e.g., Invalid P(S) and Invalid P(R)). The network will stop processing of the packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet de-coding and checking on networks is not standardized.

Note 2: The DCE will consider the receipt of a DTE INTERRUPT CONFIRMATION packet which does not correspond to a yet unconfirmed DCE INTERRUPT packet as an error and will reset the virtual call or permanent circuit (diagnostic #43). The DCE will either discard or consider as an error a DTE INTERRUPT packet received before a previous DTE INTERRUPT packet has been confirmed (diagnostic #44).

If the P(S) or P(R) received is not valid, the DCE will invoke the ERROR procedure with diagnostics #1 and #2 respectively, and enter state d3.

ANNEX 4
(to Recommendation X.25)

PACKET LEVEL DCE TIME-OUTS AND DTE TIME-LIMITS

DCE time-outs

Under certain circumstances this Recommendation requires the DTE to respond to a packet issued from the DCE within a stated maximum time.

Table A4.1/X.25 covers these circumstances and the actions that the DCE will initiate upon the expiration of that maximum time.

DTE time-limits

Under certain circumstances, this Recommendation requires the DCE to respond to a packet from the DTE within a stated maximum time. Table A4.2/X.25 gives these maximum times. The actual DCE response times should be well within the specified time-limits. The rare situation where a time-limit is exceeded should only occur when there is a fault condition.

To facilitate recovery from such fault conditions, the DTE may incorporate timers. The time-limits given in Table A4.2/X.25 are the lower limits of the times a DTE should allow for proper operation. A time-limit longer than the values shown may be used. Suggestions on possible DTE actions upon expiration of the time-limits are given in Table A4.2/X.25.

Note: A DTE may use a timer shorter than the value given for T21 in Table A4.2/X.25. This may be appropriate when the DTE knows the normal response time of the called DTE to an incoming call. In this case, the timer should account for the normal maximum response time of the called DTE and the estimated maximum call set-up time.

TABLE A4.1/X.25

DCE TIME-OUTS

Time-out number	Time-out value	State of the logical channel	Started when	Normally terminated when	Actions to be taken when the time-out expires (see Note 1) Local side	Remote side
T10	60 s	r3	DCE issues a restart indication	DCE leaves the r3 state (i.e., the restart confirmation or restart request is received)	DCE remains in r3 and may issue a Diagnostic packet (Note 2)	For permanent virtual circuits, DCE enters the d3 state signaling a reset indication (remote procedure error)
T11	180 s	p3	DCE issues an incoming call	DCE leaves the p3 state (e.g., the call accepted, clear request or call request is received)	DCE enters the p7 state signaling a clear indication (local procedure error)	DCE enters the p7 state signaling a clear indication (remote procedure error)
T12	60 s	d3	DCE issues a reset indication	DCE leaves the d3 state (e.g., the reset confirmation or reset request is received)	For virtual calls, DCE enters the p7 state signaling a clear indication (local procedure error). For permanent virtual circuits and datagram logical channels, DCE remains in d3 and may issue a Diagnostic packet (Note 3)	For virtual calls, DCE enters the p7 state signaling a clear indication (remote procedure error). For permanent virtual circuits, DCE enters the d3 state signaling a reset indication (remote procedure error)
T13	60 s	p7	DCE issues a clear indication	DCE leaves the p7 state (e.g., the clear confirmation or clear request is received)	DCE remains in p7 and may issue a Diagnostic packet (Note 4)	

NOTES TO TABLE A4.1/X.25

<u>Note 1</u>: The following Notes 2, 3 and 4 describe alternative DCE actions on timer expiration. It is envisaged that all networks will eventually conform to Table A4.1/X.25, however for an interim period the following procedures may be used.

No values have yet been assigned to the time-out t and the maximum number of retries n applying to the following notes, however it should be noted that some Administrations may use the combination t-infinite, n-zero (i.e., no retries and no recovery action) or t-finite, n-zero (i.e., no retries with recovery action on timer expiration). The values of n and t will not necessarily be the same for the clear, reset and restart procedures.

<u>Note 2</u>: Alternatively, the DCE will retransmit the RESTART INDICATION at regular intervals of t until a DTE RESTART CONFIRMATION is received or a restart collision occurs or a period (n + 1)t elapses since the first transmission of the RESTART INDICATION. If the restart procedure is not completed within the time-out period, appropriate recovery action will be taken.

<u>Note 3</u>: Alternatively, the DCE will transmit the RESET INDICATION at regular intervals of t until a DTE RESET CONFIRMATION is received or a reset collision occurs or a period (n + 1)t elapses since the first transmission of the RESET INDICATION. If the reset procedure is not completed within the time-out period the DCE will either:

i) clear the virtual call with an indication of procedure error, or

ii) in the case of permanent virtual circuit forward a RESET INDICATION (remote procedure error) to the local DTE at regular intervals t until a DTE RESET CONFIRMATION is received or a reset collision occurs.

<u>Note 4</u>: Alternatively, the DCE will retransmit a CLEAR INDICATION at regular intervals of t until a DTE CLEAR CONFIRMATION is received or a clear collision occurs or a period (n + 1)t elapses since the first retransmission of the CLEAR INDICATION. If the clear procedure is not completed within the time-out period, appropriate recovery action will be initiated. The nature of the recovery action is for further study.

TABLE A4.2/X.25

DTE TIME-LIMITS

Time-out number	Time-limit value	State of the logical channel	Started when	Normally terminated when	Preferred action to be taken when time-limit expires
T20	180 s	r2	DTE issues a restart request	DTE leaves the r2 state (i.e., the restart confirmation or restart indication is received)	-To retransmit the restart request (Note 1)
T21	200 s	p2	DTE issues a call request	DTE leaves the p2 state (e.g., the call connected, clear indication, or incoming call is received)	-To transmit a clear request
T22	180 s	d2	DTE issues a reset request	DTE leaves the d2 state (e.g., the reset confirmation or reset indication is received)	-For virtual calls, to retransmit the reset request or to transmit a clear request -For permanent virtual circuits and datagram logical channels, to retransmit the reset request (Note 2)
T23	180 s	p6	DTE issues a clear request	DTE leaves the p6 state (e.g., the clear confirmation or clear indication is received	-To retransmit the clear request (Note 2)

Note 1: After unsuccessful retries, recovery decisions should be taken at higher levels.

Note 2: After unsuccessful retries, the logical channel should be considered out-of-order. The restart procedure should only be invoked for recovery if reinitialization of all logical channels is acceptable.

ANNEX 5
(to Recommendation X.25)

CODING OF X.25 NETWORK GENERATED DIAGNOSTIC FIELDS IN CLEAR, RESET AND RESTART INDICATION AND DIAGNOSTIC PACKETS (Notes 1, 2 and 3)

Diagnostics	Bits								Decimal
	8	7	6	5	4	3	2	1	
No Additional Information	0	0	0	0	0	0	0	0	0
Invalid P(S)	0	0	0	0	0	0	0	1	1
Invalid P(R)	0	0	0	0	0	0	1	0	2
				•	•	•			
	0	0	0	0	1	1	1	1	15
Packet type invalid	0	0	0	1	0	0	0	0	16
for state r1	0	0	0	1	0	0	0	1	17
for state r2	0	0	0	1	0	0	1	0	18
for state r3	0	0	0	1	0	0	1	1	19
for state p1	0	0	0	1	0	1	0	0	20
for state p2	0	0	0	1	0	1	0	1	21
for state p3	0	0	0	1	0	1	1	0	22
for state p4	0	0	0	1	0	1	1	1	23
for state p5	0	0	0	1	1	0	0	0	24
for state p6	0	0	0	1	1	0	0	1	25
for state p7	0	0	0	1	1	0	1	0	26
for state d1	0	0	0	1	1	0	1	1	27
for state d2	0	0	0	1	1	1	0	0	28
for state d3	0	0	0	1	1	1	0	1	29
				•	•	•			
	0	0	0	1	1	1	1	1	31
Packet not allowed	0	0	1	0	0	0	0	0	32
unidentifiable packet	0	0	1	0	0	0	0	1	33
call on one way logical channel	0	0	1	0	0	0	1	0	34
invalid packet type on a permanent virtual circuit	0	0	1	0	0	0	1	1	35
packet on unassigned logical channel	0	0	1	0	0	1	0	0	36
REJECT not subscribed to	0	0	1	0	0	1	0	1	37
packet too short	0	0	1	0	0	1	1	0	38
packet too long	0	0	1	0	0	1	1	1	39
invalid general format identifier	0	0	1	0	1	0	0	0	40
restart with nonzero in bits 1-4,9-16	0	0	1	0	1	0	0	1	41
packet type not compatible with facility	0	0	1	0	1	0	1	0	42
unauthorized interrupt confirmation	0	0	1	0	1	0	1	1	43
unauthorized interrupt	0	0	1	0	1	1	0	0	44
				•	•	•			

	0	0	1	0	1	1	1	1	47
Timer expired	0	0	1	1	0	0	0	0	48
for INCOMING CALL	0	0	1	1	0	0	0	1	49
for CLEAR INDICATION	0	0	1	1	0	0	1	0	50
for RESET INDICATION	0	0	1	1	0	0	1	1	51
for RESTART INDICATION	0	0	1	1	0	1	0	0	52
				•	•	•			
	0	0	1	1	1	1	1	1	63
Call setup problem	0	1	0	0	0	0	0	0	64
facility code not allowed	0	1	0	0	0	0	0	1	65
facility parameter not allowed	0	1	0	0	0	0	1	0	66
invalid called address	0	1	0	0	0	0	1	1	67
invalid calling address	0	1	0	0	0	1	0	0	68
				•	•	•			
	0	1	0	0	1	1	1	1	79
Not assigned	0	1	0	1	0	0	0	0	80
				•	•	•			
	0	1	0	1	1	1	1	1	95
Not assigned	0	1	1	0	0	0	0	0	96
				•	•	•			
	0	1	1	0	1	1	1	1	111
Not assigned	0	1	1	1	0	0	0	0	112
				•	•	•			
	0	1	1	1	1	1	1	1	127
Reserved for network specific diagnostic information	1	0	0	0	0	0	0	0	128
				•	•	•			
	1	1	1	1	1	1	1	1	255

Note 1: Not all diagnostic codes need apply to a specific network, but those used are as coded in the table.

Note 2: A given diagnostic need not apply to all packet types (i.e., RESET INDICATION, CLEAR INDICATION, RESTART INDICATION and DIAGNOSTIC packets).

Note 3: The first diagnostic in each grouping is a generic diagnostic and can be used in place of the more specific diagnostics within the grouping. The decimal 0 diagnostic code can be used in situations where no additional information is available.

APPENDIX B

PROPOSED DRAFT RECOMMENDATION S.h

NETWORK INDEPENDENT; BASIC TRANSPORT SERVICE FOR TELETEX

EDITOR'S NOTE: A CCITT Transport working committee is expected to identify and approve LAPX requirements in September 1980.

TITLE : PROPOSED DRAFT RECOMMENDATION S.h,
NETWORK INDEPENDENT; BASIC TRANSPORT SERVICE FOR TELETEX

1 The CCITT considering that
- The Teltex Service will be introduced in different types of network, i.e.

i) Circuit Switched Public Data Network (CSDN)
ii) Packet Switched Public Data Network (PSDN)
iii) General Switched Telephone Network (GSTN)

- There is a need for international interworking between Teletex terminals connected to different types of networks. Unanimously declares that:- this Recommendation defines the Network Independent Basic Transport Service (NITS) applicable Teletex terminals connected to the above mentioned types of network in terms of the

- Transport Services provided to the higher layer. The Transport Services are provided by the transport layer (layer 4) in association with the underlying services provided by the supporting layers 1-3.

- Transport layer procedure (see section 5).

2 TRANSPORT SERVICE

2.1 Objectives of Transport Service

The purpose of the transport service is to provide two communicating session entities within Teletex terminals with transport services, i.e. the means for transparent and reliable end-to-end transfer of data between them irrespective of the particular type of network used. The main requirements of the transport service to be provided by a transport entity to the local transport user, i.e. the session entity, are:

i) Network Independence. The transport service shall be homogeneous, while allowing a suitable wide variety of underlying communications media, protocols and mechanisms.

ii) End-to End Significance. The transport service shall have end-to-end significance, connecting the end users irrespective of the number of individual communications links used.

iii) Transparency. The transport service shall be octet transparent, i.e. not restrict the content, format or coding of the information (data or control), received from or delievered to the transport user.

iv) Error Free Delivery. The transport service shall assure error-free delivery. Non-recoverable errors are to be visible to the transport service user.

v) Cost Efficiency. The transport service shall optimize the use of the available communication resources to provide the performance required by each communicating transport user at maximum efficiency.

2.2 GENERAL STRUCTURE OF THE TRANSPORT SERVICE

The general structure of the transport service is shown in Fig. 2.1/s...

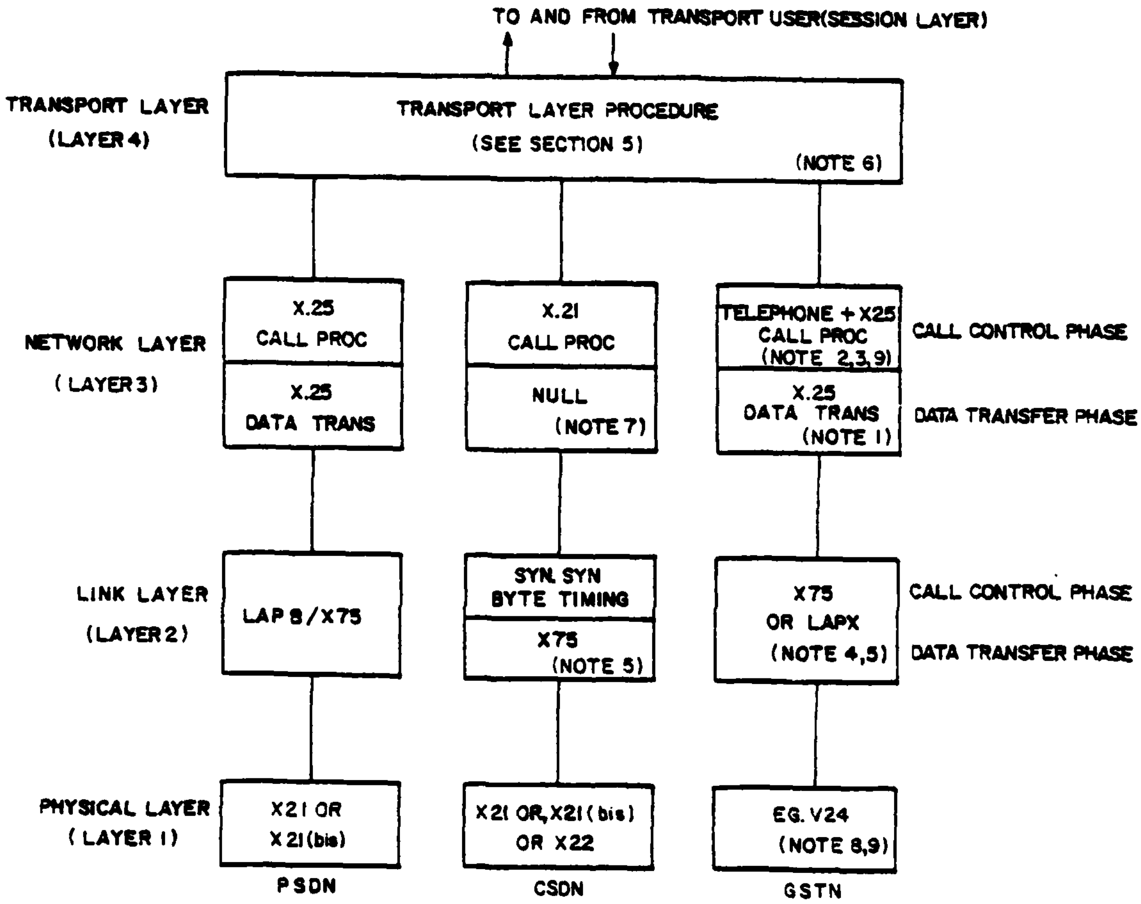


Figure 2.1/S ... Transport Service General Structure

Notes:

1. The X.25 network layer procedure is introduced to ease inter-working with PSDN's.

2. The establishing of the network connection is performed in two stage selection, first using normal telephone procedures and second using X25 call control procedures.

3. For terminals connected to GSTN accessing PSDN, the procedures in note 2 apply.

4. LAP X is a half-duplex link access procedure, based on recommendation X75 for single link operation (See section 3.2.2.).

5. The link level procedures are in accordance with X75 for single link operation (however see section 3.2.2 and 3.3.2) and in this respect Recommendation X75 (1980 version) is to be regarded as the reference specification of this protocol.

6. In case of interworking between Teletex Terminals connected to different types of networks (i.e. CSDN, PSDN, GSTN) this Transport Layer Procedure is executed peer-to-peer between the communication Teletex Terminals.

7. For terminals connected to CSDNs, no function is needed in the network layer in the data transfer phase as indicated in fig. 2.1/S. However, in order to facilitate interworking with PSDNs a minimum network layer is introduced (see section 3.3.3).

8. The modem may also be integrated within the terminal and in such cases recommendation V24 need not apply (see 3.2.1).

9. For autmatic calling and/or answering recommendation V.25 may be applicable.

3. TRANSPORT SERVICE REALIZATION FOR DIFFERENT TYPES OF NETWORKS

The transport layer procedure on all types of network is defined in section 5. The network dependent control procedures of the underlying layers are described in the following sections.

3.1 Terminals connected to a Packet Switched Public Data Network (PSDN)

3.1.1 Physical layer DTE/DCE interface characteristics

The physical layer of Recommendation X.25 applies.

3.1.2 Link Layer Procedure

The link layer procedure shall, unless otherwise specified be the symmetrical procedures as specified in X25 LAPB and compatible with Recommendation X.75 for single link operation.

3.1.3 Network Layer Procedure

Recommendation X25 Virtual Call procedures apply. However the following points should be noted:

1) Qualifier bit in Data Packets should always be set to zero.

2) Delivery Confirmation bit in all packets should be set to zero.

3) The Teletex terminal should not send an Interrupt Request packet.

4) Normal X25 Reset procedures will apply. However for CSDN/PSDN interworking X25 reset will be mapped to link level disconnection on CSDN.

5) Transport Control Blocks and Transport Data Blocks shall be carried in a complete Data Packet sequence.

6) The Teletex Terminal should not send a DTE REJ packet.

7) Terminals using this transport protocol shall use a specific protocol identifier within Call Request/ Incoming Call packets for the Teletex Service. This identifier is represented by the first octet of the Call User Data field as shown below:

bit	8	7	6	5	4	3	2	1
octet 1	0	0	0	0	0	0	1	0

In the case of CSDN/PSDN interworking the functional mapping of this protocol identifier requires further study.

8) Teletex terminals shall not use the Fast Select facility.

3.2 Terminals connected to the General Switched Telephone Network

3.2.1 Physical layer DTE/DCE Interface characteristics

The DTE/DCE physical interface characteristics defined as the physical layer element shall be in accordance ewith existing V series Recommendations. The physical layer may provide for half-duplex or full-duplex transmission depending on the modern standard.
Note: The GSTN modern standards are discussed in SG XVII. Furthermore, in case of modem integrated in the terminal the interface may only be functionally equivalent to V series Recommendations. This is also for further consideration of SG XVII.

3.2.2 Link Layer Procedure

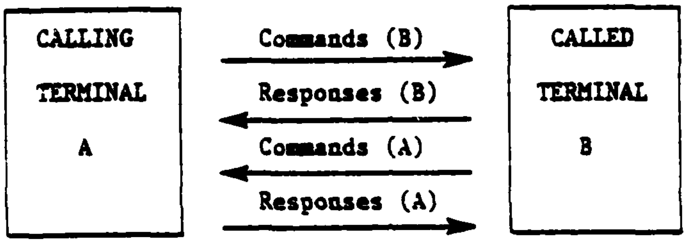
Depending on the service provided by the physical layer, the link layer procedures over a single physical circuit between two terminals have to cater for half-duplex or full-duplex transmission facility to provide a full-duplex service to the network layer. For full-duplex physical layer service, the link layer procedure shall conform to the Link Access Procedure described in Rec X75, for single link operation. For addressing assignments and the system parameters see sections 3.2.2.1, 3.2.2.2 respectively. For half-duplex physcial layer service the link layer procedure (LAPX) will apply. LAPX is a half-duplex Link Access Procedure, based on recommendation X75 for single link operation. Some elements of the link layer procedure have been established but neet to be studied further under Q... These elements which have already been proposed are appended to the text of the question.

3.2.2.1 Procedure for Addressing

The following describes the application of the link addressing procedure of Rec. X.75. Link addresses (A and B) shall be assigned dynamically or on a per call basis according to the following rule:

The calling terminal shall take Address A
The called terminal shall take Address B

Commands and Responses shall be transfered as shown below:



A and B addresses are coded as follows:

Address	1	2	3	4	5	6	7	8
A	1	1	0	0	0	0	0	0
B	1	0	0	0	0	0	0	0

Note: The termianl will discard all frames received with an address other than A and B

3.2.2.2 Systems Parameters

Timer, T1
Maximum number of retransmission, N2
Maximum number of bits in a I frame, N1
Maximum number of outstanding I frames, K

The above system parameters are to be specified by the Administration.* however the possible range of values which may be attributed to each presenter is to be standardized and such values are for further study.

3.2.3 Network Layer Procedure

See section 3.1.3. In addition the following points apply:-

1. For all Calls (GSTN only, GSTN - PSDN, GSTN, PSDN - GSTN) second stage addressing will apply using X25 virtual call procedures. The calling terminal should include the called address and teh calling address (see note 2) in all request packets. The format of the called address shall conform to:-

a) the telephone network addressing scheme for GSTN only calls.

b) the telephone network addressing scheme with an X121 DNIC for GSTN - PSDN - GSTN calls. (see note 3)

ø c) the X121 addressing scheme for GSTN - PSDN calls.

ø Note 1: For other cases of internetworking the above rule shall apply.

Note 2: In the case of GSTN - PSDN calls the verification of the calling address by the network requires further study.
The format of the calling address is for further study.

Note 3: The feasibility of such connections is for further study.

3.3 Terminal connected to Circuit Switched Public Data Network (CSDN)

3.3.1 Physical Layer DTE/DCE Interface Characteristics

The DTE/DCE physical interface characteristics shall be in accordance with Recommendation X.21, or as an option, X.22 for multi-call operation.

3.3.2 Link Layer Procedure

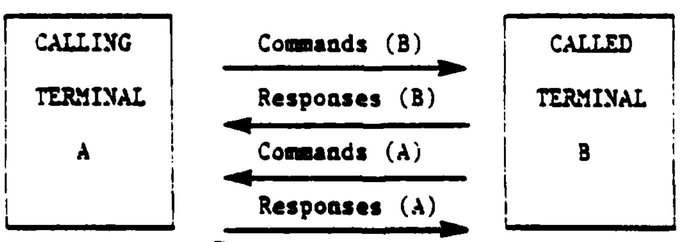
The Link Layer Procedure shall be used during the data phase of Rec. X.21 or X.21 bis for data interchange over a single physical circuit between two terminals operating in user classes 3-7 as indicated in Rec. X.1. The Link Layer Procedures shall conform to the level 2 procedures described in Rec. X75 for single link operation.

3.3.2.1 Procedure for Addressing

The following describes the application of the Link Addressing Procedures of recommendation X75. Link addresses (A and B) shall be assigned dynamically on a per call basis according to the following rule:

The calling terminal shall take Address A
The called terminal shall take Address B

Commands and Responses shall be transferred as shown below:



The coding addresses A and B are chosen below:

Address	1	2	3	4	5	6	7	8
A	1	1	0	0	0	0	0	0
B	1	0	0	0	0	0	0	0

Note: The terminal will discard all frames received with an address other than A and B

3.2.2.2 System parameters

The system parameters shall have the following values:

Timer T1 = 6 sec (for average I frame length of 518 octets)
Maximum number of retransmission N2 = 8
Maximum number of outstanding I frames k = 7
Maximum number of bits in an I frame N1 = 16512 bits

The actual maximum number of bits in an I frame is a terminal design parameter which may depend upon the maximum length of the network layer data block. The lower limit for N1 to be implemented by Teletex terminals is 1152 bits.

3.3.3 Network Layer Procedure

a) Call Control phase

Call control procedures conforms to Recommendation X.21, or as an option, X.22 for multi-call operation.

b) Data transfer phase

A minimal network layer is present during the data transfer phase and accommodated through the use of a two octet Network Block Header. The header comprises a one octet length indicator followed by a network block type code. The only network block currently defined is a Network Data Block as shown in Fig. 3.1/S.

OCTETS \ BITS	8	7	6	5	4	3	2	1
1	0	0	0	0	0	0	0	1 [1)]
2	M [2)]	Q [3)]	0	0	0	0	0	0
	NETWORK USER DATA FIELD							

Fig . 3.1/S ... Network Data Block.

1) Length Indicator
   This indicator expresses in octets the length of the Network Data Block header. This length does not include octet 1.

2) The More Data mark (M) is used to preserve the integrity of Transport Layer Control and Transport Data Blocks. When M is set to 1 it indicates that more data is to follow.

3) The Qualifier Bit (Q) is introduced to provide a functional mapping with the X25 Qualifier bit for CSDN/PSDN interworking. The Q bit is not used for the Teletex service and shall be set to zero.

4 INTERWORKING BETWEEN NETWORKS

4.1 It is responsibility of Administrations* to decide in which network(s) the Teletex service is to be provided.

4.2 Three possibilities are considered below:

i) Teletex Terminals connected to a Circuit Switched Public Data Network (CSDN)

ii) Teletex Terminals connected to a Packet Switched Public Data Network (PSDN)

iii) Teletex Terminals connected to a General Switched Telephone Network (GSTN)

Interworking between Teletex terminals connected any network must be possible.

4.3 International interworking between Teletex Terminals shall preferably take place between networks of the same type when these networks are provided by both countries involved.

4.4 In the case of international interworking between Teletex terminals connected to Public Data Networks of different types Recommendation X75 shall apply.

Note: The interworking between CSDNs and PSDNs will require a gateway function between the two networks. Two specific requirements of this gateway function have been identified:

1. For an interim period a packet level Reset in a PSDN will be mapped to a link level disconnection in a CSDN. Alternative functional mappings are for further study.

2. The execution of necessary supervisory functions. This aspect requires further definition.

5 TRANSPORT LAYER PROCEDURE

5.1 Transport Functions

5.1.1 General Overview

The transport layer will perform all those functions that are necessary to bridge the gap between the services provided by the Network layer and the services needed by the Session layer. Therefore, the functions performed are dependent on two criteria: the services provided by the underlying Network layer and the services required by the Session layer.

It is the responsibility of the transport service user to select a given quality of service which may imply the use of certain transport layer functions such as:

- Establishment of a Transport Connection
    - . transport connection identification
    - . transport connection multiplexing
- Data Transfer
    - . sequence control
    - . error detection
    - . error recovery
    - . segmenting and combination
    - . flow control
    - . purge
- Termination of a Transport Connection

Note: Not all of the above functions will be available in the basic transport service (see 5.1.2).

5.1.1.1 Transport Service Classes and Functions

A limited set of functions is proposed for a basic transport service. It is recognized that as more general studies on Transport Service progress more sophisticated functions will be introduced within the Transport Layer and a functional negotiation mechanism will be required during connection establishment to facilitate interworking between different Transport Service implementations. Furthermore it seem likely that Transport Service functions will be grouped (for ease of negotiation) into a hierarchical system of classes whereby classes occupying superiro positions in the hierarchy implement all functions of lower classes together with the additional functions identified for their own class.

It is therefore proposed that during transport connection establishment the use of a given transport service and/or individual transport service functions hould be negotiated according to the following rules:

- Calling terminal indicates transport service class and/or optional functions required.
- Called terminal indicates the transport service class and/or optional functions that it is willing to support
- All parameters to be used in the transport connection must be explicity indicated otherwise default values will apply

The transport service class for the basic teletex service is denoted as class zero.

5.1.2 The basic Transport Service for Teletex

Transport Layer functions are performed by Transport Layer Protocol Elements.

Transport protocol information and control units are called blocks (see Table 5.1/S..).

The Transport Connection Request and Transport Connection Accept blocks are used to indicate the protocol class, and optional functions, applying to a transport connection. The Connection Clear block is used to indicate the reason for refusing a connection establishment.

Transport Connection Request Block
Transport Connection Accept Block
Transport Connection Clear Block
Transport Data Block
Transport Block Reject Block

Table 5.1/S.. Transport Layer Block Types

5.1.2.1 Transport Layer Functions

Basic class functions and associated transport layer protocol elements, i.e. blocks, include:

- Transport Connection Establishment, Transport Connection Identification, optional extended addressing and optional transport data lbock size negotiation (Transport Connection Request Block, Transport Connection Accept Block and Transport Connection Clear Block);

- Data delimitation, segmentation/combination of arbitrarily long transport service data units (TSDU). These are contained within Transport Data blocks. The end of a TSDU is indicated by a TSDU End Mark in the last data block.

- Detection and indication of procedural errors (Block Reject block).

Other characteristics of the Basic Transport Service are:

- Maintenance of Transport Service Data Unit integrity

- Overflow: If the user cannot absorb new data and if the appropriate buffers and not available, flow control is performed at network/ link level as appropriate.

- Error: No mechanism is provided within the Transport Service to facilitate recovery from detected errors. Where such errors are detected the user of the Transport Service should be informed in order that appropriate recovery action may be taken.

5.2 <u>Description of connection establishment and termination procedures</u>

The transport layer connection establishment and termination procedures shall also be used for negotiating Transport Service Class and/or optional Transport connection functions.

The basic transport service class provides means to establish a transport connection using a Transport Connection Request block and a Transport Connection Accept block. This exchange provides:

- A way to negotiate options

- A transport connection identification. The transport connection is identification by use of cross-reference. Each end of the connection is responsible for selecting a suitable Transport Connection Identifier.

This mechanism provides also an identification of the transport connection independent of any network connection identification and therefore provides independence from the life of the network connection. The binary value 0 should not be used as an identifier. The use of such references for reconnection requires further definition.

5.2.1 Transport Connection Request Block

The calling terminal shall indicate a transport connection request by transferring a Transport Connection Request block to the remote terminal. The Transport Connection Request block includes the transport functions (e.g. source reference, class, and optional functions) for negotiation of the characteristics of the transport connection being established.

5.2.2 Transport Connection Accept Block

The called terminal shall indicate is acceptance of the transport connection by transferring a Transport Connection Accept block to the remote terminal. The Transport Connection Accept block includes the transport parameters applying to the connection and to be used by the calling terminal.

5.2.3 Transport Connection Clear Block

If a transport connection cannot be established, the called terminal shall respond to the Transport Connection Request block with a Transport Connection Clear block. The clearing cause shall indicate why the connection was not accepted.

Note: There is no explicit Transport Connection Termination procedure for the basic class. For the basic class the lifetime of the transport connection is directly correlated to the lifetime of the supporting network connection.

5.2.4 Transport Connection Collision

If the calling terminal receives a Transport Connection Request block it shall transfer a Block Reject Block to notify the called terminal of the procedure error.

5.3 Description of Data Transfer Procedures

5.3.1 General

The data transfer procedure described in the following subsections applies only when the transport layer is in the data transfer phase, that is after completion of Transport Connection establishment and prior to a clearing.

Note: When a connection is cleared, Transport Data blocks may be discarded. Hence it is left to the Transport Service User to define protocols able to cope with the various possible situations that may occur.

5.3.1.1 Transport Data Block Length

The standard maximum Transport Data Block length is 128 octets including the data block header octets. However, the Transport Data Block length may be restricted to a lower value when the Transport Data Block is concatenated with other Transport Data Blocks (see 5.5.3).

Other maximum data field lengths may be supported by Teletex Terminals in conjunction with an optional Transport Data Block Size Negotiation connection function (see section 5.5.5.2 and 5.5.6.2). Optional maximum data field lengths shall be chosen form the following list: 256, 512, 1024 and 2048 octets.

5.3.1.2 Transport Service Data Unit (TSDU) End

The TSDU End mark is used to preserve the integrity of the TSDU. The TSDU End mark is set to binary 1 in the last Transport Data Block carrying information related to a certain TSDU. In case of a TSDU that comprises a single Transport Data Block the TSDU End mark is also set to 1. In all other cases the TSDU End mark is set to zero.

5.4 Treatment of Procedure Errors

At any time, a terminal may send a Transport Block Reject Block to report to the remote terminal the receipt a block which is invalid or not implemented. No confirmation is required to be issued by the terminal following the receipt of a Transport Block Reject Block. A terminal receibing a Transport Block Reject Block shall take appropriate recovery action.

5.5 Formats

5.5.1 General

All Transport Protocol Information Units are called Blocks. All blocks contain a integral number of octets.

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of a block are consecutively numbered starting form 1 and are transmitted in this order.

Data blocks are used to transfer Transport Service Data units (TSDU) transparently whilst maintaining the structure of the latter by means of TSDU End mark.

Control blocks are used to control the transport protocol functions, including optional functions.

A parameter field is present in all control blocks within the basic transport service to indicate optional functions.

The parameter field contains one or more parameter elements. The first octet of each parameter element contains a parameter code to indicate the functions(s) requested.

The general coding structure is shown in Figure 5.1/S..

	8 1
1	parameter code
2	parameter length indicator
3	≈ parameter value ≈

Figure 5.1/S.. Parameter Element Coding Structure

The parameter code field is binary coded and, without extension, provides for a maximum of 255 parameter.

Parameter code 11111111 is reserved for extension of the parameter code. The extension mechanism is for further study.

Octet 2 indicates the length, in octets, of the parameter value field. The parameter field length is binary coded and bit 1 is the low order bit of this indicator.

Octet 3 and subseuqent octets contain the value of the parameter identified in the parameter code field. The coding of the parameter value field is dependent on the function being requested.

5.5.2 Structure of Transparent Control and Transparent Data Blocks

Bits 8   1

Length indicator	Block type	Functional Code Field (Fixed Format)	Parameter or Data Field (Variable Format)

Fig. 5.2/S.. General Block Structure

	octet 1	octet 2	octet 3	octet 4	octet 5	octet 6	octet 7	
TCR	Length	1110 0000	00000000	00000000	Source	Refer.	00000000	Parameters
TCA	Length	1101 0000	Destin.	Refer.	Source	Refer.	00000000	Parameters
TCC	Length	1000 0000	Destin.	Refer.	Source	Refer.	Clearing Cause	Parameters
TBR	Length	0111 0000	Destin.	Refer.	Reject Cause	Parameters		
TDT	Length	1111 0000	TSDU End Mark	00000000	DATA			

TCR Transport Connection Request Block
TCA Transport Connection Accept Block
TCC Transport Connection Clear Block
TBR Transport Block Reject Block
TDT Transport Data Block

Fig. 5.3/S... Transport Layer Block Types

Figure 5.2/S.. illustrates the general structure of transport layer blocks. A summary of transport layer blocks is given in Figure 5.3/S..

5.5.2.1 Length Indicator Field (LI)

Octet 1 contains the length indicator (LI). The value of this indicator is a binary number that represents the length on octets of the Control block (including parameters) and the header length in octets of Data blocks (excluding any subsequent user information). In both cases this length does not include octet 1.

The basic LI consists of a single octet with a maximum value of 254 in decimal (i.e., a binary value of 1 1 1 1 1 1 1 0). The use of the binary value 1 1 1 1 1 1 1 1 for extension purposes is for further study.

5.5.2.2 Block Type Field

Octet 2 contains the block type code. Bits 1 to 4 of octet 2 are set to 0 for all transport layer blocks currently defined. It is for further study to determine whether or not bits 1 to 4 are required for future extension to the range of transport layer blocks currently defined or are used for other functions.

5.5.2.3 Functional Code Field

Octet 3 and subsequent octets contain functional codes in a fixed format as per the block type (see Figure 5.3/S.).

5.5.2.4 Parameter or Data Field

A parameter field or a data field may optionally follow the functional code field.

5.5.3 Concatenation

Concatenation of Transport Control and/or Transport Data Blocks is not applicable to the basic class. However where concatenation is used in the future, the arrangement shown in figure 5.4/S.. would apply.

BITS

8 7 6 5 4 3 2 1	
HDLC Flag	Link Level
HDLC Address Field	
HDLC Control Field	
Network Header (eg X.25 or as per section 3.3.3)	Network Level
Transport Control Block	Transport Level
Transport Control Block	
. . .	
Transport Data Block Header	
Transport User Data . . .	Session Level and Above
HDLC Frame Check Sequence	Link Level
HDLC Flag	

Fig. 5.4/S.. Information Field structure of HDLC I - frame (Example)

<u>Note</u>: This figure does not imply that a transport data or control block will fit within a single network data block.

5.5.5 <u>Transport Connection Request block format</u>

Figure 5.5/S.. illustrates the format of the Transport Connection Request block.

Octets	Bits 8 7 6 5 4 3 2 1
1	Length (Octets)
2	1 1 1 0 0 0 0 0 1)
3	not used (set to 0)
4	not used (set to 0)
5	Source
6	Reference
7	0 0 0 0 0 0 0 0 2)
8	Parameters (optional) 3)

Fig. 5.5/S.. - Transport Connection Request Block (TCR)

1) Block Type: TCR

2) Transport Service Extension Field: Octet 7 is reserved for any future extension such as providing for a range of Transport Service Classes. In the basic Transport service this octet shall be set to zero.

3) The Parameter field is present only when the terminal is requesting an optional Transport connection function.

5.5.5.1 <u>Parameters For Extended Addressing</u>

Separate parameters are provided for the indication of called and calling Extension Addresses. The coding of these parameters is shown below:-

Octets	Bits 8 7 6 5 4 3 2 1
1	Extension Address parameter type
2	Parameter Length Indicator
	IAS digit 1 IAS digit 2 . . . IAS digit n

Octet 1: 11000001...Calling address Type
or
11000010...Called Address Type

5.5.5.2 Parameter For Transport Data Block Size Negotiation

This parameter defines the proposed maximum Transport Data Block Size (in octets including the Transport Data Block Header) to be used over the requested transport connection. The coding of this parameter is shown below:-

Octet	Bits 8	7	6	5	4	3	2	1	
1	1	1	0	0	0	0	0	0	Parameter Type Code
2	0	0	0	0	0	0	0	1	Parameter Length Indicator
3	0	0	0	0	X	X	X	X	Transport Data Block Size

X X X X = 1001 - 2048 octets
1010 - 1024
1001 - 512
1000 - 256
0111 - 128

5.5.6 Transport Connection Accept Block Format

Figure 5.6/S.. illustrates the format of the Transport Connection Accept Block.

Octet	Bits 8 7 6 5 4 3 2 1
1	Length (Octets)
2	1 1 1 0 0 0 0 0 1)
3	Destination
4	Reference
5	Source
6	Reference
7	0 0 0 0 0 0 0 0 2)
	Parameters (optional) 3)

Figure 5.6./S.. - Transport Connection Accept Block (TCA).

1) Block Type: TCA

2) Transport Service Extension Field: Octet 7 is reserved for any future extension such as providing for a range of Transport Service Classes. In the basic Teletex service this octet shall be set to zero irrespective of the setting in the Transport Connection Request Block.

3) The Parameter Field is present only when the terminal is requesting an optional Transport Connection function.

5.5.6.1 Parameters For Extended Addressing

See section 5.5.5.1.

5.5.6.2 Parameter For Transport Data Block Size Negotiation

See section 5.5.5.2. The parameter value shall be equal to or less than the value specified in the Transport Connection Request Block.

5.5.7 Transport Connection Clear Block Format

Figure 5.7/S.. illustrates the format of the Transport Connection Clear Block.

Bits	8 7 6 5 4 3 2 1
Octet 1	Length (Octets)
2	1 0 0 0 0 0 0 0 1)
3	Destination
4	Reference
5	Source
6	Reference
7	Clearing Cause 2)
	Parameters (optional)

Figure 5.7/S.. - Transport Connection Clear Block (TCC)

1) Block Type: TCC

2) Clearing Cause:

	Bit 8	7	6	5	4	3	2	1
0 - Reason not specified	0	0	0	0	0	0	0	0
1 - Terminal occupied	0	0	0	0	0	0	0	1
2 - Terminal out of order	0	0	0	0	0	0	1	0
3 - Address unknown	0	0	0	0	0	0	1	1

5.5.7.1 Parameter For Additional Clearing Information

This parameter is provided to allow additional informating relating to the clearing of the connection. The coding of this parameter is given below:-

Bits	8	7	6	5	4	3	2	1	Parameter Code
Octet 1	1	1	1	0	0	0	0	0	Parameter Code
1	Parameter Length Indicator								
n	Additional Information								

5.5.8 <u>Transport Block Reject Block Format</u>

Figure 5.8/S.. illustrates the format of the Block Reject block.

Bits		8	7	6	5	4	3	2	1
Octet	1	Length (octets)							
	2	0	1	1	1	0	0	0	0
	3	Destination							
	4	Reference							
	5	Reject Cause							
		Parameter Field							

Figure 5.8/S... - Transport Block Reject block (BRB)

1) Block Type: TBR

2) Reject cause:

Bit	8	7	6	5	4	3	2	1
0 - Reason not specified	0	0	0	0	0	0	0	0
1 - Function not implemented	0	0	0	0	0	0	0	1
2 - Invalid block	0	0	0	0	0	0	1	0
3 - Invalid parameter	0	0	0	0	0	0	1	1

5.5.8.1 <u>Rejected Block Parameter</u> (mandatory)

This parameter is used to indicate the bit pattern of the rejected block up to and including the octet which caused the rejection. Only the first detected procedural error or parameter, which cannot be acted upon, shall be indicated by this method. The coding of this paramter is given below:-

Bits	8	7	6	5	4	3	2	1
Octet 1	1	1	0	0	0	0	0	1
1	Parameter Length Indicator							
n	Rejected Information							

5.5.9 Transport Data Block

Figure 5.9/S... illustrates the format of the Transport Data Block

Octet	Bits	8	7	6	5	4	3	2	1
1		Length (octets)							
2		1	1	1	1	0	0	0	0 1)
3	2)	TSDU END	0	0	0	0	0	0	0
4		DATA							
n									

Figure 5.9/S... - Transport Data Block (TD)

1) Block Type: TDT

2) TSDU End: indicates the end of TSDU when set to one.

APPENDIX C

PROPOSED RECOMMENDATION S.d

CONTROL PROCEDURES FOR THE TELETEX SERVICE

Recommendation S.d

CONTROL PROCEDURES FOR THE TELETEX SERVICE

CONTENTS

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<u>CONTENTS (CONT'D)</u>

<u>Annexes</u>

1 GENERAL

1.1 Scope

1.1.1 Recommendation F.x Lays down the operational provisions for the automatic international Teletex service. On the technical side, Recommendation S.c specifies the requirements for international compatibility between Teletex terminals and Recommendations S.f defines the character repertoire and coded character sets for the international Teletex service.*

1.1.2 Network-dependent communication procedures for call establishment and termination are defined in Recommendation S.c.

1.1.3 This Recommendation defines the end-to-end procedures to be used within the Teletex service.

1.1.4 Specifically, this Recommendation concerns the end-to-end control procedures that are network-independent. The network-dependent procedures forming a network-independent transport service are specified in Recommendations S.. .

1.1.5 The procedure described in this recommendation should also be used between a Teletex and the Teletex/Telex conversion facility.

1.1.6 Interworking between Teletex and services other than telex is for further study.

1.1.7 This Recommendation assumes that the terminal initiating a call is the terminal regarded as responsible for the call charges and that it retains full control of the call.

1.1.8 The provisions of the recommendation are to be regarded as a first stage in the establishment of a Teletex service in accordance with recommendations F.x, S.c, S.f, and S.h, as defined in 1980. Enhancements and additions to these recommendations must ensure compatibility with establishment services.

1.2 Fundamental principles

1.2.1 The relationship between the Teletex control procedures and the transport service shall respect the following principle. The higher level procedures require the transport service to preserve the structure of blocks, which may be of arbitary size, given to it by the session level for transmission. Only one session command or response is allowed in this block. Only one document command or response is allowed in a CSUI or RSUI field.

* For draft Recommendations F.x, S.c and S.f, see COM VIII-No. 179, 182 and 183 respectively.

1.2.2 The sender is responsible for the delivery of the information in his Teletex document to the recipient's store. This may include linking and other relevant information.

1.3 Definitions

1.3.1 Terms and their definitions are listed in Annex A. Where appropriate each definition mentions the Layer to which it refers.

1.3.2 Some of the terms used in this Recommendation have been defined in ways that may differ from the meanings of similar terms in other Recommendations.

2 FUNCTIONS OF PROCEDURES

2.1 General

2.1.1 The broad functional categories provided to implement the Teletex service control procedures are listed in Tables 1 and 2/S.d.

Command	Response	Abbreviation	Reference
Session establishment and clearing			
Command session start		CSS	3.2.1
	Response session start positive	RSSP	3.2.2
	Response session start negative	RSSN	3.2.3
Command session end		CSE	3.2.4
	Response session end positive	RSEP	3.2 5
Command session abort		CSA	3.2.6
	Response session abort positive	RSAP	3.2.7
Information transfer			
Command session user information		CSUI	3.2.8
	Response session user information	RSUI	3.2.9
Session management			
Command session change control		CSCC	3.2.10
	Response session change control positive	RSCCP	3.2.11

Table 1/S.d - Session commands and responses

Command	Response	Abbreviation	Reference
Document control			
Command document start		CDS*	3.4.1
	Response document general reject	RDGR	3.4.2
Command document continue		CDC*	3.4.3
Command document capability list		CDCL	3.4.4
	Response document capability list list positive	RDCLP	3.4.5
Command document end		CDE**	3.4.6
	Response document end positive	RDEP	3.4.7
Command document discard		CDD	3.4.8
	Response document discard positive	RDDP	3.4.9
Command document resynchronize		CDR	3.4.10
	Response document resynchronous positive	RDRP	3.4.11
Information transfer			
Command document user information		CDUI	3.4.12
Error recovery			
	Response document general reject	RDGR	3.4.2
Command document page boundary		CDPB	3.4.13
	Response document page boundary positive	RDPBP	3.4.14
	Response document page boundary negative	RDPBN	3.4.15

*   RDGR is used as a negative response to this command. A specific negative response is not required.

** The negative response to this command is RDPBN

Table 2/S.d - Document commands and responses

2.1.2 The procedural elements have also been listed in the appropriate categories since the definitions of the elements together with their associated rules completely specify the functions of the procedures.

2.2 Background information

This section is given as an aid for the understanding of the procedures. The exact definition of the control procedures are given in subsequent sections of this recommendation.

2.2.1 Exchange of service identification

Two terminals when connected by a transport service will, at session establishment, need to exchange information identifying the CCITT regulated service that they intend to use and thus invoke the relevant service facilities and the associated protocol e.g. the Teletex service and its protocol. The use of service identification for other services is for further study.

2.2.2 Negotiation of Optional Capability

Two methods are provided. The first is used at session innitiation to exchange a limited set of capabilities. The second method may be needed when required, after session innitiation, to indicate the sender's requirements for extended capabilities.

2.2.3 Negotiation of storage requirements

Storage availability can be indicated in the following ways.

1. When a call is established it is implicity assumed that there is adequate receive memory for the call. Exceptionally a receiver memory overflow condition may occur. The continued sending of the document from the source will be stopped by the sink. The recovery mechanism shall indicate the reason for stopping the transmission.

2. The provision is also made in the procedure for a mandatory indication that the ability of the receiving terminal to accept traffic is jeopardized.

3. The contact procedure also provides the possibility to investigate the storage availability at the receiving terminal prior to the transmission of a document. The use of this possibility is for further study within the SAI.

3 ELEMENTS OF PROCEDURE

3.1 General

3.1.1 This section contains elements of procedure and rules of use that, when combined, define the Teletex procedure.

3.1.2 Definitions applying to the elements of procedure may be found in Annexes A and B.

3.1.3 Annexes C and D describe the Two-way simultaneous (TWS) mode of session operation and the session suspension function, which are not applicable to the basic Teletex service.

3.2 Session commands, responses and parameters

(For a summary of session commands and responses, see Table 1/S.d.)

3.2.1 Command session start (CSS)

3.3.2.2 The CSS initiates entry into a session.

3.2.1.2 Command parameters are:-

a) Service identifier. This mandatory parameter identifies the service (e.g. Teletex, facsimile) that the sender of this command intends to use.

b) Terminal identifier. This mandatory parameter identifies the calling terminal in accordance with the terminal identification specified in Recommendation F.x.

c) Date and time. This mandatory parameter gives date and time information as specified in Reccomdataion F.x.

d) Additional session reference number. This number may be used in addition to the basic session reference (called terminal's identifier, calling terminal's identifier, date and time) to identify uniquely the session. If the additional session reference number is not used parameter shall not be included.

e) Non-basic terminal capabilities - these parameters indicate which non-basic terminal capabilities are available as receiving capabilities of the sender of this command.

These parameters are mandatory if the terminal is capable of any of the specific functions listed below, absence of the parameter indicates that the specific function is not available.

Parameter	Function
i) Control character sets	Reverse line feed
ii) Page formats	A4 printable area (vertica and horizontal orientation)
iii) Miscellaneous terminal capabilities	Character spacing of 2.12 mm (12 characters per 25.4 mm). Character spacing of 1.69mm (15 characters per 25.4 mm. Line feed parameter value of one spacing of 3.175 mm. Line feed parameter value of one spacing of 0.5, 1.C 1.5 and 2 spacings of 5 mm.

Note: The definitions of these presentation capabilities may be found in Recommendation S.c. Future extension and private-use capabilities are to be accommodated in CDCL.

f) Non-basic session capabilities. If used, this non-mandatory parameter indicates which non-basic session capabilities are available as receiving capabilities of the sender of this command.

Note: Examples of the uses for this parameter are session suspension (see Annex D), two-way simultaneous operation (see Annex C) and negotiation of the window size for checkpointing (see section 4.3).

g) Private use parameters. These parameters are not mandatory. Their definition and use are not standardized.

3.2.2 <u>Response session start positive</u>(RSSP)

3.2.2.1 The RSSP shall be used to acknowledge entry into a session. It indicates that the CSS command has been understood and is in a correct format.

3.2.2.2 Response parameters are:-

a) Service identifier. This mandatory parameter identifies the service (e.g. Teletex, facsimile that the sender of this response intends to use.

Note: For the basic Teletex service the service identifiers in RSSP and CSS must be identical.

b) Terminal identifier. This mandatory parameter provides the terminal identification of the sender of the RSSP in accordance with the terminal identification specified in Recommendation F.x.

c) Date and time. This mandatory parameter must be identical to the corresponding parameter in the CSS. It is used in conjunction with the terminal identifications of both terminals in a session as a reference to that session.

d) Additional session reference number. If used in the CSS and if used by the receiver of CSS, this parameter shall have the same value as in the CSS. If it is not used by the receiver of CSS it shall not appear in the RSSP.

e) Non-basic terminal capabilities (i.e. those available as receiving capabilities of the sender of the RSSP) - the same conditions apply as for 3.2.1.2 e above.

f) Non-basic session capabilities - 3.2.1.2 f above.

g) Private use parameters - 3.2.1.2 g above.

3.2.3 Response session start negative (RSSN)

3.2.3.1 The negative response indicates that the session was not entered by the receiver of the CSS. It is not mandatory to indicate the reasons for rejection. A non-mandatory private use parameter may be used with this response.

Note: Reasons to be identified and coded - for further study.

3.2.4 Command session end (CSE)

3.2.4.1 The CSE is used for normal (or error-free) termination of a session.

Note: A parameter is reserved to indicate whether the transport connection is to be cleared. Absence of this parameter will cause the transport connection to be cleared.

3.2.5 Response session and positive (RSEP)

3.2.5.1 The RSEP indicates to the calling terminal that the called terminal can enter the idle state in an orderly manner.

3.2.6 Command session abort (CSA)

3.2.1.6.1 The CSA may be used at any time by either terminal to terminate a session, whenever a condition is detected indicating that the session cannot be continued successfully.

3.2.1.6.2 One of the following reasons for the abnormal termination of the session must be given as a CSA parameter:-

a) local terminal error;

b) unrecoverable procedural error;

c) reason not defined.

Note: One value is reserved to indicate whether the transport connection is to be cleared.

3.2.7 Response session abort positive (RSAP)

3.2.7.1 The RSAP response indicates to the sender of a CSA command (either the source or the sink terminal) that the receiver of CSA has entered the idle state in an orderly manner.

3.2.8 Command session user information (CSUI)

3.2.8.1 The CSUI is used to indicate to the receiver that the associated information field of this command conveys commands, parameters and information for the document procedures.

3.2.8.2 CSUI does not call for a response. There is no relationship between this command and the response RSUI.

3.2.9 Response session user information (RSUI)

3.2.9.1 The RSUI is used to indicate to the receiver of this response (source) that the associated information field conveys responses and parameters for the document procedures. A non-mandatory parameter "request session function" may be used with this response.

3.2.9.2 This RSUI response is not related to any CSUI command.

3.2.10 <u>Command session change control</u> (CSCC)

3.2.10.1 In two-way alternate (TWA) mode CSCC changes the source/sink relationship between the two terminals.

Note: A signal for Request Transmit is available in some responses (see coding scheme). It may be used to indicate that a terminal sending this signal has information to transmit. The terminal receiving this signal is not required to take any action if this signal is detected.

3.2.11 <u>Response session change control positive</u> (RSCCP)

3.2.11.1 The RSCCP indicates to the sender of the CSCC that the sink terminal intends to enter the session sending state.

3.3 <u>Session procedures</u>

3.3.1 <u>Session modes of operation</u>

3.3.1.1 The following provisions concern the <u>two-way alternate</u> (TWA) mode of session operation:-

a) The basic Teletex protocol provides the capability of TWA mode;

b) At session initiation the sender of the CSS is defined as being the current source of any text information and is therefore the source terminal;

c) The CSCC exchanges the source/sink relationship between the two terminals. The CSCC command should only be invoked outside document boundaries;

d) Only the terminal that is currently the source terminal may send the CSCC;

e) There is no requirement for sending text information prior to sending a CSCC.

f) When the called terminal has finished transmitting text it shall hand back the right of sending text to the calling terminal. Only the calling terminal is allowed to send CSE.

3.3.1.2 The following provisions concern the <u>one-way communication</u> (OWC) mode of sesion operation:-

a) The CWC mode is achieved by the CSS sender's not issuing a CSCC;

b) There is no requirement to send text information;

c) This mode is a subset of TWA.

3.3.2 <u>Rules for session elements of procedure</u>

3.3.2.1 Only the terminal that has established the transport connection (the "calling" terminal) shall send CSS.

3.3.2.2 It is the responsibility of the sender of CSS to examine the parameters of RSSP and to determine whether the session should continue. If it is not to be continued, the session shall be ended normally (by CSE).

3.3.2.3 In continuing the session, neither terminal is permitted to use any procedure or to send any information that does not comply with the receiving capabilities indicated by the session partner, in the Service Identifier and Non-Basic Terminal Capabilities Parameters of the CSS/RSSP exchange at session initiation and/or by the parameters of CDCL/RDCLP exchange.

3.3.2.4 In the TWA or OWC mode only the sender of CSS may send CSE when he is the current source.

3.3.2.5 In the TWA mode, the recipient of both CSS and CSCC must terminate his period as source by sending CSCC.

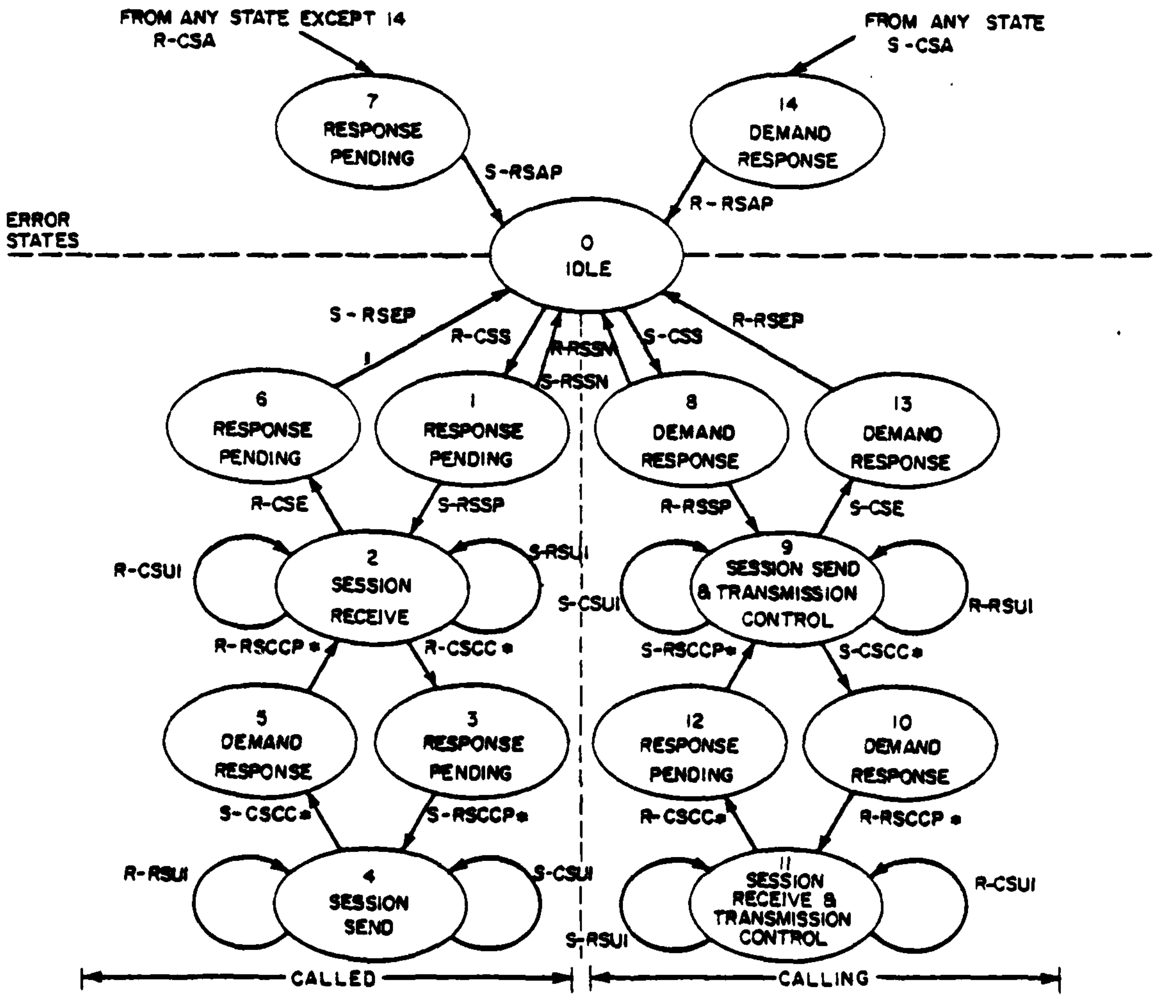
3.3.2.6 After having sent CSA the sender may clear the connection. In all cases the connection must be cleared when the inactivity timer has expired.

3.3.2.7 The parameter value "window size" is not mandatory and may have a value in the range of 1 to 255. If the parameter is indicated and accepted, the sendor of CSS must take during the session the smaller window size exchanged.

3.3.2.8 Figure 1/S.d is a state transition diagram for TWA and OWC modes. The "change control" commands (marked with an asterisk in the diagram) do not apply to the OWC mode. The general description and rules of operation for state diagrams may be found at Annex E.

3.3.2.7 The parameter value "window size" is not mandatory. The default value is three. If the parameter is indicated and accepted, the sender of CSS must take during the session the smaller window size exchanged.

3.3.2.8 Figure 1/S.d is a state transition diagram for TWA and OWC session modes. The "change control" commands (marked with an asterisk in the diagram) do not apply to the OWC mode. The general description and rules of operation for state diagrams may be found at Annex E.



* The "change control" commands marked with an asterisk in the diagram do not apply to the OWC mode.

Figure 1/S.d - State transition diagram for TWA and OWC session modes

3.4 Document commands, responses and parameters
(For a summary of document commands and responses, see Table 2/S.d.)

3.4.1 Command document start (CDS)

3.4.1.1 The CDS indicates the start of a document (delivery unit) to the receiver of this command. It also indicates the start of the first page (commitment unit). (For the definition of delivery and commitment units, see Annex B.)

3.4.1.2 Command parameters are:-

a) service interworking identifier - not mandatory field;

Note: When communicating with a conversion facility an identifier may be required for:

> a) Teletex/telex interworking - the identifier will indicate that the document(s) has been prepared in accordance with the rules given in Recommendation F.x;
>
> b) Teletex/Videotex interworking - for further study;
>
> c) Teletex/facsimile interworking - for further study.

b) document type identifier - not a mandatory field, absence of this parameter indicates a normal document (for a description of types of document, see Annex F);

c) document reference number (see point 4.2.8);

d) indication of required terminal capability (standardized or private use) - not a mandatory field, however, this parameter must be used if standardized optional terminal capabilities are required for the document;

e) private use parameters (not mandatory) - definition of such parameters is not stnadardized.

3.4.1.3 There is no response to CDS except in the case of an error, for which RDGR is used.

3.4.2 Response document general reject (RDGR)

3.4.2.1 The RDGR may be used by the sink to indicate the source that procedural error has occured and that resynchronization is requested. The bit pattern of the command or response up to and including the error shall be returned to the source. Only the first detected error within a command or response must be processed by this method.

3.4.2.2 The response parameter is the bit pattern required by point 3.4.2.1.

3.4.2.3 It is the responsibility of the terminal receiving an RDGR response to take appropriate action.

Note: Use of RDGR for other kinds of errors is for further study.

3.4.3 Command document continue (CDC)

3.4.3.1 The CDC indicates to the receiver of this command the continuation of transmission of a document (delivery unit) that has previously been partially transmitted. There is no response to CDS except in the case of an error, for which RDGR is used.

3.4.3.2 Command parameters are:-

a) Document linking information, in order to identify the previous transmission of the partial document, including:

- the checkpoint reference number (see point 4.2.6) from which the transmission is being continued;

- the document reference number, which shall be the same as the document reference number in the CDS;

- the session reference information identifying the session in which the first part of the document was sent;

Note: If several continuation are required to complete transmission of a document, all are linked to the partial transmission in which the CDS was used. The sequence of checkpoint reference numbers is then used to identify the correct sequencing for linking and all such continuations shall be transmitted in this sequence.

It is the responsibility of the receiving terminal to discard any text information that has been duplicated in the process of continuation of an interrupted transmission.

b) service interworking identifier - not a mandatory field (see the note under 3.4.1.2 a) for CDS);

c) document type identifier - not a mandatory field, absence of this parameter indicates a normal document (for a description of the types of document, see Annex F);

d) document reference number (of the current session) - see point 4.2.8;

e) optionally, any other parameter field(s) that appeared in the CDS command at the start of the document may be repeated as parameters in CDC.

3.4.3.3 There is no response to CDC except in the case of an error, for which RDGR is used.

3.4.4 Command document capability list (CDCL)

3.4.4.1 The CDCL initiates an exchange of information to enable a check of the terminal capabilities (both standardized and private use). The command shall include a list of receiving capabilities that may be needed at the receiver by the sender of this command.

3.4.4.2 The command may also be used to investigate the storage capability of the remote terminal. The required amount of storage (given in kilo-octets) is indicated in a parameter of the command in this case.

Note: Other mechanisms for storage are for further study.

3.4.4.3 Command parameters are the list of receiving capabilities and the required amount of storage.

3.4.4.4 The CDCL command should only be invoked outside document boundaries.

3.4.5 Response document capability list positive (RDCLP)

3.4.5.1 The RDCLP acknowledges the CDCL and contains one of the following three parameters:-

a) Confirmation that all the requested capabilities are available at the receiver;

b) A list of the requested capabilities that are available at the receiver;

c) A complete list of non-basic receiving capabilities.

3.4.5.2 If the CDCL is used for memory negotiation, one of the following parameters shall also be included:-

a) confiramtion that the amount of memory requested is available and has been reserved;

b) indication of the available (and reserved) amount of memory (in kilo-octets);

c) indication that the available memory cannot be estimated;

d) indication that the requested memory capacity cannot now be reserved.

3.4.6 Command document end (CDE)

3.4.6.1 The CDE shall be used to indicate to the receiver of this command the end of a document delivery unit. It also represents the final checkpoint to which a response shall be made.

3.4.6.2 The command parameter is the checkpoint reference number.

3.4.6.3 The RDPBN shall be used as the negative response to the checkpoint in CDE.

3.4.7 Response document end positive (RDEP)

3.4.7.1 The RDEP gives a positive acknowledgement to the last checkpoint (commitment unit). In the basic Teletex service this is the last page reference number.

3.4.7.2 The RDEP shall also indicate that the receiver:-

a) has not detected any error;

b) accepts responsibility for the received document (delivery unit).

c) is ready to receive a new CDS or CDC.

3.4.7.3 The RDEP shall include as a parameter the checkpoint reference number of the CDE.

3.4.7.4 After sending RDEP there is no further means within these control procedures for error recovery for that document.

3.4.8 <u>Command document discard</u> (CDD)

3.4.8.1 The CDD shall be used to indicate to the receiver of this command the abnormal ending of a document and that the receiver of the command is not held responsible for the part of the document received so far. Therefore, as a local function outside these control procedures, the receiver can delete the part of the text received.

Note: The receiving terminal may discard the document from its memory and/or indicate to the operator that this part of the document has no value.

3.4.8.2 The reason for sending a CDD command may be given as a CDD parameter. If used only one of the following reasons shall be indicated:-

a) local terminal error;

b) unrecoverable procedural error;

c) reason not defined.

3.4.8.3 The CDD may only be used to terminate the current document, instead of using CDE or CDR. It cannot be used after a CDR has been sent;

3.4.8.4 The receiver of a CDD is allowed to delete the received part of the document, but has no obligation to do so. If the text is not deleted, the operator shall be informed.

3.4.9 <u>Response document discard positive</u> (RDDP)

3.4.9.1 The RDDP acknowledges the CDD and indicates that the receiver of the command is ready to receive a new CDS or CDC. No negative response is allowed.

3.4.10 <u>Command document resynchronization</u> (CDR)

3.4.10.1 The CDR shall be used by the source to indicate to the sink the point of resynchronization. If used within a document it shall abnormally end that document.

3.4.10.2 The reason for an abnormal ending of a document may be given as a CDR parameter. If used, only one of the following reasons may be given.

a) local terminal error;

b) unrecoverable procedural error;

c) reason not defined.

3.4.10.3 If, during the transmission of a document, there is an interruption of the transport connection or session such that another call and/or session establishement is needed, the following rules apply:-

a) the receiving terminal shall treat the failure as if a CDR had been received and an RDRP, had been sent;

b) the sending terminal shall treat the failure as if a CDR had been sent and a RDRP had been received.

3.4.11 Response document resynchronization positive (RDRP)

3.4.11.1 The RDRP is sent by the receiver of a CDR as a positive acknowledgement of the command.

3.4.11.2 If RDRP is used within a document, it confirms to the sender of a CDR that the sender of RDRP has already accepted responsibility for the received document (up to the last checkpoint for which a positive acknowledgement has been sent). It does not indicate the possibility of the receiver of the command's performing linking of the following parts of the interrupted document (delivery unit).

3.4.11.3 The control procedures provide a means for resuming transmission of an interrupted document.

3.4.11.4 The linking of the parts of an interrupted document is a local operation at the receiver and is therefore not within the responsibility of the control procedures. Thus these procedures cannot guarantee that this linking of parts of a document will be effected.

3.4.12 <u>Command document user information</u> (CDUI)

3.4.12.1 The CDUI indicates to the receiver of this command that the associated information is to be interpreted as the user text information field being conveyed by the Teletex service.

3.4.12.2 The basic Teletex service does not require any parameter for CDUI. The procedure provides means for adding paramters. Any such need is for further study.

3.4.13 <u>Command document page boundary</u> (CDPB)

3.4.13.1 The CDPB indicates to the receiver the boundary between pages. It also indicates a checkpoint for error recovery purposes (see section 4). CDPB invites the sink to accept responsibility for the previously received page (page commitment unit-see Annex B).

3.4.13.2 The CDPB command parameter is the checkpoint reference number, which, in the basic Teletex service, is the page reference number.

3.4.14 <u>Response document page boundary positive</u> (RDPBP)

3.4.14.1 This response shall be used to indicate that the receiver accepts responsibility for that page (acknowledgement of commitment unit).

3.4.14.2 Response parameters are:

a) This mandatory parameter gives the checkpoint reference number (see 3.4.13.2 above);

b) This mandatory parameter indicates that the ability of the receiving terminal to continue to accept traffic is jeopardized (e.g. memory threshold reached).

3.4.15 <u>Response document page boundary negative</u> (RDPBN)

3.4.15.1 The response shall be used to indicate that the receiver does not accept the responsibility for that page (commitment unit), for example due to a detected error or other failure.

3.4.15.2 The value of the mandatory parameter giving the reason for a negative response should be one of the following:

a) memory overflow;

b) sequence error;

c) local terminal error;

d) unrecoverable procedural error;

e) No specific reason stated. (Used for reasons other than those listed.)

3.5 General rules for document elements of procedure

3.5.1 When a document has been either started by CDS or continued by CDC, it must be terminated by either CDE, CDR or CDD prior to sending the next CDS or CDC.

3.5.2 The following rules relate to the CDS and CDC parameters:-

a) the service interworking parameter may be used to indicate that the document is suitable for interworking; however, use of this parameter is mandatory in the case of service interworking;

b) absence of the document type identifier indicates that the associated document is a normal text document.

3.5.3 No negative response to CDS or CDC may be sent after the sending of a positive response to any checkpoint within that document.

3.5.4 No negative response to CDD or CDR is allowed except for error conditions where RDGR is allowed.

3.5.5 With regard to the responses to CDPB (RDPBP or RDPBN), the receiver may reject reception for a detected error, but the receiver is not obligated to monitor for errors in the document. Once a page (commitment unit) has been positively acknowledged, any error recovery for the subsequent detection of an error is beyond the scope of these control procedures.

3.6 Rules for document state diagrams in the basic Teletex service

3.6.1 General

3.6.1.1 The rules common to all state diagrams are given in Annex E.

3.6.1.2 For any error a terminal is permitted to send CSA. If this procedure is not used, the following rules shall apply.

3.6.2 Rules for the sending protocol (See Figure 2/S.d)

3.6.2.1 Any command or response received in state 1, 1 and 3 shall cause an abnormal end of the session and sending of CSA.

3.6.2.2 Reception of any command or response except RDPBP in states 2 - 8, 10 and 11 (or RDEP in state 9) shall cause CDR or CDD to be sent.

3.6.2.3 Reception of any command or response except RDCLP in state 14 shall cause CDR to be sent.

3.6.2.4 In state 13 receipt of RDRP or RDDP will cause a transition to state 1. Any other command or response will be discarded.

3.6.2.5 The inactivity timer started when state 13 is entered is only reset when a valid response is received.

3.6.3 Rules for the receiving protocol (See Figure 3/S.d)

3.6.3.1 Reception of any command or response except CDS, CDC, CDCL in state shall cause RDGR to be sent.

3.6.3.2 In state 12 receipt of CDR or CDD will cause a transition to state 13. Any other command or response received will be discarded.

3.6.3.3 Reception of any command or response not allowed in the state diagram or any invalid parameters or paremeter values in state 2 to 11 may cause RDGR to be sent.

3.6.3.4 The inactivity timer started when state 12 is entered is only reset when a valid command is received.

Figure 2/S.d - Document state diagram for a window size of three (sending protocol).

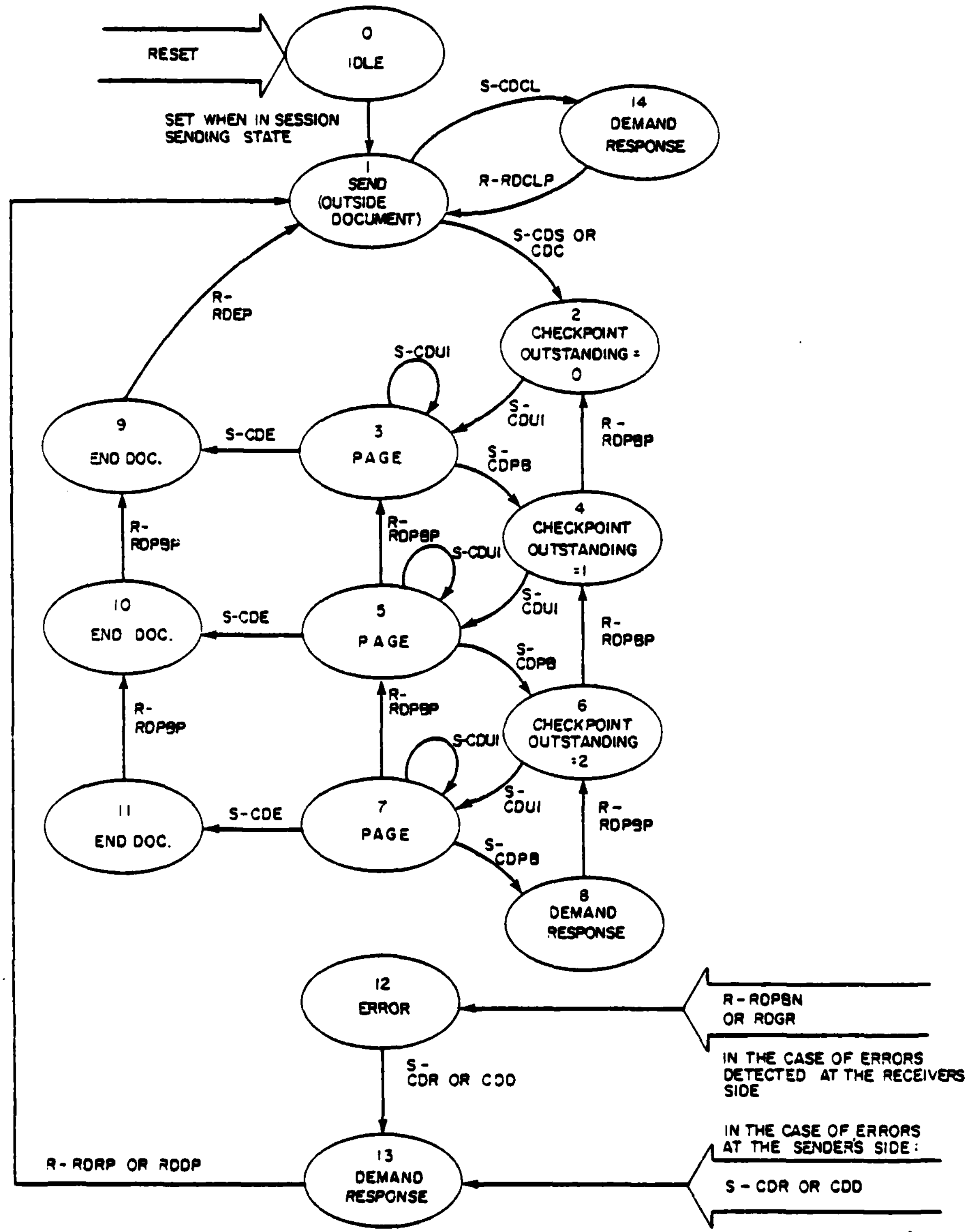
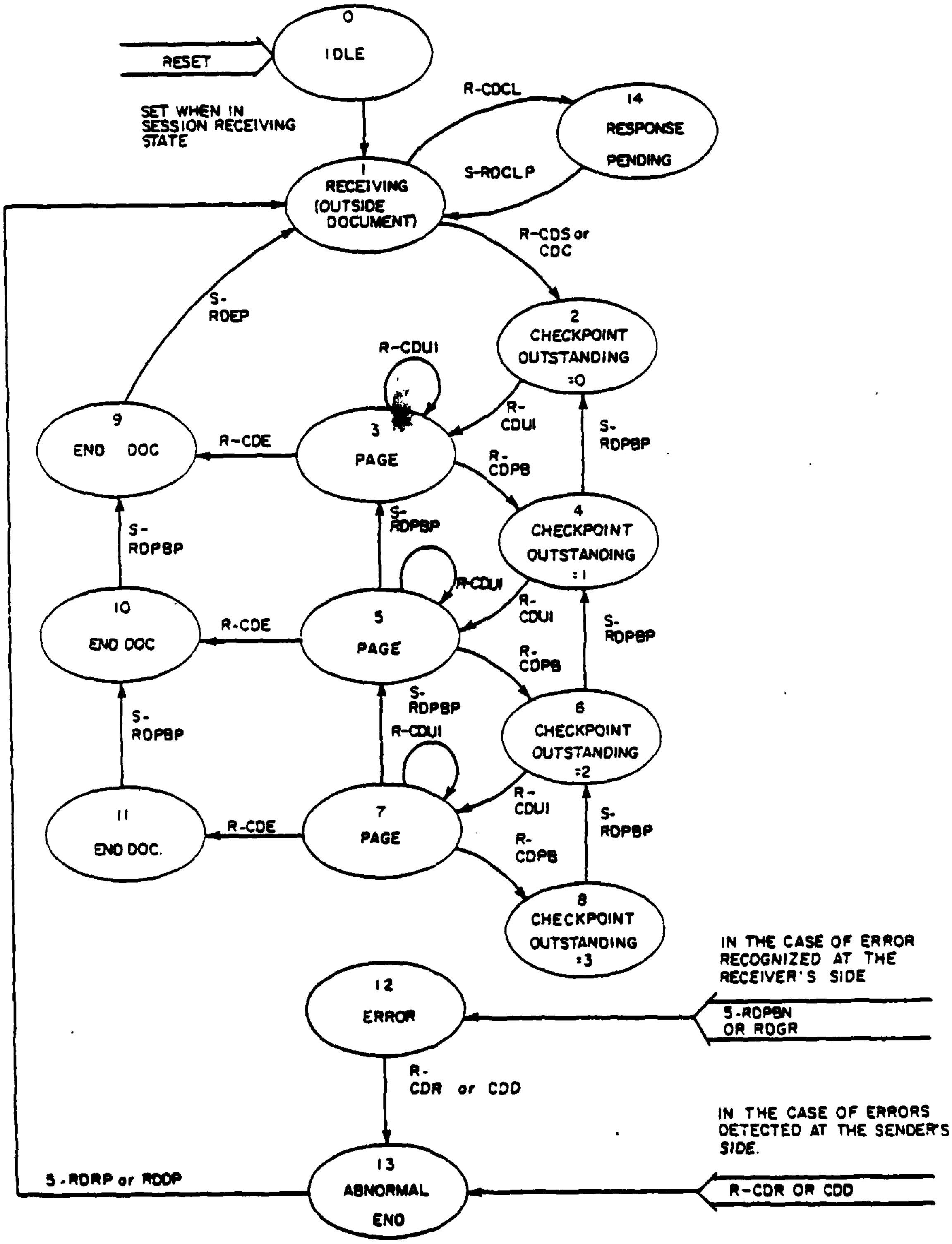


Figure 3/S.d - Document state diagram for a window size of three (receiving protocol).



4 ERROR RECOVERY IN THE BASIC TELETEX SERVICE

4.1 General principles

4.1.1 During a session, each partner is responsible for the correct operation of the following:-

a) maintenance of the currently agreed source/sink relationship;

b) proper use of the command/response procedural sequences as described in the state diagrams and rules for operation (see section 3.6);

c) detection of any period of inactivity in excess of 60 s (indicating, for example, a failure or other inability to continue productive use of the session).

4.1.2 Upon detection of any failure to maintain proper operation as described in point 4.1.1., use of the error recovery procedures defined for each state is mandatory; or, where such error recovery procedures are not specifically defined, session termination (abnormal end) is mandatory.

4.1.3 In the event of an error, this control procedure allows for repeated transmission of information. The number of repetitions should be limited by the sender.

4.2 Rules for checkpointing

4.2.1 After an abnormal termination of a document, for recovery in the same session the checkpoint reference number and the document reference number are required in order to identify unambiguously the point from which to recover.

4.2.2 A new session (and call) has to be initiated after abnormal termination of a document where recovery is to be effected in a subsequent session or after an abnormal termination and/or interruption of the call. The information required in order to identify unambiguously the point from which to recover is:-

a) the reference for the interrupted session;

b) the document reference number; and

c) the checkpoint reference number.

4.2.2 In the basic Teletex service a checkpoint must be inserted at each page boundary using CDPB.

4.2.3 If a negative response is received to a command representing a checkpoint, the transmission must be interrupted by sending a CDR or CDD.

4.2.4 Within a document, a final checkpoint will be represented by the CDE. Transmission of another document is not permitted until the response to this command has been received.

4.2.5 No other checkpointing is permitted in the basic service. For other applications an optional checkpointing mechanism may be used, as described in Annex G.

4.2.6 Each command representing a checkpoint shall contain a parameter showing the reference number. Each such command calls for a response, which shall contain a parameter showing the checkpoint reference number to which that response applies.

4.2.7 Checkpoint reference numbers shall be assigned as decimal digits starting from 001 and sequentially incremented by one for each successive checkpoint within a document.

4.2.8 Document reference numbers shall be assigned as decimal digits, preferably, but not necessarily, starting from 001 and sequentially incremented by one for each successive document. Document reference numbers shall be assigned to all documents in a session, irrespective of the document type identifier or whether CDS or CDC is used as the initiating command.

4.2.9 The sum of the number of digits contained in the checkpoint reference number and the document reference number shall not exceed six, to permit printing in the available space in the Call Identification Line as defined in Recommendation F.x. There is no constraint on the maximum number of digits in either number as long as this limitation is not exceeded.

4.3 <u>Acknowledgement window</u>

4.3.1 In the basic Teletex service the sender is prohibited from exceeding an acknowledgement window size of three. The maximum window size may be negotiated during session establishment using the CSS command parameters. (See paragraph 5.7.8)

4.3.2 The sender is permitted to recover from an interrupted transmission at only one of two points:-

a) the sender may transmit the entire document, cancelling the earlier partial transmission of that document;

b) the sender may resume, starting at the point in the text of the last checkpoint for which an acknowledging response was received.

c) On this basis, the receiver must be able to resume reception at any checkpoint ranging from the last acknowledged checkpoint plus one, minus the window size.

4.3.3 The window mechanism has been introduced in order to allow continuous transmission of documents. The window mechanism has been introduced in order to allow continuous transmission of documents. The window mechanism may also be used by the receiving terminal to resolve local time problems without affecting the continuous transmission.

The design of a terminal should be such that continuous reception is possible in normal operation of the terminal with an average page size of 1500 octets. The use of the mechanism should take into account the quality of service of F.x.

If a transmission flow control mechanism is needed, it shall be provided by the transport service.

5 CODING

5.1 Definition of terms used in coding

5.1.1 A Command Identifier (CI) or Response Identifier (RI) is the heading information that identifies the command or response concerned.

5.1.2 A Length Indicator (LI) represents the length in octets of an associated, field or group of fields.

5.1.3 A Parameter Identifier (PI) indicates the type of information contained in an associated field or group of fields.

5.1.4 A Parameter Group Identifier (PGI) is a special case of a PI, which indicates that the associated field consists entirely of a group of parameters, each identified by a PI.

5.1.5 A Parameter Value (PV) is the information that represents the value of the parameter identifed by either a PI or PGI.

5.1.6 A "field" is either a group of one or more bits within a single octet or a group of one or more octets, used to represent a particular set of information.

5.2 Principles of coding

5.2.1 The coding of session commands and parameters is independent of the coding of document commands and parameters and vice versa.

5.2.2 Binary field encoding principles have been used to allocate bit patterns for the CI, RI, PGI and PI.

5.2.3 The first section of a session or document field consists of either a CI or an RI. Each CI or RI is always immediately followed by an LI.

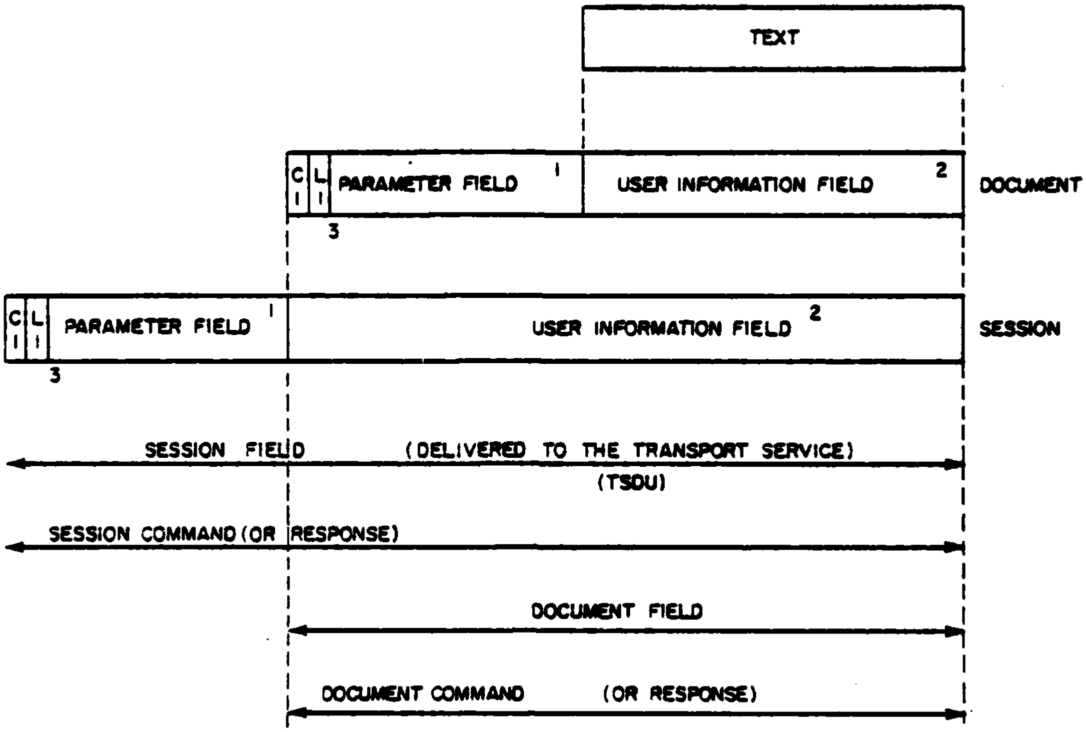
5.2.4 The value of an LI is a binary number that represents the total length of the immediately following parameter field(s) in octets. The value of the LI does not include either itself or any subsequent user information.

5.2.5 If a parameter field indicated by a PGI appears within a parameter field initiated by a PGI, the PV field of the "nested" PGI field may not extend beyond the end of the PV of the enclosing PGI field.

5.2.6 To decode CI, RI, PGI and PI, all the bits of the identifier must be considered.

5.2.7 The format of a paramter field initiated by a PGI is the same as the format of such a field initiated by a PI except that the entire PV field consists of a sequence of one or more parameter fields, each of which is initiated by either PI or PGI.

5.2.8 Figures 4, 5 and 6/S.d illustrate the coding principles.

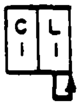


Notes: 1. Present only if LI ≠ 0

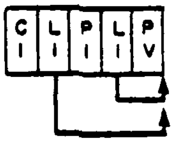
2. Present only after user information commands (or response)

3. See point 5.2.4

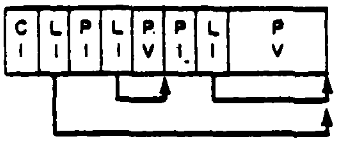
Figure 4/S.d - Illustration of the relationship between session and document commands



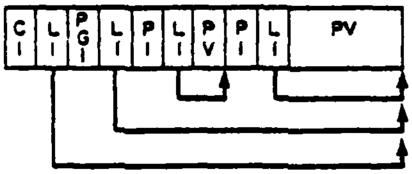
A) LI =0 (i.e. NO PARAMETER FIELD)



B) LI=3 AND 1 RESPECTIVELY MEANS ONE PARAMETER OF ONE OCTET VALUE

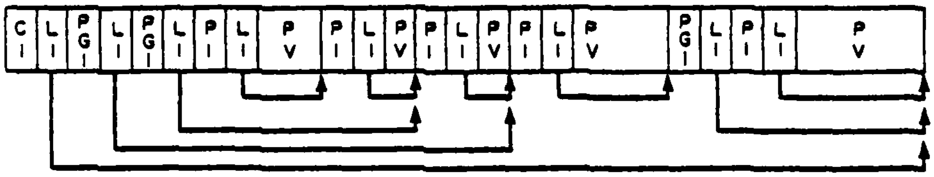


C) TWO PARAMETERS OF 1 AND 3 OCTETS RESPECTIVELY, LIs ARE 8, 1 AND 3 RESPECTIVELY



D) ONE PGI WITH TWO ENCLOSED PIs

E) THE MOST SIMPLE CARRIER OF USER INFORMATION

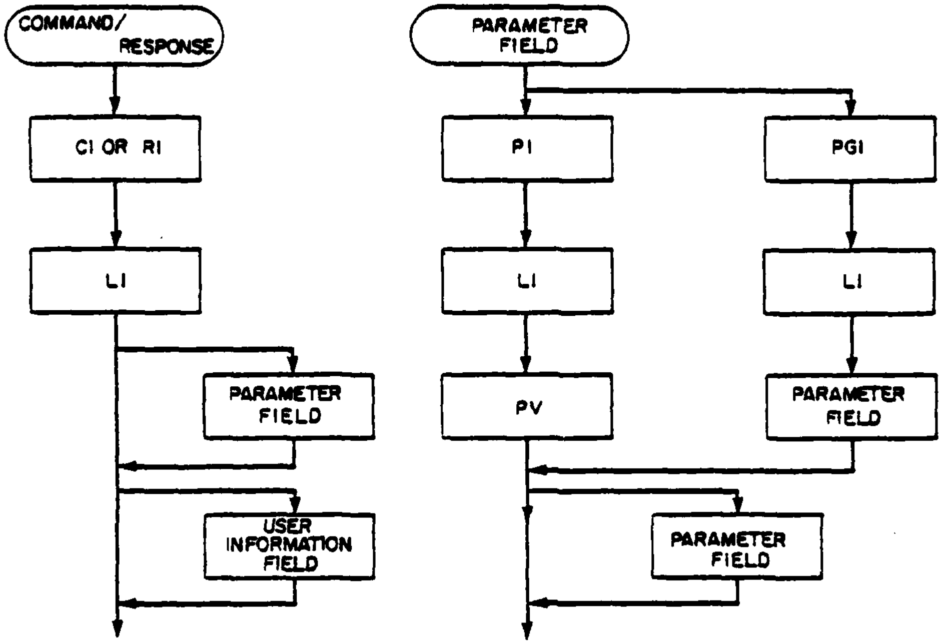


F) EXAMPLE OF COMPLEX USE OF PGIs

Notes: In every case the CI can be replaced by an RI.

Any PI or PGI may be omitted when it is not used for conveying information (i.e. parameter values). PIs and PGIs within the same nesting level are put in order of increasing binary value.

Figure 5/S.d - Examples of command structure



Note: This figure may need further study

Figure 6/S.d - Allowable sequences of units within a command or response

5.3 Coding of length indicators

5.3.1 The value of an LI is a binary number that represents the total length in octets of the immediately following CI, RI, PI and/or PGI fields. The value of the LI does not include either itself or any subsequent user information, as noted in 5.2.4 above.

5.3.2 The basic LI consists of a single octet with a maximum value of 254 in decimal (i.e., a binary value of 1 1 1 1 1 1 1 0).

5.3.3 If the first octet of the LI is 255 decimal (i.e., a binary value of 1 1 1 1 1 1 1 1), this indicates that the value of the LI is contained in the next two following octets allowing a maximum value of 65535 octets.

5.3.4 Within any octet, the highest order bit is bit 8 with the remaining bits assigned in descending order. Where the length value is represented in two octets, the first contains the higher order bits.

5.4 Coding of CI and RI for session elements

5.4.1 The coding of CI and RI for session commands and responses is shown in Table 3/S.d.

Table 3/S.d - CI and RI for session elements

Command/Response	Bit Number 8	7	6	5	4	3	2	1
CSS	0	0	0	0	1	1	0	1
CSE	0	0	0	0	1	0	0	1
CSA	0	0	0	1	1	0	0	1
CSCC	0	0	0	1	0	1	0	1
CSUI	0	0	0	0	0	0	0	1
RSSP	0	0	0	0	1	1	1	0
RSSN	0	0	0	0	1	1	0	0
RSEP	0	0	0	0	1	0	1	0
RSAP	0	0	0	1	1	0	1	0
RSCCP	0	0	0	1	0	1	1	0
RSUI	0	0	0	0	0	0	1	0
CSTW	0	0	0	1	1	1	0	1
RSTWP	0	0	0	1	1	1	1	0
RSTWN	0	0	0	1	1	1	0	0
Private use	1	1	1	1	X	X	X	X

5.4.2 Apart from private use, the codes of the commands and responses in Table 3/S.d are assigned in such a way that the bits may be interpreted as follows:-

Bit			
1	1 =	Command	0 = Response
2	1 =	positive	0 = negative (response)
3	1 =	initiate	0 = stop (for most commands)
4,5	1 1	Session	
	1 0	Session	
	0 1	Interaction	
	0 0	Session user	
6,7,8	Set to zero and reserved for extension.		

Note: If possible, this bit coding structure should be followed in making future code assignments, but this is not mandatory if the number of available code combinations is insufficient. Therefore, it is not intended as a guide for implementation.

5.4.3 One or more of the non-allocated values are to be reserved for future extension. The method of future extension is for further study.

5.5 Coding of CI and RI for document elements

5.5.1 The coding of CI and RI for document commands and responses is shown in Tables 4 and 5/S.d respectively.

Table 4/S.d for document commands

Command	Bit number 8	7	6	5	4	3	2	1
CDS	0	0	1	0	1	1	0	1
CDC	0	0	0	1	1	1	0	1
CDE	0	0	1	0	1	0	0	1
CDR	0	0	0	1	1	0	0	1
CDD	0	0	1	1	1	0	0	1
CDPB	0	0	1	1	0	0	0	1
CDRP	0	0	1	0	0	0	0	1
CDRR	0	0	1	0	0	0	0	1
CDCL	0	0	1	1	1	1	0	1
CDUI	0	0	0	0	0	0	0	1
Reserved for private use	1	1	1	1	X	X	X	X

Table 5/S.d - Coding of RI for document responses

Response	Bit number 8	7	6	5	4	3	2	1
RDEP	0	0	1	0	1	0	1	0
RDRP	0	0	0	1	1	0	1	0
RDDP	0	0	1	1	1	0	1	0
RDPBP	0	0	1	1	0	0	1	0
RDPBN	0	0	1	1	0	0	0	0
RDCLP	0	0	1	1	1	1	1	0
RDGR	0	0	0	0	0	0	0	0
RDRPR	0	0	1	0	0	1	0	0
Reserved for private use	1	1	1	1	X	X	X	X

5.5.2 Apart from private use, the codes of the commands and responses in Tables 4 and 5/S.d are assigned in such a way that the bits may be interepreted as follows:-

Bit	1	1 = Command	0 = Response
	2	1 = positive	0 = negative (for response)
	3	1 = initiate	0 = stop (for most command_)
	4,5,6	1 1 1, 1 1 0, 1 0 1	Document/Delivery unit
		1 0 0	(Reserved)
		0 1 1	Page (commitment unit)
		0 1 0	Reserved
		0 0 1	(Reserved for recovery unit)
		0 0 0	Text

7,8 Set to zero and reserved for future extension.

5.5.3 See points 5.4.2 and 5.4.3 above.

5.6 <u>Coding of PGIs and PIs</u>

5.6.1 The coding of PGIs and PIs for session commands and responses is shown in Table 6/S.d. The coding of the PGIs and PIs for document commands and responses is shown in Table 7/S.d.

5.6.2 Tables 8 and 9/S.d list the PGIs and PIs for each command and response for the session and document elements of procedure together with an indication of whether the PGIs and PIs concerned are mandatory or not

5.6.3 Where a PI is allocated to a particular PGI this is shown in Table 6 or 7/S.d. Some PIs are not allocated to a PGI and are used as required. Some PIs may be used without preceding PGI as defined in Tables 8 and 9/S.d.

5.6.4 The codes of these PGIs and PIs are assigned in such a way that the binary field consisting of bits 8, 7 and 6 may be interpreted as follows:

bits 8 7 6	
0 0 0	Session related
0 0 1	Document related*
0 1 0	Document related
0 1 1	Reserved
1 0 0	Reserved
1 0 1	Reserved
1 1 0	Reserved
1 1 1	Private use

The binary field consisting of bits 5 and 4 may be interpreted as follows:

bits 5 4	
0 0	PGI
0 1	PI
1 0	PI
1 1	PI

The binary field consisting of bits 3, 2 and 1 is used to extend the PGIs when set to 000.

Note: If possible, this binary field coding structure should be followed in making future code assignments, but this is not mandatory if the number of available code combinations is insufficient.

5.7 Parameter values

5.7.1 Unless otherwise specified the following rules apply to the fields containing parameter values (PV):

a) where a binary number is used to represent a value, the highest order bit of each octet is bit 8 with the remaining bits assigned in descending order. Where a binary value is represented by more than one octet, the first octet contains the highest order bits, with successive octets assigned in descending order;

b) all bits reserved for future standardization shall be set to zero;

* These Document related PGIs and PIs may possibly be of use to other services.

TABLE 6/S.d

Coding of session PGIs and PIs

Parameter group identifiers (PGI)									Parameter identifiers (PI)								
Name or function	Bit number 8	7	6	5	4	3	2	1	Name	Bit number 8	7	6	5	4	3	2	1
Reserved for extension	0	0	0	0	0	0	0	0									
Session reference	0	0	0	0	0	0	0	1	Terminal identifier of the called term.	0	0	0	0	1	0	0	1
									Terminal identifier of the calling term.	0	0	0	0	1	0	1	0
									Date and time	0	0	0	0	1	0	1	1
									Additional session reference number	0	0	0	0	1	1	0	0
Non-basic session capabilities	0	0	0	0	0	0	1	0	Miscellaneous session capabilities	0	0	0	0	1	1	0	1
									Window size	0	0	0	0	1	1	1	0
Non-basic terminal capabilities	0	1	0	0	0	0	0	1									
									Control character set	0	1	0	0	1	0	0	1
									Page format	0	1	0	0	1	0	1	0
									Miscellaneous Terminal capabilities	0	1	0	0	1	0	1	1
Private use	1	1	1	0	0	X	X	X	Private use	1	1	1	0	1	X	X	X
									Private use	1	1	1	1	0	X	X	X
									Private use	1	1	1	1	1	X	X	X
No PGI associated with these PIs									Service identifier	0	0	0	0	1	0	0	0
									Request session functions	0	0	0	1	0	0	0	0
									Session termination parameter	0	0	0	1	0	0	0	1
									Graphic character set	0	1	0	0	1	0	0	0

Note: Term. abbreviation for Terminal

TABLE 7/S.d

Coding of Document PGIs and PIs

Parameter group identifiers (PGI)									Parameter identifiers (PI)								
Name or function	Bit number 8	7	6	5	4	3	2	1	Name	Bit number 8	7	6	5	4	3	2	1
Reserved for extension	0	0	1	0	0	0	0	0									
Reserved for extension	0	1	0	0	0	0	0	0									
Document linking	0	0	1	0	0	0	0	1	Terminal identifier of the called term.	0	0	0	0	1	0	0	1
									Terminal identifier of the calling term.	0	0	0	0	1	0	1	0
									Date and time	0	0	0	0	1	0	1	1
									Additional session reference number	0	0	0	0	1	1	0	0
									Document reference number	0	0	1	0	1	0	0	1
									Check point reference number	0	0	1	0	1	0	1	0
Non-basic terminal capabilities	0	1	0	0	0	0	0	1									
									Control charater set	0	1	0	0	1	0	0	1
									Page format	0	1	0	0	1	0	1	0
									Miscellaneous terminal capabilities	0	1	0	0	1	0	1	1
No PGI associated with these PIs									Service interworking identifier	0	0	1	0	1	0	0	0
									Document reference number	0	0	1	0	1	0	0	1
									Reserved (possible binary check point number)	0	0	1	0	1	0	1	1
									Acceptance of CDCL parameters	0	0	1	0	1	1	0	0
									Storage capacity negotiation	0	0	1	0	1	1	0	1
									Storage overflow warning	0	0	1	0	1	1	1	0
									Reserved	0	0	1	0	1	1	1	1
									Document type identifier	0	0	1	1	0	0	0	0
									Reflect parameter values	0	0	1	1	0	0	0	1
									Reason (Document)	0	0	1	1	0	0	1	0

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5.7.9 Graphic character sets (refer to Recommendations S.c and S.f)

A variable length field indicating the receiving capabilities for non-basic standardized graphic character sets. Each such graphic character set shall be indicated by the sequence of characters used after an ESCAPE character to designate that set, as defined in Recommendation S.f. Where more than one such character set is to be indicated, a single SPACE shall be used as a separator between the character set indicators.

5.7.10 Control character sets (refer to Recommendations S.c and S.f)

A variable length field indicating the receiving capability for non-basic standardized control character sets. Each such control character set shall be indicated by the sequence of characters used after an ESCAPE character to designate that set, as defined in Recommendation S.f. Where more than one such character set is to be indicated, a single SPACE shall be used as a separator between the character set indicators.

5.7.11 Page formats (refer to Recommendations S.c and S.f)

Bit 1 of the first octet set to "one" shall indicate the capability for use of the optional maximum printable area for the ISO A4 paper size, as defined in Recommendation F.x. All other bit values are reserved for future standardization.

5.7.12 Miscellaneous terminal capabilities (refer to Recommendation S.f)

A variable length field indicating the receiving capabilities for non-basic standardized values of character spacing, line spacing and graphic renditions. Each such function shall be indicated by the sequence of characters used after a Control Sequence Introducer (CSI) for the Select Horizontal Spacing (SHS) for a character pitch, for the Select Vertical Spacing (SVS) for a line pitch and for Select Graphic Rendition (SGR) for a graphic rendition. When more than one such character sequence is to be indicated, a single SPACE shall be used as a separator between them.

5.7.13 Service identifier

Bit 1 of the first octet set to "one" indicates the intention to use the Teletex service. All other bit values are reserved for future standardization.

c) where a PV contains graphic characters that may be printed or displayed, they shall be in the intended printing/display sequence and shall be coded as defined in Recommendation S.f;

d) for a PGI designated for extension, the PIs and/ or PGIs included in the parameter field do not necessarily conform to the following assignments of PI and PGI values.

5.7.2 Assignment of coding to the various parameter values is shown in the following points.

5.7.3 Identification of the called terminal

A sequence of graphic characters as defined in Recommendation F.x.

5.7.4 Identification of the calling terminal

A sequence of graphic characters as defined in Recommendation F.x.

5.7.5 Date and time

A sequence of graphic characters as defined in Recommendation F.x.

5.7.6 Additional session reference number

A fixed length sequence of two decimal digits as coded in Recommendation S.f.

5.7.7 Miscellaneous session capabilities

Bit 1 of the first octet set to "one" indicates the terminal capability for two-way simultaneous information transfer.

Bit 2 of the first octet set to "one" indicates the terminal capability for session suspension.

All other bit values are reserved for future standdardization.

5.7.8 Window size

A binary number of fixed length of one octet, with a minimum value of one and a maximum value of 255 in decimal (i.e., a binary value of 11111111). The default value is three in decimal (i.e., a binary value of 00000011).

5.7.19 Document reference number

A sequence of decimal digits as coded in this in Recommendation.

5.7.20 Checkpoint reference number

A sequence of decimal digits as coded in this Recommendation.

5.7.21 Acceptance of CDCL parameters

Bit 1 of the first octet set to "one" indicates acceptance of all non-basic terminal capabilities requested by a CDCL command.

All other bit values are reserved for future standardization.

Note: Parameters b and c of RDCLP are coded as non-basic terminal capabilities.

5.7.22 Storage capacity negotiation

A fixed length sequence of two octets:

a) bit 1 of the first octet set to "one" indicates that a terminal has reserved a requested amount of storage;

b) bit 2 of the first octet set to "one" indicates that the binary field in the following octet contains a number indicating storage capacity requested/reserved in kilo-octets;

c) bit 3 of the first octet set to "one" indicates that a terminal cannot estimate its memory capacity;

d) bit 4 of the first octet set to "one" indicates that a terminal cannot now reserve the requested amount of memory;

e) bits 5 to 8 of the first octet are reserved for future standardization.

Octet 2 indicates the memory size available and/or reserved (the meaning is defined in the first octet). It shall be set to 11111111 if bit 3 and/or 4 in the first octet is set to "one".

5.7.23 Receiving ability jeopardized

Bit 1 of the first octet set to "one" indicates that the ability of the receiving terminal to continue to accept user information is jeopardized (e.g. memory threshold reached).

All other bits are reserved for future standardization.

5.7.14 Reason (session)

For further study (RSSN).

5.7.15 Session termination parameter

Bit 1 of the first octet set to "one" indicates that the transport service connection shall be cleared (default value). When set to '0' it indicates that the transport connection should be cleared.

Bit 2 of the first octet set to "one" indicates a local terminal error.

Bit 3 of the first octet set to "one" indicates an unrecoverable procedural error.

Bit 4 of the first octet set to "one" indicates that no reason is given.

All other bits are reserved for future standardization. The CSE command uses only bit 1, all other bits shall be set to "zero".

5.7.16 Request session functions

In the first octet the following bit assignments are defined:

a) bit 1 if set to "one" indicates request transmit (as defined in this Recommendation).

b) bit 2 if set to "one" indicates request session suspension (as defined in this Recommendation).

All other bits are reserved for future standardization.

5.7.17 Private use

A set of PGI and PI values is designated as being for private use. Other than the PGIs designated for extensions and the permitted use of private parameters only with certain commands and responses, the use of these parameters is not defined.

5.7.18 Service interworking identifier

Bit 1 of the first octet set to "one" shall indicate that the associated document is suitable for forwarding via the telex service.

All other bit values are reserved for future standardization.

Table 8/S.d - PGIs and PIs for session elements of procedure

5-4-2 SESSION LEVEL

SESSION Command or Response Identifier	PGI Description	PGI Mandatory or not Man	PI Description	PI Mandatory or not Man
CSS	Session Reference	m	Terminal Identifier of the calling Term.	m
			Date and time	m
			Additional Session Ref. No.	Nm
	Non-Basic Session Capabilities	Nm	Window size	Nm
			Miscellaneous Session Capabilities	Nm
	Non-Basic Terminal Capabilities	Nm	Control Character Set	Nm
			Page Formats	Nm
			Miscellaneous Terminal Capab.	Nm
	Private Use	Nm	-	-
			Service Identifier	m
CSE			Session Termination	Nm
CSA			Session Termination	m
CSCC				
CSUI				
RSSP	Session Reference	m	Terminal Identifier of the called term.	m
			Date and time	m
			Additional Session Ref. No.	Nm
	Non-Basic Capabilities Session	Nm	Window Size	Nm
			Miscellaneous Session Capabilities	Nm
	Non-Basic Terminal Capabilities	Nm	Control Character Sets	Nm
			Page Formats	Nm
			Miscellaneous Terminal Capabilities	m
			Service Identifier	m
	Private Use	Nm	-	-
RSSN	For Further Study	-	-	-
	Private Use			Nm
RSEP				
RSAP				
RSCCP				
RSUI			Request Session Function	Nm

Editorial Note : Private use has not been restricted to only those private use fields indicated in the tables. Private use may be attached to any command or response.

Note: Term. abbreviation for Terminal

5.7.24 Document type identifier

Absence of this parameter shall indicate a normal text document. This parameter, if used, is a binary encoded field of fixed length of one octet, identifying the document type as follows:

	bit 8	7	6	5	4	3	2	1
Operator Document	0	0	0	0	0	0	0	1
Control Document	0	0	0	0	0	0	1	0
Monitor Document	0	0	0	0	0	0	1	1

All other binary values are reserved for future standardization.

5.7.25 Reflect parameter value

This is an arbitrary length field that contains the bit pattern of the command or response up to and including the detected error.

5.7.26 Reason (Document)

A binary encoded field indicating the reason for failure:

Bit 8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Used for reasons other than those stated
0	0	0	0	0	0	0	1	Memory overflow
0	0	0	0	0	0	1	0	Transmission error
0	0	0	0	0	0	1	1	Sequence error
0	0	0	0	0	1	0	0	Format error
0	0	0	0	0	1	0	1	Local terminal error
0	0	0	0	0	1	1	0	Unrecoverable procedural error

The absence of this parameter indicates that no reason is given.

Annexes : 7 (A-G)

DOCUMENT Response Identifier	PGI Description	PGI Mandatory or not Man	PI Description	PI Mandatory or not Man
RDEP			Checkpoint reference No.	m
RDRP				
RDDP				
RDPBP			Checkpoint Reference No.	m
			Storage overflow warning	Nm
RDPBN			Reason (Document)	Nm
RDCLP			Acceptance of CDCL Parameters	Nm
			Storage capacity negotiation	Nm
	Non-Basic Terminal capabilities	Nm	Control character sets	Nm
			Page Formats	Nm
			Miscellaneous Term. Capabilities.	Nm
	Private Use		-	-
			PI graphic character sets	Nm
RDGR			Reflect parameter values	m

Table 9/S.d - PGIs and PIs for document elements of procedure

DOCUMENT	PGI		PI	
Command Identifier	Description	Mandatory or not Man	Description	Mandatory or not Man
CDS			Document Ref. No.	m
			Service Interworking Identifier	Nm
			Document Type Ident.	Nm
	Non-basic Terminal Capabilities	Nm	Control character sets	Nm
			Page Formats	Nm
			Miscellaneous Term. Capabilities	Nm
	Private Use	Nm	-	-
CDC	Document linking	m	Document reference No checkpoint	m
			Reference No.	m
			Terminal identifier of the called term.	m
	Only required if linking in a new session		Terminal identifier of the calling term.	m
			date and time	m
			additional session ref. no.	m
	-	-	Service interworking identifier	Nm
	-	-	Document type identifier	Nm
	-	-	Document reference (current session)	Nm
	-	-	Other parameters of CDS	Nm
CDE			Checkpoint ref. No.	m
CDR			Reason (Document)	Nm
CDD			Reason (Document)	Nm
CDPB			Checkpoint ref. No.	m
CDCL			Storage capacity Negotiation	Nm
	Non-basic Terminal Capabilities	Nm	Control character sets	Nm
			Page Formats	Nm
			Miscellaneous Term. Capabilities	Nm
	Private Use	Nm	-	-
CDUI			PI graphic character sets	Nm
CDUI				

Note: Term. - abbreviation for Terminal

2.2 Modes of session: There are three different modes:

a) One way Communication (OWC). Customer information is transferred in one direction only during the session, i.e. only one of the terminals will have the right to be the source.

b) Two way Alternate (TWA). Customer information is transferred in both directions, but only in one direction at a time, i.e. the source/sink relation will be changed one or more times during the session.

c) Two Way Simultaneous (TWS). Customer information is transferred in both directions simultaneously, i.e. both terminals are simultaneously a source as well as a sink.

Note: TWS mode is for further study.

2.3 Basic session reference: The basic session reference is used to identify a session. It consists of:-

a) called terminal's identifier;

b) calling terminal's identifier;

c) date and time.

2.4 Expanded session reference: The expanded session reference is used to identify a session uniquely. It consists of the mandatory basic session reference plus an optional additional session reference number.

3 TERMS SPECIFIC TO DOCUMENT PROCEDURES

3.1 Document: A document is a sequence of one or more pages intended by the originator to be delivered to the address(es) as a single entity in the original page sequence.

3.2 Teletex Page: The basic element of office correspondence in the Teletex service. One A4 (or A4L or North American Standard) page or the information that may be presented on it.

3.3 Check point: A check point is a numbered mark inserted by the sender in the text stream to provide a reference point for error recovery.

3.4 Acknowledgement windows: The maximum number or check points that a sender can transmit without receiving an acknowledgement from the receiver.

ANNEX A

DEFINITIONS

Note: Some of the terms used in this Recommendation have been defined in ways that may differ from the meanings of similar terms in other Recommendations.

1. GENERAL

1.1 Teletex Terminal: A device that is capable of transmitting and receiving Teletex documents in accordance with the basic requirements of Recommendation Sc.

1.2 Teletex Call: The temporary connection (or apparent connection as perceived by the caller) of one terminal to another for the purpose of exchanging information.

1.3 Calling Terminal: That terminal that initiates the procedures to establish a call.

1.4 Called Terminal: That terminal to which a call is made.

1.5 Service interworking: The facility of sending and receiving information between a Teletex terminal and a terminal of another service, eg Telex.

1.6 Command: A command is control information sent to another terminal to initiate execution of a specific function. Some commands require a response.

1.7 Response: A response is control information sent by the recipient of the command to advise the sender of the command of the action taken. Exceptionally, the reaction to a response may be another response.

1.8 Source/sink relationship

174 Customer information is transferred from a source to a si: :
4.1.2

2 TERMS SPECIFIC TO SESSION PROCEDURES

2.1 Session: A session is the interval during which a logical, mutually agreed correspondence between two application/presentation processes exists for the transfer of application and presentation related information.

2.2 Commitment unit (CU)

Element inviting the sink to take over responsibility for the transmitted information.

2.3 Delivery unit (DU)

One or more commitment units that are to be considered as a single entity for the purpose of synchronization.

2.4 Interaction unit (IU)

Element indicating the change of source and sink of data.

3 USER STRUCTURE ELEMENTS

3.1 Document user information block (DU)

Smallest quantity of information preserved as one unit by the procedure.

3.2 Page (P)

The unit of information that may be presented on one physical page.

3.3 Document (D)

A sequence of one or more pages intended to be delivered as a single unit in the original page sequence.

4 RULES

4.1 The dialogue elements are related in accordance with the following hiearchy:-

RU - lowest level in the hierarchy
CU
DU
IU - highest level in the hierarchy

4.2 Initiation/termination of any unit in this hierarchy also initiates/terminates all units at lower levels of the hierarchy.

A N N E X B

ELEMENTARY FUNCTIONS OF THE PROCEDURE

1 INTRODUCTION

1.1 The purpose of this Annex is to provide a more formal description of the document elements of procedure. The definition of independent and elementary functions forming a basic set of elements leads to:-

a) the description of each element of procedure in this basic set is unambiguous (open to a single interpretation);

b) the functions that are common in two different elements of procedure appear clearly in the description of these elements (see Table 1);

c) the separation of the elements of procedure into dialogue elements and elements concerning the structure of the user information;

d) for future elements of procedure, this basic set helps to re-use the elements in the basic set, which are already implemented, in new combinations.

1.2 Sections 2 and 3 below describe the basic set of elementary functions. These functions have been selected such that:-

a) they are elementary (they cannot be subdivided);

b) they are independent;

c) any element of procedure shall be capable of being described using the basic set.

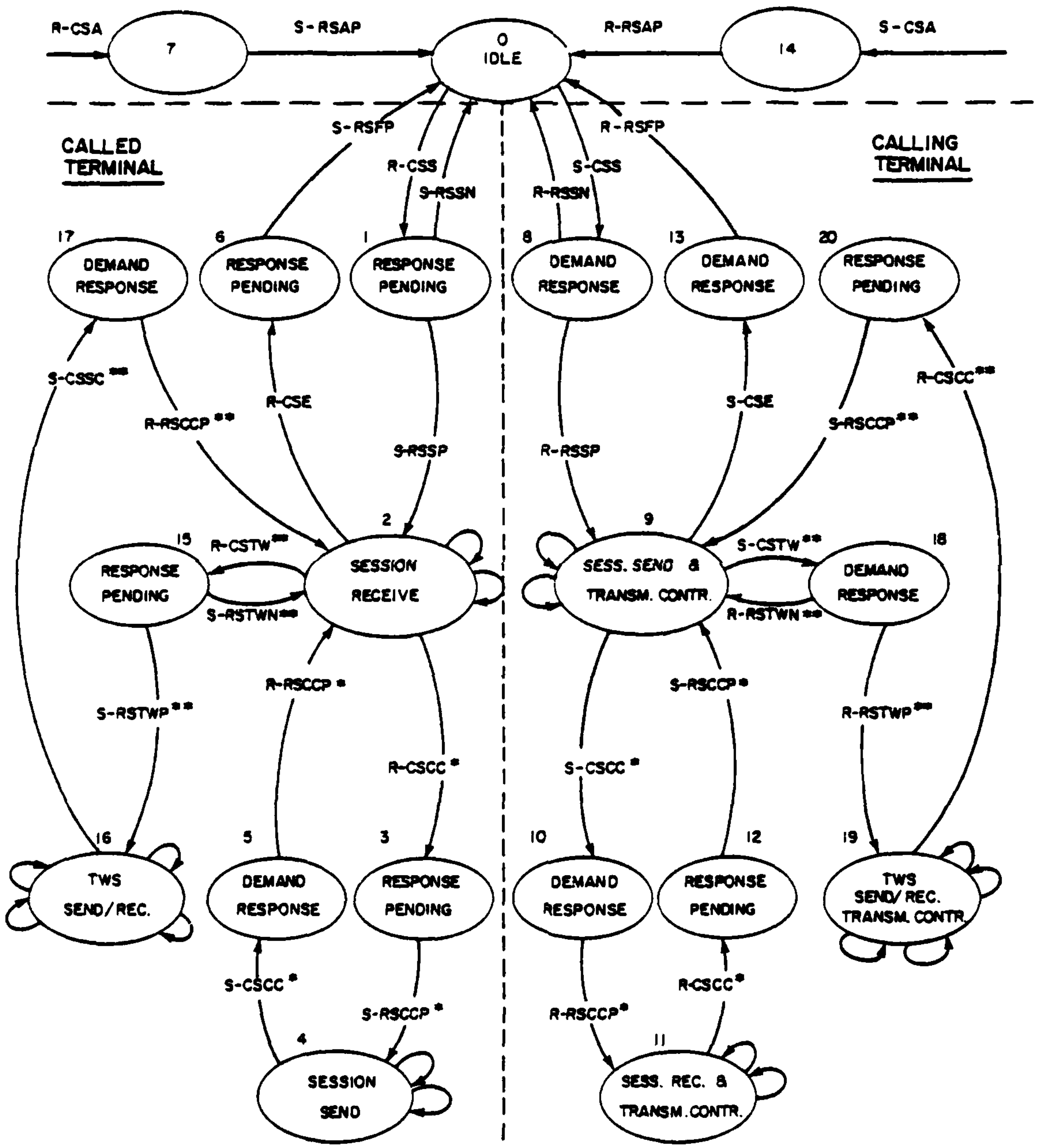
1.3 Only the document elements of procedure have been taken into account.

2 DIALOGUE ELEMENTS

2.1 Recovery unit (RU)

A unit delimited by a recovery mark inserted by the sender in the text stream to provide a reference point for resuming transmission after a transmission interruption.

Note: The RU may be used to provide for different recovery mechanisms. The recovery mark may or may not require an acknowledging response depending upon the recovery mechanism.



* only applicable for TWA mode
** only applicable for TWS mode

Figure 1/Annex C - State diagram for OWC, TWA and TWS modes (error states)

Table 1/Annex ... - Analysis of document layer commands and responses in terms of elementary functions

Command	User structure	Dialogue
CDS	Start of D, P	Start of DU (CU, RU)
CDE	End of D, P	End of DU (CU, RU)
CDR	Suspend D Discard current P	End of DU (CU, RU)
CPB	End of P Start of P	End of CU (RU) Start of CU (RU)
CDUI	Start of DU	
CDC	Continue D Start of P	Start of DU (CU, RU)
CDD	Discard D	End of DU (CU, RU)
RDEP	-	Ack XU (CU, RU)
RDPB RDPBN RDRP	 - -	Ack CU (RU) Nack CU (RU) Ack DU (CU, RU)
RDGR		End of DU (CU, RU)
Positive	-	Ack DU (CU, RU)
RDCP Positive	 -	 Ack RU
RDGR	-	End of DU (CU, RU)

2.4 Command session suspension request (CSUR)

2.4.1 The CSUR can be used by the called terminal to indicate that a halt in the information flow is needed. The calling terminal can then decide what to do.

2.4.2 No explicit response is required since a suspension is implicitly the positive response and negative response has no meaning. The request shall be void if not acted upon within (period to be defined).

2.4.3 The CSUR parameter is an indication of the required duration for the suspension.

2.5 Command session reactivate (CSR)

2.5.1 The CSR is sent when reactivating a suspended session.

2.5.2 The terminal that initiated the session is responisble for reactivating it before the time that was indicated in the suspension command has expired. This responsibility does not exclude the possibility of the other terminal's reactivating the session.

Note: The rules for reactivation require further study.

2.5.3 The parameters required for the linking of the reactivated session require further study.

2.6 Response session reactivate positive (RSRP)

2.6.1 The RSRP indicates that the session reactivation is accepted and that the communication can start.

2.6.2 The RSRP parameters are for further study.

2.7 Response session reactivate negative (RSRN)

2.7.1 The RSRN indicates that the session reactivation cannot be effected.

2.7.2 The RSRN parameter shall indicate the reason for the negative response from amongst the following (for further study):-

a) the command was used illegally (sent by the called terminal, refers to a session that is already active, or is sent before clearing or suspension of another session);

A N N E X D

SESSION SUSPENSION FACILITY

Note: Further study required

1 GENERAL

1.1 The session suspension facility is an extension of the basic Teletex control procedure. For a negotiable time, it gives the possibility of clearing the call without losing the logical relationship represented by the session.

2 ELEMENTS OF PROCEDURE

2.1 Command session suspend (CSSU)

2.1.1 The CSSU is sent by the calling terminal when a suspension of the session is required. A session cannot be expected to exist after the indicated time has expired (see CSR in point 2.5 below).

2.1.2 The command parameters are:-

a) the time interval during which the session may be reactivated (format for study under coding);

b) an indication for the release of the transport connection.

2.2 Response session suspend positive (RSSP)

2.2.1 The RSSP indicates that the suspended state has been entered by the called terminal in a controlled way.

2.3 Response session suspend negative (RSSUN)

2.3.1 The RSSUN indicates that the session suspension cannot be accepted. The reason for the rejection shall be indicated as a parameter.

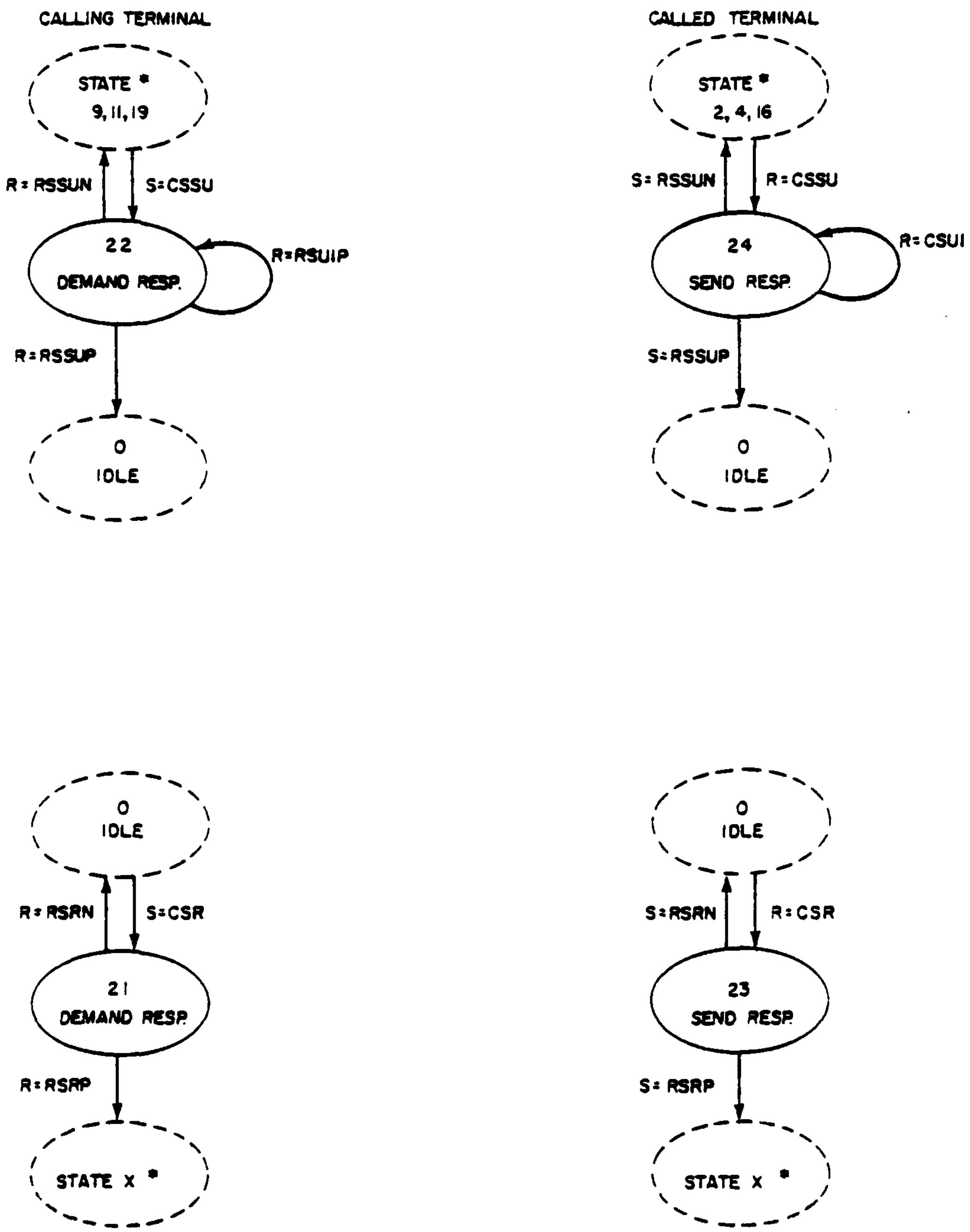
2.3.2 The RSSUN parameter indicates one of the following reasons for rejection:-

a) the CCSU was illegally used (e.g. by a terminal that is not the paying terminal), this shall not be regarded as an error leading to clearing;

b) a suspended session is temporarily not possible;

c) more than one suspended session per terminal is not possible;

d) the indicated time for the suspension is too long.



* This is the state from which the session was suspended and from which it is to be resumed.

Figure 1/Annex D - Session state diagram for session suspend

b) the linking information is not recognized (wrong terminal identifier, wrong session identifier, or the session has been cleared during the suspension by the called terminal).

3 STATE DIAGRAM

3.1 Figure 1/Annex D is a session state transition diagram for the session suspension facililty (showing additions to the session state transition diagram required for the facility).

Upon detection of a failure to maintain proper operation as described above, use of error recovery procedures defined for each state diagram is mandatory, or where such error recovery procedures are not specifically defined, session termination (abnormal end) is mandatory. This is necessary in order to avoid unproductive use of Teletex facilities, incurring unnecessary charges where the service is not being used effectively, and causing degradation of the service.

10. The purpose of the state diagrams is to assist in defining proper use of the elements of procedure, not to define any particular implementation.

A N N E X   E

GENERAL DESCRIPTION AND RULES OF OPERATION FOR STATE DIAGRAMS

1. Each state diagram is in only one state at any time.

2. Each state is represented as an ellipse, which contains a number for reference and a descritpvie name.

3. Permissible transitions from one state to another are shown as connecting lines with an arrow indicating the permitted direction of the state transition and labelled with the even or events that cause that transition.

4. Where a transition may originate from any of several states, it may be indicated by a broad arrow terminating on the description state and labelled with the permissible states of origination and with the even or events that cause that entry into the estination state.

5. An event is either the sending (S -) or reception (R -) of a command or a response or an indicated local operation.

6. Each state diagram has a state named "idle" and numbered zero. This is the initial or reset sate when that state diagram is inactive.

7. Upon sending any command that causes entry into a state named "demand response", the sending of any additional commands is not permitted until a response is received. An inactivity timer is started, and, if a response is not received prior to expiration of that timeout, session termination either directly if Command Session Abort (CSA) was sent or by sending CSA is mandatory.

8. The effect of each event that causes a state transition must be completed prior to consideration of a subsequent event.

9. During a session, each session partner has a responsibility for monitoring for proper operation as follows:-

a) maintenance of the currently agreed source/sink relationship;

b) proper use of command/response procedural sequences as described in the state diagrams and the rules for their operation;

c) monitoring for a period of inactivity (e.g. indicating a failure or other inability to continue productive use of the session).

4 CONTROL DOCUMENT (OPTIONAL)

4.1 The control document can be used in communication with intermediate stor-and-forward equipment.

4.2 The addressing information (and other control information required) can be included as text within such a document. The control document shall, except for the document type indication, follow the same rules (in the procedure) as a normal document. The use of the control document is a national matter and is outside the scope of this recommendation.

5 MONITOR DOCUMENT (OPTIONAL)

5.1 The monitor document will not be made available to the user. It is intended to be available for purposes that can be defined by each administration, e.g. for maintenance purposes.

5.2 The monitor document will be handled by the operating system of the terminal and not displayed to the operator. The monitor document shall, except for the document type indication, conform with the same rules (in the procedure) as a normal document.

ANNEX F

TYPES OF DOCUMENT

1 GENERAL

1.1 An indication of the type of document that is transferred shall be given at the start of each document, if not the normal type of document is used.

1.2 A document type indication will indicate to the operating system of the receiving terminal that a special action is required (the action is defined for each type of document).

1.3 No additional procedure elements or changes in state transition diagrams are required.

2 NORMAL DOCUMENT

2.1 This is the normal type of document to be used to transfer text in the Teletex service. The document is supposed to be immediately stored. Presentation of the text is a local function and is not controlled by the procedure. The unit document can in its turn be divided into a number of pages. The subdivision of the text into different pages must be maintained in the handling and during the presentation. The same is valid for the presentation format within the page.

2.2 From the procedures point of view, every Teletex terminal must be able to handle this type of document.

Note: Where appropriate the rules for the usage of optional functions have to be followed.

3 OPERATOR DOCUMENT (OPTIONAL)

3.1 The operator document represents a type of priority message. It can be used in the conversational mode of operation.

It is intended to be presented immediately to the operator (although the decision to present it is left to the receiving operator). It may therefore be immediately indicated to the operator that a new operator document has been received. The operator document shall conform with the same presentation control functions and be treated in the procedure as a normal document. The length of an operator document is arbitrary but it shall preferably (due to the application) not exceed one page. Note that a terminal that does not have a special dialogue mode, can handle an operator document as a normal document.

5 RESPONSE DOCUMENT RECOVERY POINT RESTART (RDRPR)

5.1 The RDRPR shall be used by the sink to indicate to the source from which recovery point the resynchronization is available.

5.2 The RDRPR parameter is the recovery point reference number.

5.3 The recovery point reference number shall be lower than or equal to the number indicated by the source in the RDRPR command.

A N N E X G

OPTIONAL ERROR RECOVERY MECHANISM (for further study)

1 INTRODUCTION

1.1 Section 4 of this Recommendation describes the error recovery mechanism used in the basic Teletex service. With mixed-mode operation (e.g. Teletex and facsimile) or with facsimile alone, there is a need for another recovery mechanism, as described below, that allows resynchronization of the source and the sink within a page (commitment unit) or a document (delivery unit) without ending the document and discarding the whole current page.

1.2 This recovery mechanism may also be applied, as an option, in the Teletex service.

1.3 The commands and responses, together with their parameters, required for this optional recovery (or resynchronization) mechanism are described below.

2 COMMAND DOCUMENT RECOVERY POINT (CDRP)

2.1 The CDRP shall be used to indicate a recovery point from which the source or the sink may ask for a resynchronization.

2.2 The CDRP parameter is the recovery point reference number.

2.3 The CDRP command is sent by the source at arbitrary points in the text.

2.4 The commands CDS, CDC, CDPB are to be considered as an implicit recovery-point number 0.

3 RESPONSE DOCUMENT RECOVERY POINT NEGATIVE (RDRPN)

3.1 The RRPN shall be used by the sink to resynchronize the source from a recovery point.

3.2 The RRPN parameter is the recovery point reference number.

4 COMMAND DOCUMENT RECOVERY POINT RESTART (CDRPR)

4.1 The CDRPR shall be used by the source to resynchronize the sink from the indicated recovery point.

4.2 The CDRPR parameter is the recovery point reference number.

DAT

FILM

6 –