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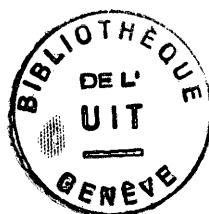
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INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE



Recommendation X.32 **provisionally approved**

**Interface between Data Terminal Equipment (DTE) and
Data Circuit-Terminating Equipment (DCE) for terminals
operating in the packet-mode and accessing a packet switched
public data network through a public switched telephone network
or a circuit switched public data network**



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Recommendation X.32 (provisionally approved)

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE)
AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR
TERMINALS OPERATING IN THE PACKET MODE AND
ACCESSING A PACKET SWITCHED PUBLIC DATA NETWORK
THROUGH A PUBLIC SWITCHED TELEPHONE NETWORK
OR A CIRCUIT SWITCHED PUBLIC DATA NETWORK

Preface

The establishment in various countries of packet switched public data networks (PSPDN) providing data services creates the need to produce Recommendations to facilitate access to the PSPDN through a public switched telephone network (PSTN) or a circuit switched public data network (CSPDN).

The CCITT,

considering:

- a) that Recommendation X.1 specifies the user classes of service for DTEs operating in the packet mode, that Recommendation X.2 defines user facilities provided by public data networks, that Recommendation X.10 defines categories of access, that Recommendations X.21 and X.21 bis define DTE/DCE physical level interface characteristics, that Recommendation X.25 defines the interface between the DTE and the DCE for terminals operating in the packet mode and connected to public data networks by dedicated lines, that Recommendation X.121 defines the international numbering plan for public data networks (PDNs), that Recommendation X.300 defines the principles and arrangements for interworking between PDNs and other public networks;
- b) that the Series-V Recommendations define modem and interface characteristics for use of data services on the PSTN;
- c) that Recommendation T.70 defines the procedures and interfaces to be used by telematic terminals, that Recommendation T.71 defines the extension of Link Access Procedure Balanced (LAPB) procedure to be used in half-duplex transmission facilities (LAPX);
- d) that a need has been identified to access a PSPDN through a PSTN or CSPDN, either because a dedicated circuit to the PSPDN is not justified or because global service availability is required with back-up network access via public switched networks;

e) that some Administrations have considered the provision of Telematic services in different types of networks, e.g. PSPDN, PSTN and CSPDN;

f) that, when this Recommendation is used to provide the Network Service defined in Recommendation X.213, the physical, link and packet levels correspond to the Physical, Data link and Network layers respectively, as defined in Recommendation X.200,

(unanimously) recommends

that the functional and procedural aspects of packet mode DTEs accessing a PSPDN through a PSTN or CSPDN should be as specified in this Recommendation.

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1 Scope

This Recommendation defines the functional and procedural aspects of the DTE/DCE interface for packet mode user classes of service DTEs as defined in Recommendations X.1 and X.10, for DTEs that access a PSPDN via public switched networks. In this Recommendation, a public switched network (PSN) is either a public switched telephone network (PSTN) or a circuit switched public data network (CSPDN).

Note - It is left for further study to enlarge the scope of Recommendation X.32 to include access of a PSPDN through an Integrated Services Digital Network (ISDN) circuit switched connection.

In the PSTN case, the X.32 DTE/DCE interface coincides with the interface between the DTE and the modem. In the CSPDN case, the X.32 DTE/DCE interface coincides with the X.21 or X.21 bis interface. This definition applies whether or not the administration provides the DCE and regardless of how the interface is physically realized (e.g. whether or not the DTE and DCE are contained within the same enclosure). In either case, the PSN is involved only:

- a) in the establishment of the switched access path;
- b) to provide a transmission medium; and
- c) optionally, to provide a PSN number for purposes of identification and addressing.

Administrations may offer one or more of the following physical level interfaces:

- 1) for access by way of a CSPDN, either Recommendation X.21 or Recommendation X.21bis will be used, as described in §§ 4.1 or 4.2, respectively;
- 2) for access by way of a PSTN, appropriate V-Series Recommendations will be used as described in § 4.3.

The exact use of the relevant points in these Recommendations is given in § 4.

The transmission facility is duplex or, optionally, half-duplex. Specific procedures are defined in § 5.6 of this Recommendation for operation over a half-duplex transmission facility.

At the link level, the LAPB link access procedure of Recommendation X.25 is used over a single switched physical circuit. The LAPB formats and procedures shall be in accordance with §§ 2.2, 2.3 and 2.4 of Recommendation X.25, with additions as noted in § 5 of this Recommendation.

The formats and the procedures at the packet level shall be in accordance with §§ 3, 4, 5, 6 and 7 of Recommendation X.25 with the additions noted in § 6 of this Recommendation.

2 Functional aspects

2.1 Dial-in and dial-out considerations

Dial-in operation allows a packet-mode DTE to access a PSPDN by means of selection procedures on a PSTN or CSPDN (see Figure 1/X.32). This operation is termed "dial-in-by-the-DTE" within this Recommendation.

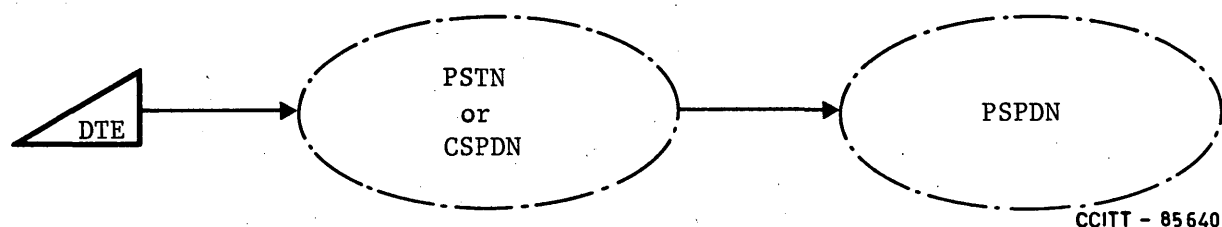


FIGURE 1/X.32

Dial-in-by-the-DTE operation

For performing this operation, the DTE may use an automatic or manual calling procedure.

Dial-out operation allows a PSPDN to access a packet-mode DTE by means of selection procedures on a PSTN or CSPDN (see Figure 2/X.32). This operation is termed "dial-out-by-the-PSPDN" within this Recommendation.

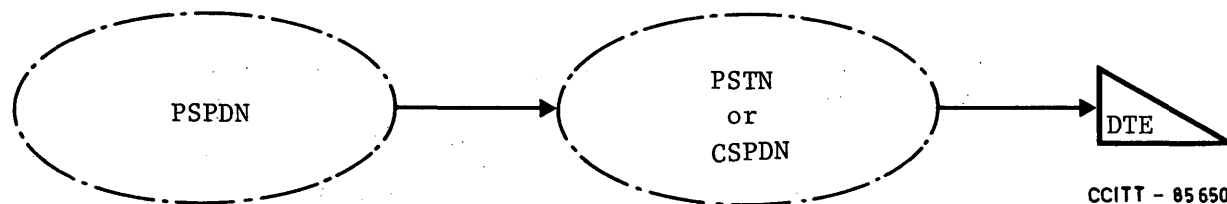


FIGURE 2/X.32

Dial-out-by-the-PSPDN operation

For dial-out-by-the-PSPDN operation, the DTE should use the automatic answering procedure but may use manual answering.

Virtual call origination is independent of dial-in-by-the-DTE and dial-out-by-the-PSPDN operations. That is, a DTE that has been involved in a dial-in-by-the-DTE or dial-out-by-the-PSPDN operation may then initiate or receive virtual calls, subject to the limitations in specific situations as described in § 3.

2.2 Identification

2.2.1 DTE identity

When a DTE accesses a PSPDN through a PSN (dial-in-by-the-DTE) or when a DTE is accessed by a PSPDN through a PSN (dial-out-by-the-PSPDN), there may be a requirement for identification of the DTE to the DCE.

The DTE "identity" is a means of referring to the DTE. The DTE identity is either explicitly agreed to between the DTE and the Administration or is implicitly acceptable to the administration through agreements with other Administrations, organizations or authorities. It may be composed of different elements such as a number from a numbering plan, identification of the DTE service and authority, validity dates and period, public keys used for authentication, etc.

The characteristics of the service which a DTE obtains via dial-in-by-the-DTE or dial-out-by-the-PSPDN access depend upon whether the PSPDN considers the DTE identified for each particular switched access connection or virtual call. If the DTE is identified, then the PSPDN has a way to accrue charges to be paid on behalf of the DTE. That is, either the DTE or some other party is billable.

Two components are required in order for a DTE to be considered identified:

- a) the DTE is administratively registered either:
 - 1) through direct arrangement with the PSPDN (i.e. explicitly), or
 - 2) through pre-arrangement between the PSPDN and a PSN or another authority, and direct arrangement between the DTE and that authority (i.e. not explicitly),
- b) the DTE identity is made known to the DCE during the switched access connection using one of the methods described in § 2.4.

A DTE may incur charges even if not identified because some Administrations collect charges via the PSTN or CSPDN.

In any case, DTE identification is used for billing and accounting purposes. In addition to this basic function, DTE identification may optionally be used for one or both of the following purposes:

- a) enabling the PSPDN to provide a calling DTE address to a called DTE, or
- b) enabling the DTE to obtain a different service than that offered to DTEs which do not establish an identity (see § 2.3).

2.2.2 DCE identity

When a network supports dial-out-by-the-PSPDN access to DTEs, there may be a requirement for identification of the network (i.e. DCE) to the DTE. In the case of dial-in-by-the-DTE access, although the identity of the DCE may already be known by the DTE (as the DTE originated the switched access connection), there may also be a DTE requirement for identification of the network. The identification of the DCE to the DTE may be used for different purposes, such as:

- a) to enable the DTE to select the specific security related information (e.g. encrypted key, password, etc.) appropriate to that network for use in exchanges with the DCE;

- b) to enable the DTE to select different parameters, procedures or profiles appropriate to that network;
- c) to enable a DTE to ascertain by which PSPDN the switched access has been established, thus enabling proper operation of the optional closed user group facility and of the conveyance of the appropriate calling DTE address provided by the PSPDN, if applicable.

For each dial-in-by-the-DTE or dial-out-by-the-PSPDN access, the DCE may establish its identity by successfully completing one of the methods for DCE identification described in § 2.5. The DCE identity is composed of the network's Data Network Identification Code (DNIC), and optionally, a DTE profile designator (see § 3.1.11).

2.3 Service aspects

The switched access service given to a particular DTE is dependent upon:

- a) the PSPDN;
- b) the use/non-use of DTE identification, and
- c) the DTE service available to and chosen by the DTE.

Three DTE service types are defined in this Recommendation (see § 2.3.2). One of the DTE service types (nonidentified) is independent of the specific DTE identity. One service type (identified) may or may not be independent of the specific DTE identity. The third type (customized) is related to the specific DTE identity in order to provide customization of some service aspects.

The types of DTE service are further distinguished by whether there is a number assigned by the network to be used to represent the DTE identity in the address fields of call set-up packets. This number is called a "registered address" and is defined in § 3.1.3.

2.3.1 Service attributes

"Attributes" are defined to describe each aspect of switched access service. However, the values of the attributes do not necessarily include all capabilities offered to PSPDN users that access the PSPDN via a leased line. The attributes are:

- a) DTE identity;
- b) DTE identification method;
- c) registered address;
- d) registered PSN number;

- e) X.25 subscription set;
- f) logical channels assignment;
- g) dial-out-by-the-PSPDN availability;
- h) modem selection;
- i) temporary location;
- j) secure dial-back;
- k) DCE identity presentation, and
- l) link level address assignment.

For each DTE service, each attribute is either provided or not provided; if it is provided it is either:

- 1) set to a default value specified by the network (Network Default) or
- 2) set to a value selected by the user from a set of values provided by the network (user selectable). (Note - A network may define a default value for the attribute).

A DTE profile is the set of values of the Network Default and User Selectable attributes that have been selected for a particular DTE identity.

Note - The DTE profile need not be stored in the PSPDN.

Some networks may allow a subscriber to arrange for more than one DTE profile to meet different requirements for switched access service. Each DTE profile is independent. A "DTE profile designator" is used to differentiate the multiple profiles of the DTE.

2.3.2 DTE services

Some networks may offer service to unidentified DTEs, that is, to DTEs for which no identification is provided to the DCE.

Some networks may offer service to identified DTEs, that is, to DTEs for which an implicit or explicit DTE identity is provided to the DCE via one of the methods specified in § 2.4. Different types of service are defined for use in different situations. The network may offer one or more of these services.

The three types of service defined in this Recommendation are called DTE services. One is a service for unidentified DTEs. The other two are services for identified DTEs. The three DTE services are:

- a) nonidentified,
- b) identified, and
- c) customized.

2.3.2.1 Service for unidentified DTEs

The service offered to unidentified DTEs is called nonidentified DTE service and is detailed in § 3.3. This DTE service may be offered as part of dial-in-by-the-DTE or dial-out-by-the-PSPDN operation or both.

For a dial-out-by-the-PSPDN operation, the lifetime of a switched access path corresponds to the lifetime of the virtual call. That is, at the completion of the clearing procedures for the virtual call, the DCE initiates those procedures necessary to disconnect the switched access path.

For a dial-in-by-the-DTE operation, the switched access path shall not be disconnected for a period of time (T14) even in the absence of any virtual calls. This allows users a period of time to reestablish a virtual call. See § 7.5.

For dial-in-by-the-DTE operation, the PSPDN may limit the number of unsuccessful attempts to establish a virtual call.

When a DTE uses the nonidentified DTE service:

- a) it is not required to use any optional procedures;
- b) it is able to operate with different networks without having to subscribe to any of them (i.e. not administratively registered and/or assigned an identity with any PSPDN); and
- c) it should not be permitted to make paid calls or receive reverse-charged calls (i.e. the local charging prevention facility is set by the network), thus allowing the administration to guarantee collection of charges. However, some administrations may permit nonidentified DTEs to make free calls or may use other methods to collect charges (e.g. via the PSTN or CSPDN).

2.3.2.2 Services for identified DTEs

The services offered to identified DTEs provide a set of capabilities/facilities different from and/or enhanced beyond the nonidentified DTE service. In particular, on those networks which allow only identified DTEs to accrue charges, it is possible for DTEs to:

- a) make calls for which the calling DTE assumes responsibility for the charges, and/or
- b) receive reverse-charged calls.

2.3.2.2.1 Identified DTE service

The PSPDN may offer the identified DTE service in which:

- a) the DTE identity has not been explicitly agreed to with the administration, or

the DTE identity has been explicitly agreed to. In this case, allocation of registered addresses, to some DTEs, by the administration is a network option;
- b) the other attributes have the values set by the network as specified in § 3.4.

The effect of the identified DTE service is that this DTE is billable but the service is otherwise similar to the nonidentified DTE service. Note that the use of the network user identification (NUI) facility provides a DTE identity used for billing purposes and may, in conjunction with the NUI override permission facility (§ 6.3), override, for the specific virtual call, the default set of X.25 subscription facilities. However, when using the NUI override permission facility feature, overriding the facilities is performed only when a Call Request is made by the switched access DTE and not for an Incoming Call to the switched access DTE.

The identified DTE service may be offered as part of dial-in-by-the-DTE or dial-out-by-the-PSPDN operation or both.

2.3.2.2.2 Customized DTE service

The PSPDN may offer the customized DTE service in which the DTE identity has been explicitly agreed to with the administration, a registered address has been allocated and the other attributes are set according to the DTE profile which has been customized for the DTE according to the capabilities supported by the network as permitted within the specification given in § 3.5. The effect is that this DTE is billable, has an X.121 address registered with the PSPDN, and is provided a service tailored in many aspects to its requirements. This DTE service may be offered as part of dial-in-by-the-DTE or dial-out-by-the-PSPDN operation or both.

2.4 DTE identification methods

This Recommendation provides four distinct methods for DTE identification. These methods are:

- a) identification provided by the public switched network,
- b) identification by means of a link level Exchange Identification (XID) procedure,
- c) identification by means of a packet level registration procedure,
- d) identification by means of the NUI facility in call set-up packets.

(Note - For an interim period, support of the use of a DTE identification method by means of the calling address field in call request packets is a national matter. It should be remembered that the use of the calling address field for conveying identification conflicts with the use of this field for addressing, and problems can arise if both uses are needed.)

A network may support any, all or none of these methods in conjunction with the DTE services offered (see § 2.7).

The mechanisms in b), c) and d) may be used by some networks to offer functions other than, or in addition to, DTE identification.

The identity of the DTE becomes known to the network via one of the identification procedures at either or both of the following times:

- 1) prior to any virtual call establishment (see § 2.4.1), or
- 2) on a per virtual call basis (see § 2.4.2).

It is considered vital that a reasonable degree of protection be achieved in the DTE identification procedure so that administrations and subscribers can prevent fraudulent DTE identification. Therefore, the identification procedure includes the capabilities to verify and/or authenticate the correctness of the DTE identification. The XID and registration methods obey an "identification protocol" that has been defined in §§ 2.9 and 7.1 for conveying the information necessary for the DCE to receive the DTE identity, verify it to the proper degree of authenticity, and to report on the success of the procedure. Two grades of security are defined in the identification protocol. Identification provided by the public switched network and the X.25 NUI facility do not use an explicit identification protocol. However, the success of authentication is implicit in the reception by the DTE of a call connected packet.

DCE identification may be achieved by using the identification protocol while it is simultaneously being used for DTE identification, but as an independent invocation of the protocol.

Networks may choose to offer "secure dial-back" as an additional means for authentication of the DTE identity. Secure dial-back, as specified in § 7.2.1, uses physical location as a basis for DTE authentication by combining dial-in-by-the-DTE, dial-out-by-the-PSPDN, and DTE identification prior to virtual call establishment.

2.4.1 Identification prior to virtual call establishment

There are three methods by which the identity of the DTE can be determined by the DCE prior to the establishment of any virtual call. These methods are described in the following three subsections. All three methods apply to both dial-in-by-the-DTE and dial-out-by-the-PSPDN operation.

The service that a DTE which is identified prior to virtual call establishment obtains is either the identified or the customized DTE service.

If the service obtained is the customized DTE service and includes customized values for link level options and system parameters, the DTE identification must be performed at the link level (see § 2.4.1.2) or be provided by the public switched network (see § 2.4.1.1).

The DTE identification that is determined by any of the prior-to-virtual-call-establishment methods remains in effect even in the absence of any virtual calls.

2.4.1.1 Identity provided by the public switched network

In the case of dial-in-by-the-DTE operation, the DTE identity may be provided by the public switched network (i.e. PSTN or CSPDN) to the PSPDN during the PSN connection establishment stage.

Note - The administrative arrangements described in § 2.2.1 are necessary for the calling line identification to be used by the PSPDN as a DTE identity.

The DTE is a subscriber of the PSTN or CSPDN network, and, therefore, the PSTN number or the CSPDN number (as well as some additional management information in some circumstances) may be available and will be signalled to the PSPDN.

In the case of dial-out-by-the-PSPDN, the PSPDN uses, as the DTE identification, the information which has been provided to the PSN in order to do the dial-out-by-the-PSPDN operation.

Note - This method of identification may be used in the case of dial-out-by-the-PSPDN operation even when the PSN does not provide calling line identification.

As the PSN is providing the identification information, the DTE is not required to use any optional user procedures in order to accomplish DTE identification.

The DTE identification determined by means of this method remains in effect until the switched access path is disconnected.

Note - Although the operational requirements for a DTE which is not identified or which is identified via the "provided-by-public-switched-network" method are the same, the capabilities/facilities available to DTEs using these methods can be very different. This may result in differences in general DTE operation, especially in regard to reverse charging. In particular, the differences are those between the nonidentified DTE service and the identified or customized DTE services.

2.4.1.2 Identity provided by means of the link level XID procedure

Identification of the DTE may be provided by a link level procedure, as described in §§ 5 and 7, based on exchanges of XID frames between the DTE and the DCE before the logical link is established (disconnected phase of Recommendation X.25).

This procedure may be optionally offered by networks depending, in part, on the offering by the network of the optional frames that this procedure uses. When it is offered by the network, use of this identification procedure by DTEs is optional.

The XID frame used in this method may also be used for other link level functions.

The DTE identification determined by means of this method remains in effect until the switched access path is disconnected or the link level has left the information transfer phase and has entered the disconnected phase.

2.4.1.3 Identity provided by means of the packet level registration procedure

Identification of the DTE may be provided by means of a packet level procedure described in §§ 6 and 7. This procedure is based on one or more exchanges of registration request packets (from DTE to DCE) and registration confirmation packets (from DCE to DTE) and is always initiated by the DTE. (These packets are described in § 5.7.2 of Recommendation X.25). The DTE may initiate this procedure (for purposes of identification) once at the beginning of the existence of the switched access path, i.e. before any virtual calls are made in which the nonidentified DTE service is obtained or in which a per-virtual-call-DTE identification method is used. The DTE identification

determined by means of this method remains in effect until the switched access path is disconnected or the link level has entered the disconnected phase. Also, the receipt of a restart indication packet by the DTE may mean that DTE identification has been lost (see § 6.1 of Recommendation X.25 and §§ 6 and 7 of this Recommendation).

This procedure may be optionally offered by networks depending, in part, on the offering by the network of the optional registration packets that this procedure uses. When it is offered by the network, use of this identification procedure by DTEs is optional..

The registration packets used in this method are also used by those networks which offer the optional on-line facility registration facility.

2.4.2 Identification per virtual call by means of network user identification facility

There is a method, using the network user identification facility, by which the identity of the DTE can be determined on a per-virtual-call basis.

The identification of the DTE is provided in the facility field of the call request packet via the use of the optional NUI facility. Use of NUI in the facility field in a call accepted packet allows a modification of billing (e.g. subaccount billing) to be carried out and has no effect on the values of the DTE profile in use for this DTE.

This procedure may be optionally offered by networks depending, in part, on the offering by the network of the optional NUI facility that this procedure uses. When it is offered by the network, use of this identification procedure by DTEs is optional.

The identification established by this method is accomplished at the same time as virtual call set-up and remains in effect until the virtual call is cleared.

The NUI facility may also be used when a prior-to-virtual-call-establishment identification method has been used. In this case, the service obtained by the DTE using the NUI facility in a call request packet is detailed in § 6.3.2 concerning operation of the NUI facility.

The service that a DTE using the NUI method obtains is the identified DTE service. Upon termination of the virtual call:

- a) if no prior-to-virtual-call-establishment DTE identification had been accomplished, the logical channel is usable again for a nonidentified call or a DTE-identification-via-NUI call, or
- b) if a prior-to-virtual-call-establishment DTE identification had been accomplished, the logical channel is usable again under the conditions of the DTE service that the prior-to-virtual-call DTE identity had invoked.

2.5 DCE identification methods

This Recommendation provides three distinct methods for DCE identification. These methods are:

- a) identification provided by the public switched network,
- b) identification by means of a link level XID procedure, and
- c) identification by means of a packet level registration procedure.

When a network provides dial-in-by-the-DTE access and/or dial-out-by-the-PSPDN access, it need not provide the DCE identification to the DTE. Some networks may not provide the DCE identification to the DTE regardless of the approach used for the DTE identification.

However, for the networks that choose to provide the DCE identification to the DTE using one of the optional identification procedures, it is possible that the DTE may not use that optional identification procedure and, therefore, may not recognize the DCE identification. Additionally, networks are not required to provide DCE identification on dial-in-by-the-DTE operation.

There is a need to provide a reasonable degree of protection in the identification procedure so that Administrations and subscribers can prevent inaccurate DCE identification. Therefore, the identification procedure incorporates the functions of authentication and verification of the DCE's identity. The XID and registration methods of DCE identification obey an "identification protocol" that has been defined in §§ 2.9 and 7.1 for conveying the information necessary for the DTE to recognize the DCE identity, including verifying the identity to the proper degree of authenticity and reporting on the success of the procedure.

When no DCE identification is received by the DTE, it is the responsibility of the DTE to decide if the level of security is sufficient to continue operation.

DTE identification may be achieved by using the identification protocol while it is simultaneously being used for DCE identification, but as an independent invocation of the protocol.

2.5.1 Identification prior to virtual call establishment

2.5.1.1 Identity provided by the public switched network

In the case of dial-out-by-the-PSPDN, the PSTN number or the CSPDN number identifying the DCE may be provided by the public switched network (as well as some additional network management information from the PSPDN in some circumstances).

When identification is provided by the PSN, the DCE is not required to use any optional packet/frame types or any optional packet/frame fields defined in §§ 5, 6 or 7 or in Recommendation X.25.

2.5.1.2 Identity provided by means of the link level XID procedure

DCE identification can be optionally provided to the DTE by means of the exchange of XID frames prior to the link set-up. The detailed procedure to provide such information is the identification protocol given in §§ 2.9 and 7.1.

2.5.1.3 Identity provided by means of the packet level registration procedure

DCE identification can be optionally provided to the DTE using the registration packets. The exact process is the identification protocol given in §§ 2.9 and 7.1.

2.5.2 Identification per virtual call

Identification of the DCE to the DTE on a per-virtual-call basis is currently not provided. The need for such a capability has been left for further study.

2.6 Dial-in-by-the-DTE and dial-out-by-the-PSPDN operation

All PSPDNs conforming to this Recommendation shall provide dial-in-by-the-DTE operation. Provision of dial-out-by-the-PSPDN operation is optional.

2.7 DTE service requirement

To provide a switched access service to DTEs, without introducing additional procedures, all PSPDNs conforming to this Recommendation shall offer the nonidentified DTE service and/or support use of the provided-by-the-PSN DTE identification method.

Networks may also provide access to and/or from DTEs through a PSN, with the DTE being identified to the network using one of the optional identification procedures (see §§ 2.4.1.2, 2.4.1.3 and 2.4.2).

2.8 Duplex and half-duplex operation

If CSPDN access is used, the transmission facility is duplex. If PSTN access is used, the transmission facility operation is duplex, or, optionally, some networks may also provide for half-duplex operation. The additional procedures necessary for half-duplex operation are described in § 5.6.

2.9 Identification protocol

The elements of protocol which are used in performing DTE or DCE identification by either the XID or registration methods are independent of the procedure (the vehicle) used to transfer these elements between DTE and DCE (i.e. either XID frames or registration packets).

The "identification protocol" consists of exchanges between the "challenged" party and the "questioning" party. The "challenged" party provides and, optionally, certifies its identity and the "questioning" party checks and authenticates this identity.

The DTE and DCE, either calling or called, may be questioning, challenged, or both questioning and challenged. This is the result of the identification protocol being used independently for DTE identification and DCE identification, possibly simultaneously.

The identification protocol provides two grades of security characterized by how many operations are needed and which elements are needed in each direction.

The operational details of the identification protocol are given in § 7.1.

2.10 Negotiation of values

Negotiation of link level parameters is left for further study. Presently, DCE parameters are set to specific values according to the DTE profile as outlined in §§ 2.3 and 3.

Some networks may provide the capability for negotiation of packet level facilities by means of the on-line facility registration facility. When provided, this negotiation takes as a starting point the values established in the DTE profile and, as a result, may override them.

Packet level facilities may also be overridden by using the NUI facility when the NUI override permission facility is in effect.

3 DTE service descriptions

3.1 DTE service attributes

3.1.1 DTE identity

The DTE identity attribute, when provided, defines the identity of the DTE.

3.1.2 DTE identification method

The DTE identification method attribute, when provided, defines the DTE identification method used for establishing the DTE identity (see § 2.4). The method is the same for dial-in-by-the-DTE and dial-out-by-the-PSPDN operation unless the provided-by-PSN method is selected for one operation, in which case the methods may be different.

3.1.3 Registered address

The registered address is a number assigned by the PSPDN to the DTE to be used to represent the DTE identity in the address fields of call set-up packets, when a DTE identity is directly agreed to (see § 2.3).

When a registered address is provided, the registered address attribute defines the number allocated by the PSPDN to the DTE.

This registered address may be, as a network option, either an X.121 number from the PSPDN numbering plan [data network identification code (DNIC) + network terminal number (NTN)] or an X.121 number from the PSN numbering plan. The X.121 number from the PSN numbering plan for CSPDN is DNIC + NTN. The X.121 number from the PSN numbering plan for PSTN is either DNIC assigned to PSTN + National Number (NN) or 9 + telephone country code (TCC) + NN.

Note - Whether one or both of these forms of the X.121 number from the PSN numbering plan for PSTN is allowed is a matter for further study.

3.1.3.1 Registered address not provided

When a registered address is not provided, the value given in the address field of a call set-up packet is discussed below.

In the case of dial-in-by-the-DTE, when the DTE makes a call request, the contents of the calling address field in the corresponding incoming call packet are as shown in Table 1/X.32.

If the called DTE address field in a call request packet contains an X.121 number from the PSN numbering plan, then a dial-out-by-the-PSPDN call is made to that PSN number without checking if a switched connection already exists with the DTE. If a switched connection already exists, a subsequent dial-out-by-the-PSPDN operation will result in a busy signal. Therefore, the incoming virtual call is cleared.

TABLE 1/X.32

**Calling address field content when a registered
address is not provided**

Calling DTE		Calling address field content
Nonidentified (Note 1) see § 2.3.2.1		a) Incomplete X.121 PSN number (e.g. DNIC of the PSN or 9 + TCC) or b) Temporary number from the PSPDN numbering plan (Notes 2, 3)
Identified via one of the DTE identification methods - see § 2.4	PSN number of the calling DTE cannot be derived and validated from the identification method	
	PSN number of the calling DTE can be derived and validated from the identification method	c) The X.121 PSN number of the calling DTE

Note 1 - When the PSN implements calling line identification but there is no arrangement between the PSN and PSPDN to use the number provided by the PSN as DTE identification and when no other DTE identification method is used, the PSPDN may include the PSN-provided number in the calling address field of the incoming call packet [as in item c)].

Note 2 - Further study will determine whether only one, of the incomplete number or the temporary number, can be used by a specific network or whether the network may choose to offer both of these alternatives.

Note 3 - If the temporary number is used, the called DTE must be made aware that the contents of the calling address field is not a DTE address. The means to convey this information are for further study. Pending the results of such a study, this option may be used nationally, but such a temporary number shall not be carried on international interconnections.

3.1.3.2 Registered address provided

In those cases when a registered address is provided, its use is described below.

When an identified DTE makes a call request, the calling DTE address included in the incoming call packet given to the called DTE is the registered address. This applies even if the temporary location facility has been used to change the registered PSN number (see § 3.1.9).

Upon receiving a call request with a called DTE address which is the registered address, the PSPDN needs to determine whether or not to perform a dial-out-by-the-PSPDN operation. If there is a switched connection in existence on which the DTE identity corresponding to the registered address has been established, that switched connection will be used by the PSPDN. Otherwise, the PSPDN will perform the dial-out-by-the-PSPDN operation.

Note - This dial-out-by-the-PSPDN will not be successful if there is already a switched connection to the DTE when there has not been an establishment of a DTE identity or there has been a DTE identity established that does not correspond to the registered address.

The PSN number used for the dial-out-by-the-PSPDN is the registered PSN number.

Note - In some networks, if the called address used in a call request packet to call a switched access DTE is not the registered address for a DTE identity but is a registered PSN number, the PSPDN will not recognize this as a registered address and may treat the call according to the nonidentified DTE service (see §§ 3.1.3.1 and 3.3).

3.1.4 Registered PSN number

When the registered PSN number attribute is provided, its value is used by the PSPDN for dialing out to that DTE. If a call request packet contains a registered address which is not an X.121 PSN number, the PSPDN uses the registered PSN number in order to perform the dial-out-by-the-PSPDN operation. If the registered address is an X.121 PSN number, then it is considered to be the registered PSN number.

If a DTE does not have a registered address, then the registered PSN number attribute does not apply.

3.1.5 X.25 subscription set

The X.25 subscription set attribute defines values for the X.25 link level options and system parameters and the X.25 packet level subscription-time optional user facilities which apply to switched access operation. Networks are not required to support all of the link level options and packet level subscription-time facilities, except as required in Recommendation X.2. The list of link level options and system parameters and packet level optional user facilities in the X.25 subscription set is given in Table 4/X.32 (see § 3.3).

Note - As defined in Recommendation X.25, the throughput class value is, at most, the speed of the access line (see the modem selection attribute, § 3.1.8). However, in the case of a modem with automatic fall-back capability, the DCE shall set the default throughput class value to the maximum signalling rate of the modem used, unless the user has selected a lower value for the default throughput classes assignment facility. Whether some networks may take into account the signalling rate selected by the modems in fixing the default throughput class, if it is technically possible for the DCE to be aware of this rate, is left for further study.

3.1.5.1 Network default

When the X.25 subscription set is specified as network default, the value of each of the options, parameters and facilities is a default value that is set by the PSPDN. Different defaults may apply according to the DTE service invoked.

The value of the local charging prevention facility is closely related to the policy of the PSPDN regarding accrual of charges by a nonidentified DTE (see § 3.3).

3.1.5.2 User selectable

When the X.25 subscription set is specified as user selectable, the value of each of the options, parameters, and facilities is available for customization by the user to a value from the set of values offered by the PSPDN.

3.1.6 Logical channels assignment

The logical channels assignment attribute defines the number of logical channels of each type assigned for a particular DTE.

There is a default value assigned by the PSPDN for nonidentified DTEs (see below). A different default value may be set by the PSPDN for use in cases where the DTE identity is established.

3.1.6.1 Network default

When the logical channels assignment is specified as network default, there is one virtual call logical channel with dial-out-by-the-PSPDN operation and there may be one or more virtual call logical channels with dial-in-by-the-DTE operation; the specific number is a network option. The direction of virtual call placement that is allowed on the logical channel(s) is governed by the direction of the dial operation as shown in Table 2/X.32.

TABLE 2/X.32

Direction of virtual call placement allowed as related
to direction of the dial operation when logical
channels assignment is by network default

Dial operation	Capabilities for DTE originating/receiving virtual calls	Equivalent X.25 optional user facilities (see Note)
Dial-in-by-the-DTE	Originating virtual calls	- Incoming calls barred - 1-way logical channel outgoing
Dial-out-by-the-PSPDN	Receiving virtual calls	- Outgoing calls barred - 1-way logical channel incoming

Note - The association of the dial operation with one or both of the optional user facilities is network-dependent.

3.1.6.2 User selectable

When the logical channels assignment is specified as user selectable, the number of logical channels of each type is set by the user, for the particular DTE identity, from the values supported by the network. This may include the assignment of channels for permanent virtual circuits.

3.1.7 Dial-out-by-the-PSPDN availability

The dial-out-by-the-PSPDN availability attribute allows the use of dial-out-by-the-PSPDN operation.

3.1.7.1 Network default

When the dial-out-by-the-PSPDN availability is specified as network default, the network chooses whether or not to offer dial-out-by-the-PSPDN operation. When dial-out-by-the-PSPDN operation is offered, the PSPDN attempts to establish a switched access path to the PSN number given in a call request packet.

3.1.7.2 User selectable

When the dial-out-by-the-PSPDN availability is specified as user selectable, the capability to have dial-out-by-the-PSPDN operation with a particular DTE is chosen by the user. When the dial-out-by-the-PSPDN availability is selected, the registered PSN number attribute must also be selected. Then the network dials out to the DTE whenever the registered address is used in a call request packet and there is not already a switched access path.

3.1.8 Modem selection

The modem selection attribute applies to dial-out-by-the-PSPDN operation and allows a DTE to choose modem characteristics or a user class of service, possibly other than the national default, from those offered by the network. Modem selection refers to the modem characteristics (in the case of the PSTN) or the X.1 user class (in the case of the CSPDN) that are used for switched access line operation at the physical level, see § 4. A national default modem selection is made by the PSPDN for each PSN through which access is permitted.

Note that for dial-in-by-the-DTE through the PSTN, the modem characteristics of the PSPDN port dialed into are used. For dial-in-by-the-DTE through the CSPDN, the X.1 user class of the PSPDN port called is used.

Note 1 - Some networks may use the procedures of Recommendation V.100 to perform modem selection.

Note 2 - The modem used determines whether the transmission facility is full or half duplex. Therefore, there is no attribute for the type of transmission facility operation.

3.1.8.1 Network default

When the modem selection is specified as network default, the national default modem characteristics are used for dial-out-by-the-PSPDN through the PSTN. For dial-out-by-the-PSPDN through the CSPDN, the national default X.1 user class is used.

3.1.8.2 User selectable

When the modem selection is specified as user selectable, the modem characteristics selected for this DTE identity, from those offered by the network, are used for dial-out-by-the-PSPDN through the PSTN. For dial-out-by-the-PSPDN through the CSPDN, the X.1 user class, selected for this DTE identity from those offered by the network, is used.

3.1.9 Temporary location

The temporary location attribute, when provided, allows use of the temporary location optional user facility as a means to temporarily suspend the use of the registered PSN number and substitute for it a different PSN number. At the expiration of the time given in the temporary location facility, the number used for dial-out-by-the-PSPDN reverts to the registered PSN number. (See § 7.2.2). It is optional for the PSPDN to offer this facility and it can only be used in situations where dial-out-by-the-PSPDN operation is possible.

Use of the temporary location facility by the called DTE will not cause the called line address modified notification facility to be inserted in the call connected packet. However, the called line address modified notification facility will appear in the call connected packet according to the normal conditions of Recommendation X.25.

3.1.10 Secure dial-back

The secure dial-back attribute, when provided, allows the DTE to use the secure dial-back optional user facility (defined in § 7.2.1). It is optional for the PSPDN to offer the secure dial-back optional user facility and this facility can only be used in situations where both dial-in-by-the-DTE and dial-out-by-the-PSPDN operation are possible.

3.1.11 DCE identity presentation

The PSPDN chooses whether or not to offer DCE identity presentation. When DCE identity presentation is offered, the DCE identity presentation attribute defines the DCE identification method used by the PSPDN. The PSPDN may choose to use a DCE identification method for both dial-in-by-the-DTE operation and dial-out-by-the-PSPDN operation or for only dial-out-by-the-PSPDN operation. When the DCE identification is done for both operations, the method is the same for dial-in-by-the-DTE operation and dial-out-by-the-PSPDN operation. The PSPDN selects one of the DCE identification methods given in § 2.5.

Some networks may include a DTE profile designator as part of the DCE identity in order to inform the DTE of the DTE profile applicable to the DTE/DCE interface during this instance of switched access. The DTE profile designator is a string of octets that may be assigned by the PSPDN to the DTE identity as a name for the specific DTE profile.

3.1.12 Link level address assignment

The link level address assignment attribute defines the mechanism used to determine the link level addresses.

Note - Other methods of link level address assignment than those described below are for further study.

3.1.12.1 Network default

When the link level address assignment is specified as network default, the link level addresses are assigned depending on the direction of the switched access call as defined in § 5.2 (same as Recommendation T.70).

Alternatively, link level address assignment that is dependent on the roles of the equipment as DTE and DCE, as defined in § 5.2 (same as § 2.4.2 of Recommendation X.25), may be provided by some networks.

Note 1 - The dial-out-by-the-PSPDN operation will only operate properly when the DTE and the PSPDN implement the same link level address assignment method.

Note 2 - Assigning the link level addresses according to the roles of the equipment as DTE and DCE does not allow for two DTEs to interoperate directly without an intervening PSPDN.

3.1.12.2 User selectable

When the link level address assignment is specified as user selectable, the user designates whether the link level addresses are assigned depending on the direction of the switched access call or depending on the roles of the equipment as DTE and DCE (see § 5.2).

3.2 Summary of DTE services

The type of each attribute is given for the three DTE services in Table 3/X.32.

TABLE 3/X.32

Summary of DTE services

Services Attributes	Nonidentified	Identified	Customized
DTE identity	---	Yes	Yes
DTE identification method	---	Any (ND)	Prior to virtual circuit establishment (ND)
Registered address	---	Note 1	Yes
Registered PSN number	---	---	User selectable
X.25 subscription set	ND	Note 2	User selectable
Logical channel assignment	ND	ND	User selectable
Dial-out-by-the-PSPDN availability	ND	Note 1	User selectable
Modem selection	ND	ND	User selectable
Temporary location	---	---	User selectable
Secure dial-back	---	---	User selectable
DCE identity presentation	ND	ND	ND
Link level address assignment	ND	ND	User selection Note 3

--- not provided ND network default Yes provided

Note 1 - In this DTE service, the use of registered addresses for some DTEs is a network option. When the DTE is assigned a registered address, the value of the dial-out-by-the-PSPDN availability attribute is user selectable. Otherwise, (if no registered address is assigned to the DTE), the availability of dial-out-by-the-PSPDN operation is by network default.

Note 2 - ND or, if NUI and NUI override permission are in effect, user selectable packet level facility values (Table 9/X.32).

Note 3 - In the case of dial-in-by-the-DTE operation, the link level address values assigned are the same for both assignment methods and, therefore, the values are not dependent on the assignment method selected by the user.

3.3 Nonidentified DTE service

The values of the attributes for the nonidentified DTE service defined in § 2.3.2.1 are shown in the "nonidentified" column of Table 3/X.32:

- no DTE identity is established;
- no DTE identification method is used.

Generally, no optional user facilities are available except those governing the direction of virtual call placement (i.e. incoming calls barred, outgoing calls barred, 1-way logical channel outgoing, and 1-way logical channel incoming) and those that can be used on a per-virtual-call basis without prior subscription. In addition, some networks may allow the use of:

- a) some subscription-time optional user facilities without prior subscription. (The network may make these known by publication or through the use of the on-line facility registration facility; in such cases, a PSPDN should consider making its identity known to nonidentified DTEs), and
- b) some subscription-time optional user facilities that must be requested by the DTE through the use of the on-line facility registration facility.

The X.25 link level options and system parameters and the X.25 subscription-time optional user facilities are categorized for dial-in-by-the-DTE and dial-out-by-the-PSPDN operation in Table 4/X.32 as:

- an "AVAIL-NS" link level system parameter, which is set by the network on all networks offering nonidentified DTE service;
- an "AVAIL-BAS" optional user facility or link level option, which is available on all networks offering nonidentified DTE service. This facility is in effect even if not requested;
- an "AVAIL-OPT" optional user facility, which is available on some networks offering the nonidentified DTE service and the availability of which is made known through either publication or use of the on-line facility registration facility. These facilities can be used without further request when operating on these networks;
- an "AVAIL-RQ" optional user facility, which is available on some networks offering the nonidentified DTE service and the use of which must be requested through the on-line facility registration facility; or

- "No" optional user facility or link level option, which is not available on any network offering nonidentified DTE service.

The DTE may use any per-call X.25 facility that is supported by the PSPDN and that does not require prior subscription.

TABLE 4/X.32

Availability of link level options and system parameters and packet level subscription-time facilities in the nonidentified DTE service

Option, parameter or facility (applicable to all assigned logical channels)	Available with Dial-in-by- the-DTE operation	Available with Dial-out-by-the- PSPDN operation
Link level		
K	AVAIL-NS	AVAIL-NS
T1	AVAIL-NS	AVAIL-NS
T2	AVAIL-NS	AVAIL-NS
T3	AVAIL-NS	AVAIL-NS
N1	AVAIL-NS	AVAIL-NS
N2	AVAIL-NS	AVAIL-NS
Multilink	No	No
MT1	No	No
MT2	No	No
MT3	No	No
Extended frame sequence numbering	No	No
Packet level		
On-line facility registration	AVAIL-OPT	AVAIL-OPT
Extended packet sequence numbering	AVAIL-RQ (Note 1)	AVAIL-RQ
D-bit Modification	AVAIL-RQ	AVAIL-RQ
Packet retransmission	AVAIL-OPT	AVAIL-OPT
Incoming calls barred	AVAIL-BAS	No
Outgoing calls barred	No	AVAIL-BAS
One-way logical channel outgoing	AVAIL-BAS	No
One-way logical channel incoming	No	AVAIL-BAS
Nonstandard default packet sizes	AVAIL-RQ	AVAIL-RQ

Nonstandard default window sizes	AVAIL-RQ (Note 2)	AVAIL-RQ (Note 2)
Default throughput classes assignment	AVAIL-RQ	AVAIL-RQ
Flow control parameter negotiation - subscription-time	AVAIL-RQ (Note 1)	AVAIL-RQ
Throughput class negotiation - subscription-time	AVAIL-RQ (Note 1)	AVAIL-RQ
Closed user group related facilities - Closed user group - Closed user group with outgoing access - Closed user group with incoming access - Incoming calls barred within a closed user group - Outgoing calls barred within a closed user group	No No No No No	No No No No No
Bilateral closed user group related facilities - Bilateral closed user group - Bilateral closed user group with outgoing access	No No	No No
Fast select acceptance	No	AVAIL-RQ
Reverse charging acceptance	No	No
Local charging prevention (Note 3)	Yes	Yes
Network user identification - subscription-time	No	No
NUI override permission (Note 4)	No	No
Charging information - subscription-time	No	No
RPOA selection - subscription-time	No	No
Hunt group	No	No
Call redirection	No	No

Note 1 - Further study is required to determine whether subscription should be equivalent to use in a call set-up packet (either in the general format identifier for the extended packet sequence numbering facility or in the facility field for other facilities) under the nonidentified DTE service.

Note 2 - Some networks offering half-duplex operation as part of the nonidentified DTE service may set the default window size to a single nonstandard default window size value.

Note 3 - The local charging prevention facility is in effect unless the PSPDN permits unidentified DTEs to accrue charges.

Note 4 - The NUI override permission facility is not presently included within Recommendation X.25. See § 6.3.1 for the definition of this subscription facility.

3.4 Identified DTE service

The values of the attributes for the identified DTE service (defined in § 2.3.2.2) are shown in the "identified" column of Table 3/X.32:

- A DTE identity that has been agreed to explicitly or implicitly is provided to the network.
- The X.25 subscription set is the same as in the nonidentified DTE service except that:
 - a) for dial-in-by-the-DTE operation, on which the NUI override permission facility is in effect at the DTE/DCE interface, the NUI facility, as defined in Recommendation X.25, can be used to invoke user selected packet level facility values (see § 6.3 and Table 9/X.32), and
 - b) the local charging prevention facility is not in effect.

The DTE may use any per-call X.25 facility which is supported by the PSPDN and which does not require prior subscription.

3.5 Customized DTE service

The values of the attributes for the customized DTE service (defined in § 2.3.2.2) are shown in the "customized" column in Table 3/X.32.

Note - If a public port is used, the values in the customized DTE profile may not all be supported. (The characteristics available may vary from public port to public port). The result may be service according to network default values or refusal of service.

A DTE identity that has been explicitly agreed to with the PSPDN for obtaining the customized DTE service is provided to the PSPDN.

The availability for customization of each X.25 link level option and system parameter and X.25 packet level subscription-time facility is given in Table 5/X.32.

The DTE may use any per-call X.25 facility which is supported by the PSPDN and which does not require prior subscription.

The DTE may use any per-call X.25 facility which is supported by the PSPDN and which requires a corresponding subscription-time facility to be selected, provided that the corresponding subscription-time facility has been selected.

TABLE 5/X.32

Availability for customization in the customized DTE service of the X.25 link level options and system parameters and the X.25 subscription-time facilities

Option, parameter or facility	Customization available
Link level	
K	CUSTOM
T1	CUSTOM
T2	CUSTOM
T3	CUSTOM
N1	CUSTOM
N2	CUSTOM
Multilink	(Note 1)
MT1	(Note 1)
MT2	(Note 1)
MT3	(Note 1)
Extended frame sequence numbering	CUSTOM
Packet level	
On-line facility registration	CUSTOM
Extended packet sequence numbering	CUSTOM
D-bit modification	CUSTOM
Packet retransmission	CUSTOM
Incoming calls barred	CUSTOM
Outgoing calls barred	CUSTOM
One-way logical channel outgoing	CUSTOM
One-way logical channel incoming	CUSTOM
Nonstandard default packet sizes	CUSTOM
Nonstandard default window sizes	CUSTOM
Default throughput classes assignment	CUSTOM
Flow control parameter negotiation - subscription-time	CUSTOM
Throughput class negotiation - subscription-time	CUSTOM
Closed user group related facilities - Closed user group - Closed user group with outgoing access - Closed user group with incoming access - Incoming calls barred within a closed user group - Outgoing calls barred within a closed user group	CUSTOM CUSTOM CUSTOM CUSTOM CUSTOM

Bilateral closed user group related facilities	
- Bilateral closed user group	CUSTOM
- Bilateral closed user group with outgoing access	CUSTOM
Fast select acceptance	CUSTOM
Reverse charging acceptance	CUSTOM
Local charging prevention	CUSTOM
Network user identification	
- subscription-time	CUSTOM
NUI override permission (Note 2)	CUSTOM
Charging information	
- subscription-time	CUSTOM
RPOA selection	
- subscription-time	CUSTOM
Hunt group	CUSTOM
Call redirection	CUSTOM (see Note 3)

CUSTOM can be chosen or set to a nondefault value by the DTE, if supported by the PSPDN

Note 1 - The need for multilink procedures over switched access paths is left for further study.

Note 2 - The NUI override permission facility is not presently included within Recommendation X.25. See § 6.3.1 for the definition of this subscription facility.

Note 3 - The criteria for determining that the DTE is out of order (for the purposes of call redirection) have been left for further study.

4 Interface characteristics (physical level)

Administrations may offer one or more of the physical level interfaces specified below.

4.1 X.21 interface

For establishment, maintenance, and disestablishment of a switched access path between a DTE and a PSPDN by way of a CSPDN, the interface at the physical level shall be in accordance with Recommendation X.21, as described in the following sections.

4.1.1 DTE/DCE physical interface elements

The DTE/DCE physical interface elements shall be according to §§ 2.1 through 2.5 of Recommendation X.21.

4.1.2 Alignment of call control characters and error checking

Alignment of call control characters and error checking shall be in accordance with § 3 of Recommendation X.21.

4.1.3 Procedures for entering operational phases

The call control phase shall be required prior to entering the operational phases and shall be in accordance with § 4 of Recommendation X.21.

After a call is established within the CSPDN, the physical layer interface will enter the data transfer phase, as described in § 5.1 of Recommendation X.21. While in the data transfer phase (state 13), data exchanged on circuits T and R will be as described in subsequent sections of this Recommendation.

The Not ready states given in § 2.5 of Recommendation X.21 are considered to be non-operational states, and may be considered by higher layers to be out-of-order states.

4.1.4 Clearing procedures

Clearing procedures shall be according to § 6 of Recommendation X.21.

4.1.5 Failure detection principles and test loops

Failure detection principles shall be according to §§ 6.1 and 2.6.2 of Recommendation X.21.

The definitions of test loops and the principles of maintenance testing using test loops are provided in Recommendation X.150.

A description of the test loops and the procedures for their use are given in § 7 of Recommendation X.21.

Automatic activation by a DTE of test loop 2 in the DCE at the remote terminal is not possible. However, some Administrations may permit the DTE to control the equivalent of a test loop 2 at the local data switching exchange (DSE) to verify the operation of the subscriber line, the switched access path and all or part of the DCE or line terminating equipment. Subscriber control of the loop, if provided, may be manual or automatic as described in Recommendations X.150 and X.21, respectively.

4.1.6 Signal element timing

The signal element timing shall be in accordance with § 2.6.3 of Recommendation X.21.

4.2 X.21 bis interface

For establishment, maintenance, and disestablishment of a switched access path between a DTE and a PSPDN by way of a CSPDN, the interface at the physical level shall be in accordance with Recommendation X.21 bis, as described in the following sections.

4.2.1 DTE/DCE physical interface elements

The DTE/DCE physical interface elements shall be in accordance with § 1.2 of Recommendation X.21 bis.

4.2.2 Procedures for entering operational phases

The procedures for entering operational phases shall be in accordance with § 2 of Recommendation X.21 bis. When circuit 107 is in the ON condition, and when circuits 105, 106, 108, and 109, if provided, are in the ON condition, data exchange on circuits 103 and 104 will be as described in subsequent sections of this Recommendation.

When circuit 107 is in the OFF condition, or any of circuits 105, 106, 108 or 109, if provided, is in the OFF condition, the interface is considered to be in a non-operational state and may be considered by the higher levels to be in an out-of-order state.

4.2.3 Failure detection and test loops

Failure detection principles, the description of the test loops and the procedures for their use are given in §§ 3.1 through 3.3 of Recommendation X.21 bis.

Automatic activation by a DTE of test loop 2 in the DCE at the remote terminal is not possible. However, some administrations may permit the DTE to control the equivalent of a test loop 2 at the local DSE to verify the operation of the subscriber line, the switched access path, and all or part of the DCE or line terminating equipment. Subscriber control of the loop, if provided, may be manual or automatic as described in Recommendations X.150 and X.21 bis, respectively.

4.2.4 Signal element timing

Signal element timing shall be in accordance with § 3.4 of Recommendation X.21 bis.

4.3 V-series interface

For establishment, maintenance, and disestablishment of a switched access path between a DTE and a PSPDN by way of a PSTN, the physical level interface shall be as described in the following sections.

4.3.1 Modem characteristics

Administrations may choose to offer modem characteristics in accordance with any or all of the following:

- a) 1200 bit/s V.22, Alternatives A, B or C, Mode i)
- b) 2400/1200 bit/s V.22 bis, Modes i) or iii), or
V.26 ter, Modes i) or iii)
- c) 9600/4800 bit/s V.32

In addition, those Administrations which offer half-duplex operation may choose to offer modem characteristics in accordance with any or all of the following:

- d) 2400 bit/s V.26 bis, Alternative b
- e) 4800/2400 bit/s V.27 ter

Note - In the future it is desirable that one modem characteristic should be available in all network implementations of this Recommendation. However, for the time being, it has not been possible to select a single modem type.

Other modem characteristics are left for further study or are a national matter.

Use of the backward channel, if allowed, is outside the scope of this Recommendation.

4.3.2 Procedures for full duplex operational phases

When circuit 107 is in the ON condition, and when circuits 105, 106, 108, and 109, if provided, are in the ON condition, data exchanged on circuits 103 and 104 will be as described in subsequent sections of this Recommendation.

Circuits 106 and 109 may enter the OFF condition due to momentary transmission failures or modem retraining. Higher layers should delay for several seconds before considering the interface to be non-operational.

4.3.3 Procedures for half duplex operational phases

The states of circuits 103, 104, 105, 106 and 107 shall be according to § 5.6.8, below.

4.3.4 Origination procedures

DTEs may use either:

- a) the automatic origination procedures described in § 3 of Recommendation V.25;
- b) the automatic origination procedures described in §§ 4 or 5 of Recommendation V.25 bis; or
- c) the manual origination procedures of § 6 of Recommendation V.25.

Networks will use automatic origination procedures only.

Note - Other origination procedures may be used provided that no special requirements are placed on DTEs (including DTEs having integral modems and diallers) using only V.25 or V.25 bis procedures.

4.3.5 Answering procedures

For dial-out-by-the-PSPDN procedures, DTEs should use the automatic answering procedures of Recommendations V.25 or V.25 bis. Some Administrations may also allow use of manual answering procedures, provided that doing so does not affect DTEs using automatic answering procedures.

For dial-in-by-the-DTE, networks will use automatic answering procedures only.

4.3.6 Disconnection procedures

DTEs and networks shall use the disconnection procedures specified in Recommendation V.24.

4.3.7 Test loops

The definitions of test loops and the principles of maintenance testing using test loops are provided in Recommendation V.54.

Descriptions of the test loops and the procedures for their use are given in the appropriate modem Recommendations. It should be noted that the procedures for loop testing vary among the several modem Recommendations.

Automatic activation by a DTE of test loops 2 and 4 in the DCE at the remote terminal is not possible. However, some administrations may permit the DTE to control the equivalent of a test loop 2 or 4 at the local DSE to verify the operation of the subscriber line, the switched access path, and all or part of the DCE or line terminating equipment. Subscriber control of the loop, if provided, may be manual or automatic as described in Recommendation V.54 and the appropriate modem Recommendations, respectively.

5 Link access procedure across the DTE/DCE interface

5.1 Introduction

This section specifies the mandatory and optional link level procedures that are employed to support switched access data interchange between a DCE and a DTE.

5.1.1 Compatibility with the ISO balanced classes of procedure

The switched access link level procedures defined in this Recommendation use the principles and terminology of the High-level Data Link Control (HDLC) procedures specified by the International Organization for Standardization.

DCE compatibility of operation with the ISO balanced classes of procedure (Class BA with options 2 and 8 and Class BA with options 2, 8 and 10) is achieved using the LAPB procedure described in §§ 2.2, 2.3, and 2.4 of Recommendation X.25. Class BA with options 2 and 8 (LAPB modulo 8) is available in all networks for switched access.

Class BA with options 2, 8 and 10 (LAPB modulo 128) may also be offered for switched access by some networks.

Note - The operating conditions under which modulo 128 sequence numbering applies are left for further study.

Class BA 1, 2, 8 and Class BA 1, 2, 8, 10 provide for the additional use of the unnumbered format Exchange Identification (XID) command and response. This additional capability may be used in the performance of DTE/DCE identification and authentication and in the selection of X.32 optional user facilities (see § 7.2) by the application of the proposed HDLC standard - General purpose XID frame information field content and format (Draft ISO International Standard 8885).

5.1.2 Underlying transmission facility

The underlying transmission facility is duplex or, optionally, half-duplex (see § 2.8). Specific procedures are defined in § 5.6 for operation over a half-duplex transmission facility.

5.2 Link level address assignment

Two alternative mechanisms for assigning the link level addresses are included in the procedures of this Recommendation. The conditions under which each mechanism applies are specified in the link level address assignment attribute (see § 3.1.12).

It should be noted that the alternative mechanisms result in the assignment of identical values in dial-in-by-the-DTE operation.

5.2.1 Assignment depending on switched access call direction

In accordance with Recommendation T.70, link level address assignment for dial-in-by-the-DTE and dial-out-by-the-PSPDN operation depends on the direction of the switched access call as specified in Table 6/X.32.

The DCE is always aware of whether the switched access path is established by the DTE (dial-in-by-the-DTE) or the DCE (dial-out-by-the-PSPDN). The DTEs that are not or cannot be aware of this situation shall initiate the appropriate address resolution procedures to determine the individual address of the DCE. These procedures are left for further study. However, it is intended that these procedures will not affect DTEs using the link level address assignment described in Table 6/X.32.

TABLE 6/X.32

Link level address assignment

Station 1 Link level address assignment		
Command Response	Calling A	Called B
	B A	A B

Note - For dial-in-by-the-DTE, the DTE is calling A; for dial-out-by-the-PSPDN, the DCE is calling A.

5.2.2 Assignment depending on roles of equipment as DTE and DCE

In accordance with the specifications in § 2.4.2 of Recommendation X.25, the link level address assignment depends on the roles of the equipment as DTE and DCE such that the DCE transmits to the DTE the address A in command frames and the address B in response frames and the DTE does the opposite (i.e. transmits to the DCE address B in command frames and address A in response frames).

5.3 Use of exchange identification (XID) frames

5.3.1 General

XID frames may be used by the DCE and DTE in the performance of either DTE or DCE identification and authentication, and/or by the DTE or DCE to convey X.32 optional user facilities (see § 7.2).

Note - The use of the XID command/response for address negotiation and the negotiation of link level parameters is left for further study.

5.3.1.1 XID command

The XID command is used by the DTE/DCE to cause the DCE/DTE to identify itself, and, optionally, to provide DTE/DCE identification and/or characteristics to the DCE/DTE. An information field is optional with the XID command.

5.3.1.2 XID response

The XID response is used by the DTE/DCE to reply to a XID command. An information field containing the DTE/DCE identification and/or characteristics may be optionally present in the XID response.

5.3.2 Format of XID frame

The format of the address field of the XID frame is as defined in § 5.2 above.

The format of the control field of the XID frame is given in Table 7/X.32.

Note - The first bit transmitted is bit 1, the low order bit.

TABLE 7/X.32

XID command and response control field bit encoding

Format	Command	Response	Encoding							
			1	2	3	4	5	6	7	8

After the XID control field there may be an XID information field. The general format of the XID information field, when present, is shown in Figure 3/X.32.

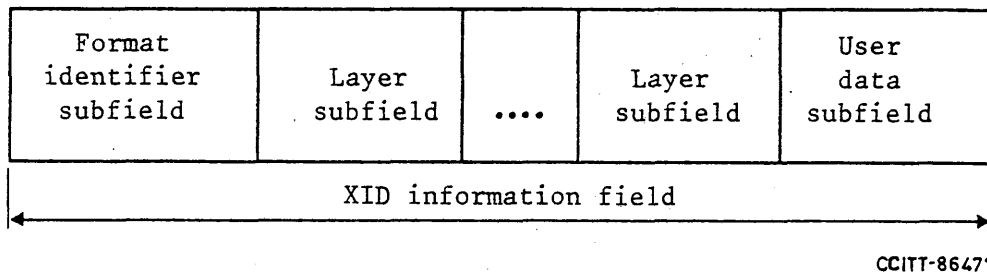


FIGURE 3/X.32

General structure of the XID information field

The XID information field is composed of a number of subfields. These subfields are a format identifier (FI) subfield, several layer subfields, and a user data subfield.

The FI subfield is a fixed one-octet field. This field is encoded to have a capability of designating 128 different ISO standardized formats and 128 different user-defined formats. The format identifier in this Recommendation is one of the ISO standardized format identifiers. The FI subfield is present if there is a layer subfield and/or a user data subfield present. The FI subfield need not be present if there is no layer subfield or data user subfield present. The format identifier is encoded as shown in Figure 4/X.32.

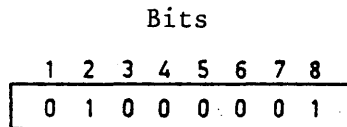


FIGURE 4/X.32

XID format identifier subfield

The layer subfields are permitted to be present in the information field of either XID command or XID response frames for the purposes of link level address resolution and link level parameter negotiation. The use of these subfields within the scope of this Recommendation is left for further study.

The user data subfield contains data link user information to be transferred during XID interchange. This data link user information is transported transparently across the data link and passed to the user of the data link. The user data subfield is composed of the two elements illustrated in Figure 5/X.32.

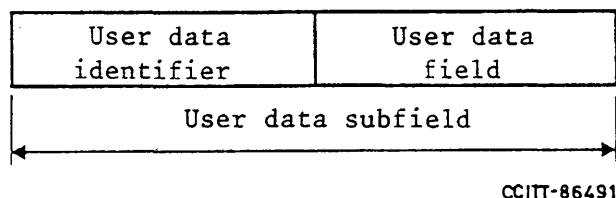


FIGURE 5/X.32

User data subfield

The user data identifier element identifies the subfield as the user data subfield. Its encoding is shown in Figure 6/X.32.

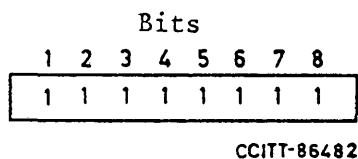


FIGURE 6/X.32

User data identifier element

The length of the user data field is the number of octets between the user data identifier and the frame check sequence of the XID frame. The user data field element contains the X.32 identification protocol elements or X.32 optional user facilities which are described in § 7 (see Table 10/X.32).

In the scope of this Recommendation, the user data subfield should only be used in XID command frames, and while in the disconnected phase.

Since the use of layer subfields is for further study within the scope of this Recommendation, the format of the information field of the XID command frames is summarized in Figure 7/X.32.

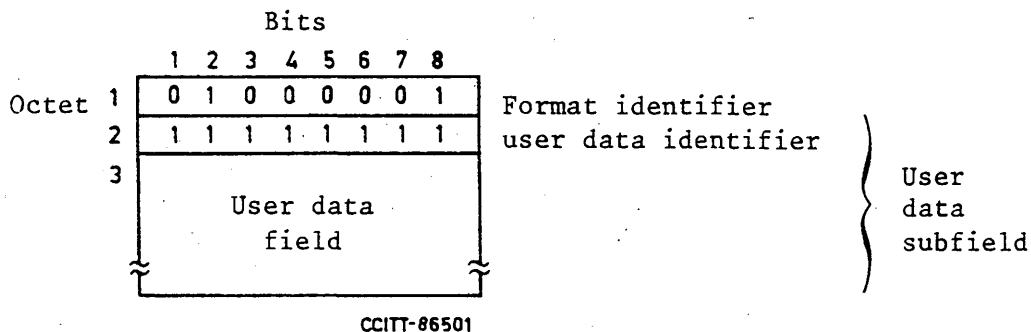


FIGURE 7/X.32

XID information field format

5.3.3 XID procedures for identification and X.32 optional user facilities

5.3.3.1 General

When a DTE/DCE determines that it is not able to act upon a received XID command, it will consider this XID command as not implemented and will act as specified in Recommendation X.25 (see Recommendation X.25, § 2.4.4.4.1 for the disconnected phase, and Recommendation X.25, § 2.4.6.1 for the information transfer phase).

When a DTE/DCE determines that it is able to act upon a received XID command, it shall process this command and acknowledge it by transmitting an XID response with the F bit set to the value of the P bit received in the XID command in any phase (disconnected phase or information transfer phase). The DCE shall and the DTE should set the P bit to 1 in the XID command frame.

For purposes of this Recommendation, the user data subfield shall only be used in XID command and while in the disconnected phase. A user data subfield will be ignored by the DCE when received in an XID response and/or while in the information transfer phase.

When transmitting an XID command, the DTE/DCE shall start timer T1. Timer T1 is stopped upon reception of the XID response with the F bit set to the value of the P bit sent in the XID command.

If timer T1 expires before the XID response (which has the F bit set to the value of the P bit sent in the XID command) is received by the DTE/DCE, the DTE/DCE retransmits the XID command and restarts timer T1. The maximum number of attempts made by the DTE or DCE to complete successful transmission of the XID command is defined by N2.

5.3.3.2 Identification, authentication and selection of X.32 optional user facilities using XID frames

The reception of an XID response by the DTE/DCE only means that the corresponding XID command has been correctly received by the DCE/DTE. If the DCE/DTE needs to transmit an identification protocol element or an X.32 facility element to the DTE/DCE, it shall transmit the element in an XID command.

Following successful identification/authentication and/or selection of X.32 optional user facilities using an XID exchange(s), the data link will be established under normal LAPB procedures (see § 5.4.1). If these procedures are not successful, the switched access path is disconnected (see § 5.4.2).

The identification of the DTE and/or DCE remains in effect until the link level or the switched access path is disconnected.

5.4 Link set-up disconnection

5.4.1 Link set-up

The initiative of the link set-up is in the charge of the DTE in dial-in-by-the-DTE operation and of the DCE in dial-out-by-the-PSPDN operation. The DCE may also initiate link set-up in the case of dial-in-by-the-DTE operation; likewise, the DTE may also initiate link set-up in the case of dial-out-by-the-PSPDN operation.

When receiving a Set Asynchronous Balanced Mode (SABM) or Set Asynchronous Balanced Mode Extended (SABME) (if supported) command during the identification procedure with XID frames, the DCE/DTE shall consider that the DTE/DCE does not want to complete the identification procedure. The DTE/DCE may then accept the link set-up initiation or may disconnect the link and the switched access path, depending on whether or not the DCE/DTE considers the completion of the identification process as mandatory.

During the period between transmitting an SABM/SABME command and receiving the UA response, the DCE/DTE shall discard any frame (including XID) except SABM/SABME, Disconnect (DISC), Unnumbered Acknowledge (UA) and Disconnected Mode (DM) as specified in § 2.4.4.1 of Recommendation X.25.

5.4.2 Disconnection

Whenever the DCE needs to disconnect the switched access path and the link is not already in the disconnected phase, it should first disconnect the link.

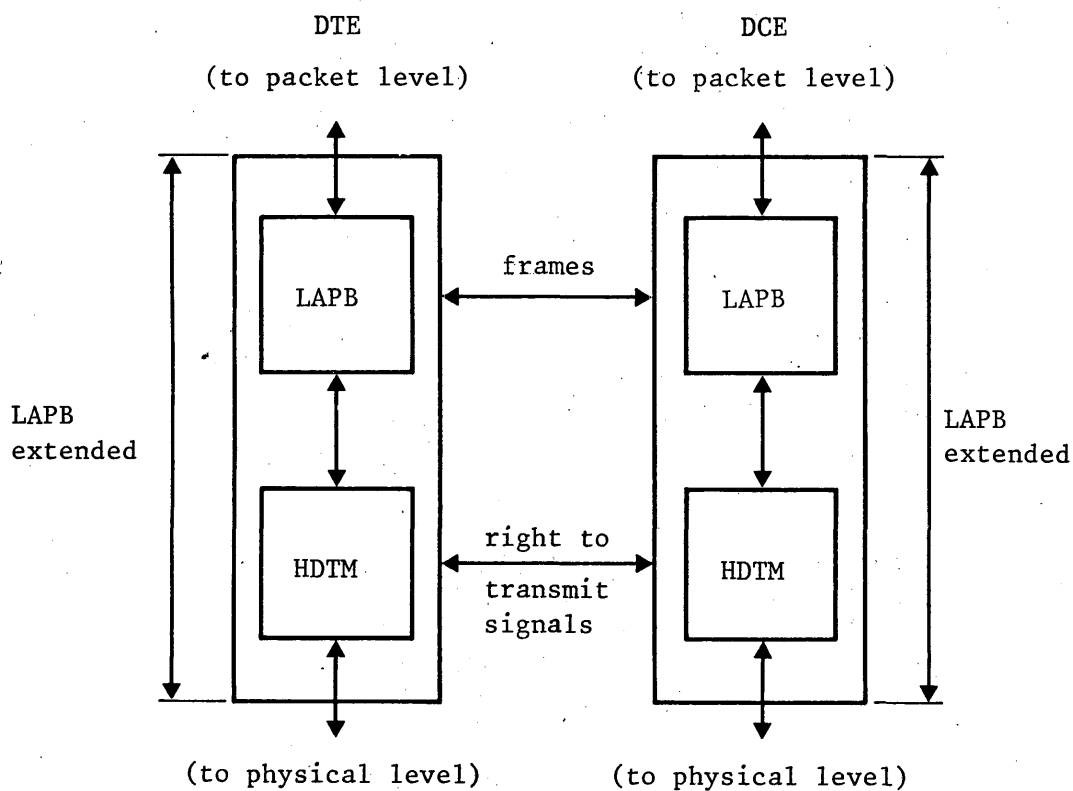
5.5 Multilink

The need for multilink procedures over switched access paths is left for further study.

5.6 Half-duplex operation

Figure 8/X.32 shows the half-duplex transmission module (HDTM) for extending LAPB for operation over the PSTN where half-duplex circuits are used. The signals which the two LAPX modules use in controlling the direction of the line are described.

Before the HDTM begins operation the physical circuit must be established by the appropriate PSTN call control procedures. The HDTM in the DTE or DCE which has established the switched access path will initially have the right to transmit. The DTE or DCE which originated the switched access path is the "calling DTE/DCE". The other DTE or DCE is the "called DTE/DCE".



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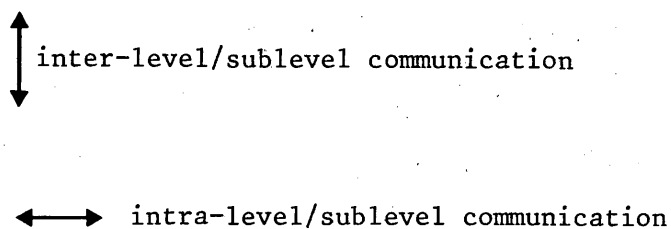


FIGURE 8/X.32

Link layer for PSTN access based on LAPB plus the HDTM

5.6.1 Right to transmit

The purpose of the HDTM is to coordinate the use of the half-duplex line between the DTE and DCE. It must exchange signals with the remote HDTM, interact with LAPB, and direct the physical level. The HDTM has the responsibility for deciding when to give up the right to transmit.

The right to transmit is exchanged between the DTE and DCE by using the idle channel state condition and flags as signals. Initially, the DTE or DCE which initiated establishing the physical connection has the right to transmit.

That DTE or DCE sends the idle channel state condition when it has finished transmitting frames. After the line has been turned around, the other DTE/DCE sends flags to confirm the exchange of the right to transmit, until it has a frame to send. If the confirmation is not received in a certain amount of time, the DTE or DCE which gave up the right to transmit may take it again by sending flags.

Note - If no frame is sent, at least five flags must be sent as the minimum signal between receiving the right to transmit and relinquishing it again.

The meaning of the idle channel state condition in this Recommendation is different from that of Recommendation X.25. As a result, the T3 timer does not apply to half-duplex operation.

An optional alternative to the detection of the idle channel state condition is to use the detection of the carrier going OFF as the signal that the sending device is giving up the right to transmit. Also, an optional alternative to the detection of flags is to use the detection of the carrier going ON as the signal that the remote device has accepted the right to transmit. This alternative behavior should only be used with modems that give substantial protection from transient errors on the line.

In those situations where the physical level cannot detect that the connection has been cut-off, an optional procedure, which detects the absence of any activity over a period of time and then disconnects the link, should be used.

5.6.2 Level relationships

In adapting LAPB for half-duplex operation, modifications have been kept to a minimum. However, there is a functional requirement that the HDTM inhibit LAPB from sending frames during certain phases of the half-duplex procedure. The means of accomplishing this functional requirement are not defined in this Recommendation. Some considerations in implementing the HDTM are discussed in Appendix I.

The logical relationships among LAPB, the HDTM, and the physical level are as shown in Figure 9/X.32.

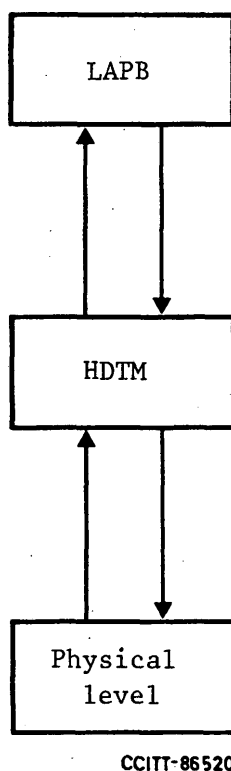


FIGURE 9/X.32

Level relationships

5.6.3 State definitions

Five states of the HDTM are defined for describing the procedure used to keep track of the right to transmit.

5.6.3.1 Idle state (state 0)

The DTE/DCE is in an inactive state. This is the initial state prior to the establishment of the switched access path and the final state after termination of the switched access path.

5.6.3.2 Half-duplex sending state (state 1)

The DTE/DCE is in a half-duplex sending state, so that all signals generated by LAPB are passed to the physical level. The calling DTE/DCE enters this state upon establishment of the switched access path.

5.6.3.3 Wait for receiving state (state 2)

The DTE/DCE is waiting for an indication that the remote DTE/DCE has entered the half-duplex sending state. No signals generated by LAPB are passed to the physical level.

5.6.3.4 Half-duplex receiving state (state 3)

The DTE/DCE is in a half-duplex receiving state, so that no signals generated by LAPB are passed to the physical level. The remote DCE/DTE is considered to be in the half-duplex sending state. The called DTE/DCE enters this state upon establishment of the switched access path.

5.6.3.5 Wait for sending state (state 4)

The DTE/DCE is awaiting indication of the availability of the physical level for transmission of frames to the remote DCE/DTE. Flag, idle channel state condition, and abort signals are passed to the physical level, but sending of frames is inhibited.

5.6.4 Timer XT1

A timer, XT1, is defined for use in recovering from an apparent failure of the remote DTE/DCE to take the right to transmit. To avoid a contention condition during this recovery process, different values of timer XT1 are to be used by the called and calling DTE/DCE. A calling DTE/DCE uses the value XT1a, and a called DTE/DCE uses the value XT1b.

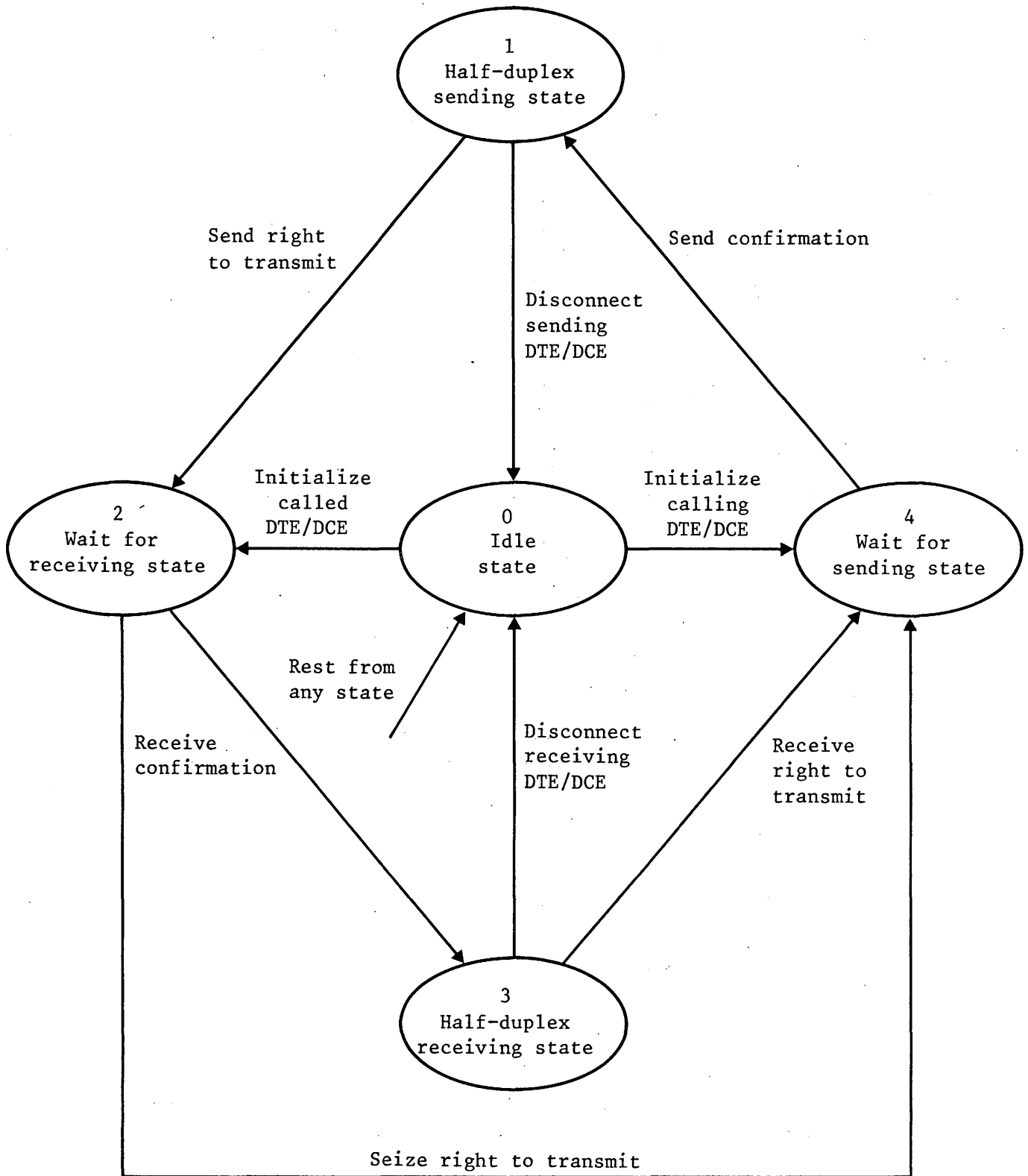
The values of XT1a and XT1b are system parameters and have been left for further study.

5.6.5 Counter XC1

An optional counter, XC1, is defined for use in determining that the connection has been cut-off. It is incremented when the DTE or DCE is given the right to transmit or seizes the right to transmit and has not received a frame or at least five continuous flags. This counter is decremented if its value is greater than zero and the flags or a frame have been received. If the counter reaches a certain level, the switched call is assumed to be cut-off. The minimum value of this cut-off level is four.

5.6.6 State diagram and descriptions

The state diagram shown in Figure 10/X.32 describes the procedure used by the HDTM for controlling the right to transmit. The number in each ellipse is the state reference number. The transitions are caused by interactions between LAPB and the HDTM, interactions between the HDTM and the physical level, signals from the remote HDTM, and timer expiration within the HDTM.



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FIGURE 10/X.32

State diagram

5.6.7 State definitions expressed in terms applicable to a modem interface

Taking the use of the HDTM with a V-series modem interface as an example, the following expressions of the state definitions can be made:

5.6.7.1 Idle state (state 0)

Circuit 107 is OFF. Circuit 105 is OFF. LAPB is inhibited from sending frames and is disconnected from circuit 103.

5.6.7.2 Half-duplex sending state (state 1)

Circuit 105, circuit 106 and circuit 107 are ON. LAPB is connected to circuit 103 and enabled to send frames.

5.6.7.3 Wait for receiving state (state 2)

Circuit 107 is ON, circuit 105 is OFF. LAPB is inhibited from sending frames and disconnected from circuit 103, which is held in the binary 1 condition. Timer XT1 is running.

5.6.7.4 Half-duplex receiving state (state 3)

Circuit 107 is ON, circuit 105 is OFF. LAPB is inhibited from sending frames and disconnected from circuit 103, which is held in the binary 1 condition.

5.6.7.5 Wait for sending state (state 4)

Circuit 105 and circuit 107 are ON, and circuit 106 is OFF. LAPB is connected to circuit 103 but is inhibited from sending frames.

5.6.8 Table of transitions between states expressed in terms applicable to a modem interface

Continuing the example, Table 8/X.32 shows, in terms of a V-series modem interface, the events that cause a state transition and the resulting action(s).

TABLE 8/X.32

Description of state transitions in terms of a V-series modem interface

Present state	Transition name		New state
	Event	Action	
0	Initialize calling DTE/DCE		4
Idle state	Calling DTE/DCE: circuit 107 ON	Turn circuit 105 ON: Connect LAPB to circuit 103.	Wait for sending state
0	Initialize called DTE/DCE		2
Idle state	Called DTE/DCE: circuit 107 ON	Start timer XT1.	Wait for receiving state
1	Send right to transmit		2
Half-duplex sending state	Transmission concluded (see Note 1)	Inhibit sending of LAPB frames. Disconnect LAPB from circuit 103. Hold circuit 103 in the binary 1 condition. Turn circuit 105 OFF (see Note 2). Start timer XT1.	Wait for receiving state
1	Disconnect sending DTE/DCE		0
Half-duplex sending state	LAPB has entered a disconnected phase	Turn circuits 105 and 107 OFF.	Idle state
2	Receive confirmation		3
Wait for receiving state	Reception of a flag or detection of carrier ON (see Note 3)	Stop timer XT1.	Half-duplex receiving state
2	Seize right to transmit		4
Wait for receiving state	Expiry of timer XT1	Turn circuit 105 ON. Release circuit 103 from binary 1 condition. Connect LAPB to circuit 103.	Wait for sending state

3 Half-duplex receiving state	Receive right to transmit		4 Wait for sending state
	Reception of 15 continuous 1 bits or detection of carrier OFF (see Note 4 and 5)	Turn circuit 105 ON. Release circuit 103 from binary 1 condition. Connect LAPB to circuit 103.	
3 Half-duplex receiving state	Disconnect receiving DTE/DCE		0 Idle state
	LAPB has entered a disconnected phase	Turn circuit 107 OFF.	
4 Wait for sending state	Send confirmation		1 Half-duplex sending state
	Circuit 106 ON	Enable sending of LAPB frames (see Note 6).	
Any	Reset from any state		0 Idle state
	Circuit 107 OFF	Inhibit sending of LAPB frames. (Turn circuit 105 OFF).	

Note 1 - The HDTM may determine that a transmission by the LAPB module has been concluded by either of the following:

- counting a sequence of continuous flags on circuit 103 while in state 1;
- a time-out;
- a signal from another source, e.g. from a higher level.

However, if no frame is transmitted while in state 1, not less than five continuous flags shall be sent in state 1 before entry into state 2.

Note 2 - It is recommended that circuit 105 not be turned OFF until 15 bit times after the binary 1 condition is established on circuit 103. This will assure transmission of an idle sequence to the remote DTE/DCE.

Note 3 - It is understood that circuit 109 will go ON. Entry into state 3 may be dependent on this condition as an implementation option.

Note 4 - It is recognized that whether or not an idle channel state condition sequence is sent by the remote DTE/DCE, the DTE/DCE will detect an idle channel state condition after circuit 109 goes OFF, since according to Recommendation V.24, § 4.3, this will hold circuit 104 in the binary 1 condition.

Note 5 - It is understood that circuit 109 will go OFF. Entry into state 4 may be made dependent on this OFF condition as an implementation option.

Note 6 - It is necessary to ensure that at least one full flag is transmitted after circuit 106 comes ON. This flag may be the opening flag of the first frame.

5.6.9 Turnaround checkpoint retransmission

In order to improve the efficiency of the LAPB procedure when using half-duplex circuits, it is highly recommended that an additional mechanism be implemented. It is called "turnaround checkpoint retransmission" and is described as follows:

- before a DTE/DCE gives the turn back (i.e. goes from state 1 to state 2 of Figure 10/X.32), it acknowledges all frames that were received and accepted during the time it was in state 3 (Half-duplex receiving state) before it got the turn;
- if a DTE/DCE gets the turn (i.e. transition from state 3 to state 4) or takes the turn (i.e. transition from state 2 to state 4 of Figure 10/X.32) then this DTE/DCE will first retransmit all I-frames that have not been acknowledged.

5.6.10 Interworking with a DTE/DCE without turnaround checkpoint additional procedures

The above procedure allows for interworking between a DTE/DCE having implemented the above additional mechanisms and a DCE/DTE not having implemented them.

In order to improve the efficiency of the procedure in such a case:

- a DTE/DCE having implemented the turnaround checkpoint retransmission is advised to replace the last RR frame of the transmit sequence, if any, by a REJ frame carrying the appropriate N(R).
- a DTE/DCE not having implemented turn around checkpoint retransmission nevertheless acknowledges during a turn all frames which have been correctly received during the previous turn.

6 Packet level

6.1 Scope and field of application

The formats and the procedures at the packet level shall be in accordance with §§ 3,4, 5, 6, and 7 of Recommendation X.25 with additions as noted in this section and in § 7 of this Recommendation.

If identification and authentication are done at the packet level, identification and authentication of the identity of both the DTE and DCE will cease to apply when a failure on the physical level and/or link level is detected.

Some DTEs may choose to use the registration procedure for on-line facility registration immediately after the switched access path has been established and the link has been set-up.

6.2 Use of registration packets for identification of DTE and/or DCE and for conveyance of X.32 optional user facilities

The registration procedure can be used for DTE and DCE identification at the packet level. The registration request packet is used to convey identification protocol elements from the DTE to the DCE. The registration confirmation packet is used to convey identification protocol elements from the DCE to the DTE.

When using registration packets for DCE identification, it is necessary for the DTE to send a registration request packet in order to give the DCE an opportunity to identify itself.

Whenever DCE identification is being done via the registration procedure, a registration confirmation packet must be sent after the identification protocol has been completed in order for the registration procedure to be completed. If the DCE identification was not successful, this packet may contain identification protocol elements to begin the DCE identification procedure again, if allowed.

The identification protocol may be used for DTE identification and DCE identification at the same time. When this occurs, a registration packet may carry elements for both directions of identification simultaneously.

A DTE may specify X.32 optional user facilities in registration packets.

Descriptions of the identification protocol elements and X.32 facilities are listed in § 7.2.

When the registration request or the registration confirmation packet is used for identification and/or the conveyance of X.32 optional user facilities, the elements and/or facilities (see § 7.3) are carried in the registration field.

Registration packets may be used to perform identification, conveyance of X.32 facilities, and on-line facilities negotiation in the same packets, subject to the restriction of § 7.1.2, below (see § 7.3 of Recommendation X.25).

6.3 Identification and authentication of the DTE using the NUI facility in call set-up packets

The NUI facility in call set-up packets can be used for DTE identification on a per virtual call basis. It can also be used in addition to one of the prior-to-virtual-call DTE identification methods. This NUI identification remains in effect for the lifetime of the virtual call and is independent of any previous NUI identification on the interface. Subsequent call requests on the switched access path will either revert to the prior DTE service on the interface or receive a DTE service associated with a NUI.

The NUI facility parameter may contain as the DTE identity either a user identifier plus a password assigned by the network to the DTE, or only a password assigned by the network to the DTE. The formats of the user identifier and the password are national matters.

6.3.1 NUI override permission facility

The NUI override permission facility is an optional user facility agreed to for a period of time. This facility, if subscribed to, permits an NUI facility, presented in a call request packet, to invoke features subscribed to by the DTE identified by that NUI and associated with the NUI. Facilities associated with the NUI shall override facilities which apply to the interface. This override does not apply to other existing calls or subsequent calls on the interface. It remains in effect for the duration of the particular virtual call to which it applies.

The optional subscription facilities that may be associated with an NUI are specified in Table 9/X.32 and designated as user selectable.

The NUI override permission facility is not negotiable in registration request and registration confirmation packets. Indication, in registration confirmation packets, of whether this facility is supported by the DCE, is for further study.

If the DCE determines that the NUI is invalid or that any of the optional facilities requested in the call request packet are not allowed for the DTE identified by the NUI, it will clear the call.

TABLE 9/X.32

Availability of X.25 subscription-time facilities by use of
NUI when NUI override permission facility is in effect

Packet level facility	Availability
On-line facility registration	No
Extended packet sequence numbering	No
D-bit modification	No
Packet retransmission	No
Incoming calls barred	No
Outgoing calls barred	No
One-way logical channel outgoing	No
One-way logical channel incoming	No

Nonstandard default packet sizes	Yes
Nonstandard default window sizes	Yes
Default throughput classes assignment	Yes
Flow control parameter negotiation - subscription-time	Yes
Throughput class negotiation - subscription-time	Yes
Closed user group related facilities - Closed user group - Closed user group with outgoing access - Closed user group with incoming access - Incoming calls barred within a closed user group - Outgoing calls barred within a closed user group	Yes Yes No No Yes
Bilateral closed user group related facilities - Bilateral closed user group - Bilateral closed user group with outgoing access	Yes Yes
Fast select acceptance	No
Reverse charging acceptance	No
Local charging prevention	No
Charging information - subscription-time	Yes
RPOA selection - subscription-time	Yes
Hunt group	No
Call redirection	No

Yes Facility can be chosen or set to a nondefault value by the DTE, if supported by the PSPDN.

No Facility cannot be chosen by the DTE; whether a default or user-specified value applies is determined by the DTE service in effect for the entire interface.

6.3.2 Operation of the per-call NUI facility

The following four cases describes the operation of the per-call NUI facility:

- 1) When a DTE identity has been established using a prior-to-virtual-call DTE identification method and the per-call NUI facility is used, two subcases are possible:

- a) NUI override permission facility is subscribed to

When a call request packet containing a valid NUI is sent, the features subscribed to by the DTE identified by that NUI and associated with that NUI apply to the virtual call, regardless of any prior identification on the interface.

- b) NUI override permission facility is not subscribed to

When a call request packet containing a valid NUI is sent, the NUI affects only the billing entity and does not affect DTE service. Thus, the DTE service obtained will be the DTE service invoked by the prior-to-virtual-call identification on the interface.

In both cases a) and b), the features invoked by the NUI remain in effect only for the lifetime of the virtual call. Subsequent call requests on the switched access path will either revert to the prior DTE service on the interface (when no per-call NUI is used) or receives a DTE service associated with an NUI. This use of NUI is independent of any previous uses of NUI on the interface.

- 2) When a DTE identity has not been established using a prior-to-virtual-call identification method and the per-call NUI facility is used, two subcases are possible:

- a) NUI override permission facility is set by the network

When a call request packet containing a valid NUI is sent, the features subscribed to by the DTE identified by that NUI and associated with that NUI apply to the virtual call.

- b) NUI override permission facility is not set by the network

When a call request packet containing a valid NUI is sent, the default X.25 subscription set applies to the virtual call.

In both cases a) and b), the NUI remains in effect only for the lifetime of the virtual call.

7 X.32 procedures, formats, and facilities

7.1 Identification protocol

7.1.1 Protocol elements

The identification protocol is for exchanging identification and authentication information in one or more pairs of messages. The two parties involved in this protocol are called the questioning party and the challenged party.

Two security options are defined: the basic option described as security grade 1 and an enhanced option described as security grade 2. The identification and authentication information are encoded in the following protocol elements:

- a) the identity element (ID) is a string of octets representing the DTE or DCE identity (see §§ 2.2.1 and 2.2.2, respectively) of the challenged party.
- b) The signature element (SIG) of the identity is a string of octets associated with the identity and used for authentication of the identity. It is assigned for a period of time by the authority that assigns the identity and may be changed from time to time. For example, the SIG may be a password or the result of an encryption process applied to the identity element (ID) of the challenged party.
- c) The random number element (RAND) is a string of octets which is unpredictable for each identification exchange. It is used only in the security grade 2 option.
- d) The signed response element (SRES) of the challenged party is the reply to the RAND protocol element by the questioning party. It is used only in the security grade 2 option.
- e) The diagnostic element (DIAG) is the result of the identification process and is transmitted by the questioning party at the end of the process.

The format of these elements is shown in § 7.3.

The sizes of values of the identity, signature and random number elements are a national matter and depend on a number of factors including:

- a) whether the authentication is of DTE identity or DCE identity,
- b) the grade of security,
- c) the method of identification,
- d) the possibilities of future improvements in computational techniques, and
- e) whether the PSPDN directly assigns DTE identities or adopts, through pre-arrangement, the DTE identities assigned by the PSN or another authority.

7.1.2 Identification protocol procedure

The first message of a pair is transmitted by the challenged party. The second message of the pair is transmitted by the questioning party. Security grade 1 provides a single exchange of elements ID [, SIG], and DIAG, whereas security grade 2 uses an additional exchange of RAND and SRES elements to provide a greater degree of security.

Note - In both security grades 1 and 2, SIG may be omitted if not required by the questioning party. If it is not required, its presence is not considered an error.

The identification protocol elements are passed between the parties in either a sequence of XID command frames or registration packets. Networks may offer either or both methods of security exchange, but an entire identification exchange must be done entirely with only one method.

The identification protocol may be used for DTE identification simultaneously but independently of its use for DCE identification. When this occurs, a registration packet or XID frame may carry elements for both directions of identification simultaneously.

The identification established using the identification protocol applies for the duration of the switched access. That is, once the DIAG element indicating acceptance of the DTE/DCE identity has been sent, the switched access path must be disconnected before another attempt to use the identification protocol to identify that challenged party can be made.

If the identification protocol is not successful, that is, the DIAG element indicates refusal of the DTE/DCE identity, the questioning party should disconnect the switched access path. In the case of security grade 1, a network may allow up to three retries of the identification protocol (i.e. the DIAG element indicates refusal of the DTE/DCE identity) before the switched access path is disconnected when the network is the questioning party. For security grade 2, only one attempt to perform the identification protocol is permitted when the network is the questioning party.

The actions of the DCE when acting as the challenged or questioning party are further described by the state diagrams and tables in Annex A.

The security grade applied on a particular switched connection is determined by the subscription of the DTE with the Administration. It is not negotiable on a per call basis. Not all networks will offer both security grade options. The use of certain optional features may be restricted to a particular security grade. A positive and secure DTE identification is limited to the security of the switched access path, particularly in dial-out-by-the-PSPDN operation.

In order to avoid situations in which both parties are waiting for the other to identify first, these principles will be followed:

- a) Each party should send its identity, if capable and willing, at the earliest opportunity. However, the called party is not required to send its own identity before complete identification of the calling party.
- b) If the calling party does not send its identity, the called party has a choice of operating a service not requiring identification or disconnecting the switched connection.

Security grade 1 involves a single pair of messages as shown in Figure 11/X.32. First the challenged party sends its identity (ID) and, if required, its signature (SIG). The questioning party responds with the diagnostic (DIAG).

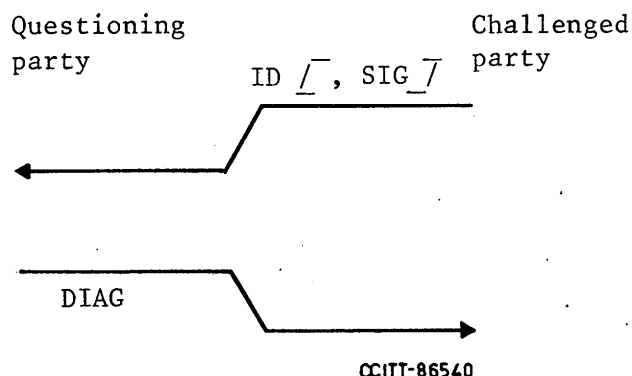


FIGURE 11/X.32

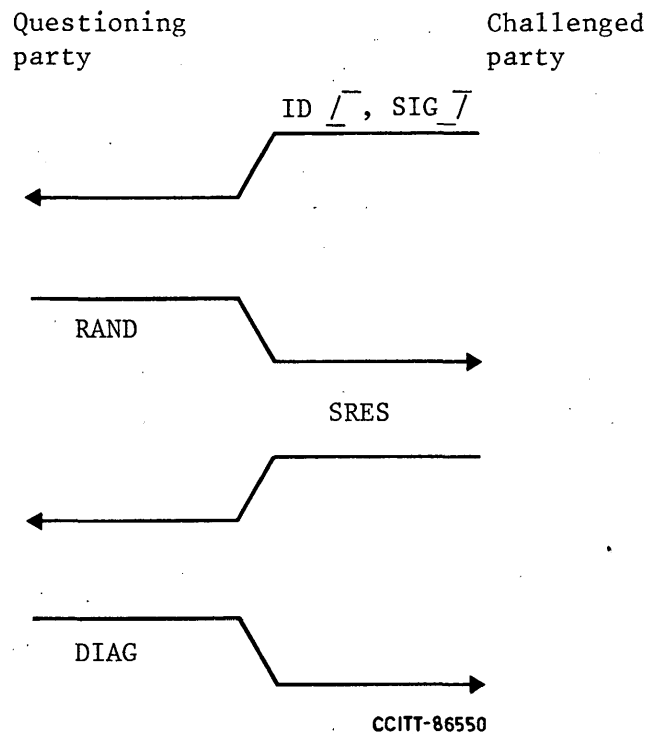
Security grade 1

As shown in Figure 12/X.32, security grade 2 involves an additional authentication exchange if the initial response (ID [, SIG]) of the challenged party is valid. If ID is an identity unknown to the questioning party or if the SIG element is required by the questioning party but either it is not present or is inconsistent with the claimed identity, then an error diagnostic (DIAG) is issued and the access path is disconnected. Otherwise, the questioning party will generate and send a random number (RAND) which the challenged party will encrypt and return as its signed response (SRES). The questioning party will then decrypt SRES and, if this operation results in a value identical to RAND, the appropriate diagnostic (DIAG) is sent to the challenged party and the identification process is successfully completed. Otherwise, an error diagnostic (DIAG) is returned and the access path is disconnected.

Note 1 - It is left for further study whether or not to define, as a mechanism for protecting against specific forms of intrusion, that the value of RAND is odd or even depending on the direction of the switched access call.

Note 2 - If the network does not store the public keys of DTEs, the SIG can be used to convey the public key and other security information of the DTE, and, in order to add to the protection, this information can be encrypted via the private key of the network.

If on-line facility registration is done simultaneously with identification, the DTE shall do so only in the packet containing SRES. If on-line facility registration is attempted prior to SRES, it will be refused by the network with a cause code value of local procedure error.



Note - The exchange depicted illustrates the case where the initial ID [, SIG] message was valid.

FIGURE 12/X.32

Security grade 2

7.1.3 Identification protocol formats

The formats for the identification protocol elements are defined in § 7.3 of this Recommendation in accordance with §§ 6 and 7 of Recommendation X.25. The elements are coded identically in registration packets and XID frames.

7.2 Procedures for X.32 optional user facilities

7.2.1 Secure dial-back facility

Networks that implement both the dial-in-by-the-DTE and dial-out-by-the-PSPDN operations may provide, as an optional user facility agreed for a period of time, a dial-back procedure. This facility, if subscribed to, combines the dial-in-by-the-DTE operation with the dial-out-by-the-PSPDN operation to offer additional protection when the identity of the DTE becomes known to the network. This procedure allows, in the customized DTE service, a DTE to use the dial-in-by-the-DTE operation, identify itself, and disconnect. Security is achieved in using the identity element of the identification protocol and a dial-out-by-the-PSPDN to the registered PSN number. The network uses the dial-out-by-the-PSPDN operation to dial back the DTE using the registered PSN number. The DCE identifies itself and the DTE identifies itself again. Some networks may offer the additional feature of limiting the use of the secure dial-back facility to specific hours of operation of the DTE.

The grade of security for secure dial-back is not negotiable per switched access call. It is one aspect of the identity and its value is set when pre-registering to the authority that defines the identity.

After the DTE has correctly identified itself to the DCE during dial-in-by-the-DTE, the DCE sends a request for dial-back confirmed via the diagnostic element of the identification protocol. Then the DTE and network should disconnect the link, if necessary, and then the switched access path as soon as possible. The network should then initiate the dial-back to the DTE as soon as possible by using dial-out-by-the-PSPDN.

If, during the dial-in-by-the-DTE operation, the DCE is aware that it cannot perform the dial-back, the DCE will indicate to the DTE that dial-back is not possible. This indication is given via the diagnostic element of the identification protocol.

When the DCE disconnects the switched access path on the dial-in-by-the-DTE it starts DCE timer T15. The DCE then attempts the dial-out-by-the-PSPDN operation as soon as possible. The period of timer T15, at the end of which the DCE abandons the attempt to dial out to the DTE, is a system parameter agreed for a period of time with the Administration.

When the network dials out, the DCE includes a "dial-back indication" to the DTE via the diagnostic element of the identification protocol.

If the DTE receives an unsolicited dial-back from the DCE, the switched access path may be disconnected.

Note - As some PSTN networks implement calling party clear, a PSPDN may wish to restrict dial-back to an outgoing only PSTN port.

7.2.2 Temporary location facility

Temporary location is an optional user facility that applies to the DTE/DCE interface for registered DTEs that accept dial-out calls from the PSPDN.

This facility can be used to substitute a different switched access number for dial-out-by-the-PSPDN to the DTE other than the registered PSN number. The switched access number specified is an X.121 number from the PSTN numbering plan.

Note 1 - Whether this facility may be used on a CSPDN is a matter for further study.

Note 2 - Extension of a switched access number to accommodate additional digits, secondary digits, secondary dial tone, or dialling delays as allowed by V.25 and/or X.24 is left for further study.

In addition, a DTE may specify, by means of this facility, the periods of time during which it may be reached at a valid number for the PSTN.

During those periods not identified by this facility, the number used to reach the DTE will be its registered PSN number.

The substitute number goes into effect at the "stay initiation" data and time. The substitute number is no longer in effect at the "stay termination" date and time.

7.3 Coding of the identification protocol elements and X.32 facilities

7.3.1 General

The general principles for coding of the identification protocol elements and X.32 facilities are the same as the ones specified for the registration field in § 7.1 of Recommendation X.25. The statements of § 7.1 of Recommendation X.25 concerning facilities do not apply to this section. The statements of § 7.1 of Recommendation X.25 concerning registration elements apply to the identification protocol elements and X.32 facilities in this section.

7.3.2 Coding of the identification protocol element and X.32 facility code fields

Table 10/X.32 gives the list of the identification protocol element and X.32 facility codes, the coding for each, and, where applicable, whether this code may be sent by the challenged or the questioning party.

TABLE 10/X.32

Identification protocol element and X.32 facility codes

Identification element or facility code	May be sent by		Bits							
	challenged party	questioning party	8	7	6	5	4	3	2	1
Identity element	x		1	1	0	0	1	1	0	0
Signature element	x		1	1	0	0	1	1	0	1
Random number element		x	1	1	0	0	1	1	1	0
Signed response element	x		1	1	0	0	1	1	1	1
Diagnostic element		x	0	0	0	0	0	1	1	1
Temporary location			1	1	0	1	0	0	0	0

7.3.3 Coding of the identification protocol element and X.32 facility parameter fields

7.3.3.1 Identity element

The octet following the code field indicates the length, in octets, of the parameter field. The following octets contain the string of octets composing the identity.

7.3.3.2 Signature element

The octet following the code field indicates the length, in octets, of the parameter field. The following octets contain the string of octets composing the signature.

7.3.3.3 Random number element

The octet following the code field indicates the length, in octets, of the parameter field. The following octets contain the string of octets composing the number which is the random number element. It is binary coded with bit 8 of the first octet following the parameter length being the high order bit and bit 1 of the last octet being the low order bit. If the number of significant bits of the random number is not octet-aligned, then zeroes precede the most significant bit to make it octet-aligned.

7.3.3.4 Signed response element

The octet following the code field indicates the length, in octets, of the parameter field. The following octets contain the string of octets composing the number which is the signed response. It is binary coded with bit 8 of the first octet following the facility parameter length being the high order bit and bit 1 of the last octet being the low order bit. If the number of significant bits of the signed response is not octet-aligned, then zeroes precede the most significant bit to make it octet-aligned.

7.3.3.5 Diagnostic element

The coding of the parameter field for the diagnostic element is shown in Table 11/X.32.

TABLE 11/X.32

Coding of the parameter field for the diagnostic element

	Bits							
	8	7	6	5	4	3	2	1
Identification/authentication confirmed	0	1	1	1	1	1	1	1
Identification or authentication failed (Note 1)								
- general	1	0	0	0	0	0	0	0
- additional	1	X	X	X	X	X	X	X
Network congestion (Note 2)	0	0	0	0	0	1	0	1
Identification in use (Note 3)	0	0	0	1	0	1	1	1
Dial-back indication (Note 4)	0	0	1	1	1	1	1	1
Network congestion for dial-back (Note 4)	0	0	0	1	1	0	1	1
Request for dial-back confirmed (Note 4)	0	0	0	1	1	1	1	1

Note 1 - Bits 7 to 1 are for maintenance purposes and are a national matter. Complete specification and provision of this information to a user represents a possible compromise of security by providing details of authentication failure.

Note 2 - Replacement of this call progress signal is for further study in close liaison with the revision of Recommendation X.96.

Note 3 - Whether multiple switched connections can be simultaneously active using the same DTE identity is for further study.

Note 4 - Used only in conjunction with the secure dial-back facility (see § 7.2.1).

7.3.3.6 Temporary location facility

The octet following the code field indicates the length, in octets, of the parameter field.

The parameter field consists of one or more instances of temporary location requested by the DTE.

For each instance of temporary location, the first 5 octets indicate the date and time of the stay initiation. The next 5 octets indicate the date and time of the stay termination. The octet following the stay termination indicates the number of semi-octets in the switched access number and is binary encoded. The following octets contain the switched access number.

Date and time of initiation/termination is a string of 10 decimal digits expressing the coordinated universal time (UTC) and has the form YYMMDDhhmm. YY is the two low-order digits of the Christian era year, and MM, DD, hh, and mm are the month, day, hour, and minute, respectively. The 10 decimal digits are BCD encoded in 5 octets with the first digit of the year encoded into bits 8 to 5 of the first octet and the last digit of the minute encoded into bits 4 to 1 of the fifth octet.

A value of all zeros for stay initiation will indicate the DTE's desire for immediate initiation.

A value of all zeros for stay termination will indicate the DTE's desire for the switched number to remain in effect until subsequent replacement (i.e. permanently).

Note - Some networks may only permit the stay termination and/or stay initiation fields to contain all zeros. In that case, the number of instances of temporary location is limited to one.

The switched access number is coded as a series of semi-octets. Each semi-octet contains either a digit in binary coded decimal or a special value in the range 1010 - 1111 binary.

Note - The special values may be used to accommodate the capabilities of V.25 and/or X.24, particularly in specifying secondary dial tone and dialling delays. Such use is left for further study.

If the switched access number contains an odd number of semi-octets, it is followed by a semi-octet containing zeros.

A switched number length of zero will indicate that the DTE is unavailable.

7.4 Security grade 2 method

The authentication method in security grade 2 provides for the use of encryption to prevent unauthorized access subject to the constraints of unit cost and computation time. One example of a public key encryption technique which could be used for this purpose is given in Appendix II. The selection and use of security grade 2 algorithms is a national matter.

Note - Further study, in close cooperation with ISO/TC 97/SC 20, will define the characteristics and length constraints of the various numbers and parameters to be used in security grade 2 algorithms. The definition of the parameters of an algorithm should strike a balance between the cost and the complexity of the algorithm, and the value of that which is protected. The goal is to make the cost of breaking the code exceed the cost of obtaining the network resources by authorized means.

7.5 DCE timer T14

The DCE may support a timer T14, the value of which should be made known to the DTE.

At the expiration of timer T14, the DCE will disconnect the link, if connected, then the switched access path.

Timer T14 is started whenever a switched access path is established. Timer T14 is stopped when either the DTE identity is established or a virtual call(s) is established which is not to be charged to the local DTE. In the latter case, timer T14 will be restarted when no assigned logical channels are active.

The relationships of timer T14 to the different methods of DTE identification are illustrated in Appendix III

The period of timer T14 shall be network dependent.

7.6 DCE timer T15

Timer T15 is used in conjunction with the secure dial-back facility (see § 7.2.1).

The period of timer T15 is left for further study.

ANNEX A

(to Recommendation X.32)

Actions taken by the DCE in the roles of questioning and challenged parties for security grade 1 and security grade 2 identifications

A.1 Introduction

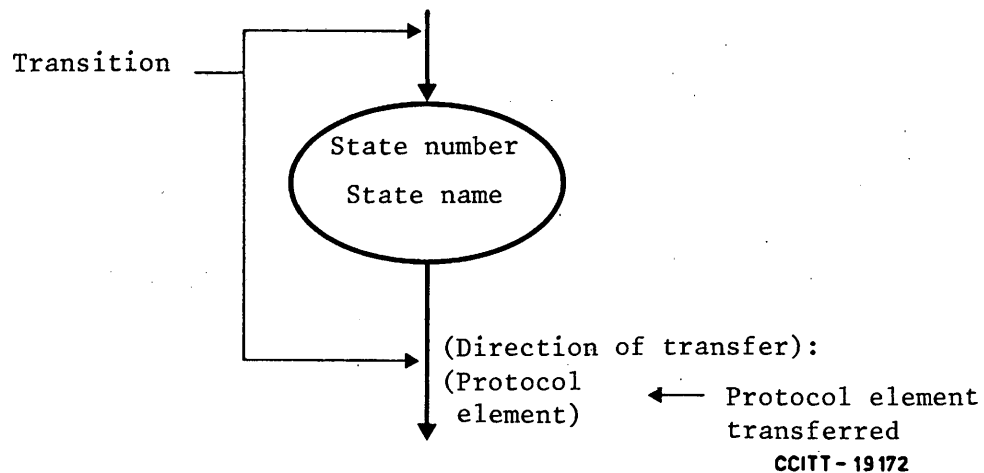
This annex specifies the actions taken by the DCE when it acts as the questioning and challenged parties for security grade 1 and security grade 2 identifications. When performing the identification procedure described in § 7.1.2, the DCE shall act as described in this annex.

Note - As the identification protocol is symmetrical and should be used by the DTE in the same manner as the DCE, the actions of the DTE should correspond directly to the actions defined for the DCE.

The identification protocol is presented as a succession of state diagrams and corresponding tables.

In this annex, a DIAG element is considered as positive when its parameter field means identification/authentication confirmed, request for dial-back confirmed, or dial-back indicator (see § 7.3.3.5). It is considered as negative in other cases.

A.1.1 Symbol definition of 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 direction of transfer and the protocol element that has been transferred are indicated beside that arrow.

A.1.2 Definition of actions

In each table, the actions taken by the DCE as the questioning party or the challenged party are indicated in the following way:

NORMAL: Normal event; protocol elements received are handled as described in § 7.1.2.

DISCARD: Received message is discarded.

RAND: RAND transmitted.

Positive DIAG: Positive DIAG transmitted.

Negative DIAG: Negative DIAG transmitted.

ID [, SIG]: ID [, SIG] transmitted.

SRES: SRES transmitted.

Each entry in the tables in this annex gives, first, the action taken, if any, then an arrow indicating the transition, and, finally, the state that the DCE as the questioning or challenged party will enter.

A.2 Security grade 1 identification

A.2.1 DCE acting as the questioning party

The DCE acts as the questioning party for security grade 1 when it offers identified or customized DTE service via the XID or registration DTE identification method with grade 1 authentication. Four states are defined for describing the procedures the DCE uses:

a) q11 - Waiting for ID [, SIG] (grade 1)

This is the initial state of the DTE identification process. It is entered after the switched connection is established and, when the registration procedure DTE identification method is used, after the link level is set up. In this state, the DCE expects to receive the ID (and possibly SIG) element(s) from the DTE. If the DCE allows retrying the identification protocol, this state is also entered when a DTE identification attempt has failed and the limit of retries has not been exhausted.

b) q12 - Evaluating ID [, SIG] (grade 1)

In this state, the DCE determines whether or not the DTE identity that was presented in the ID (and possibly SIG) element(s) is acceptable. The result is the transmission by the DCE to the DTE of the DIAG element, which has as its value the success or not of the acceptability evaluation.

c) q13 - DTE identification successful (grade 1)

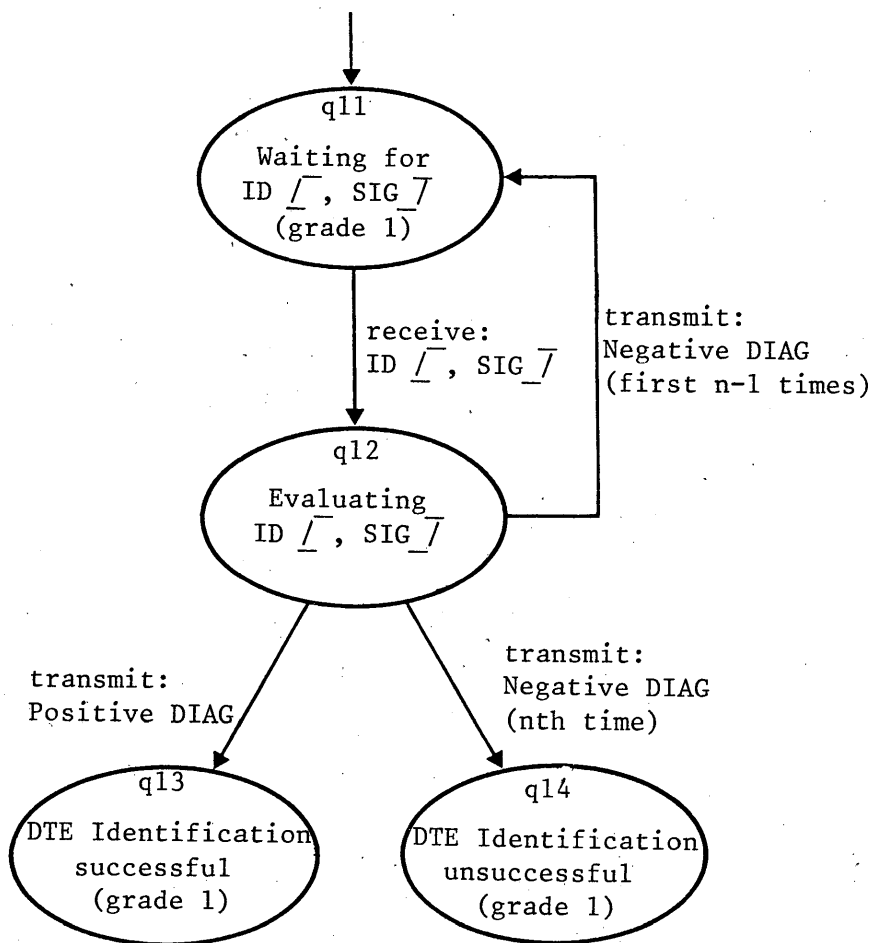
In this state, the DCE provides the identified or customized DTE service to the identified DTE. The DCE remains in this state until the switched connection is disconnected.

d) q14 - DTE identification unsuccessful (grade 1)

In this state, the DCE does not provide the identified or customized DTE service (unless NUI is used on a per virtual call basis for the Identified DTE service) but may provide the Nonidentified DTE service if it is supported. The DCE enters this state when the last DTE identification attempt allowed by the retry limit has failed. The DCE remains in this state until the switched connection is disconnected.

Figure A-1/X.32 provides the state diagram for the DCE acting as the questioning party in the case of security grade 1 identification.

The actions to be taken by the DCE acting as the questioning party for security grade 1 identification, when one of the listed events occurs, are indicated in Table A-1/X.32.



CCITT-92350

n = number of DTE identification attempts permitted

FIGURE A-1/X.32

Diagram of states for DCE acting as questioning party for security grade 1 identification

TABLE A-1/X.32

Actions taken by the DCE as the questioning party (security grade 1)

[illegible]

Note 1 - When in this state, the DCE should disconnect the switched access path when it is sure that the DIAG element has been received by the challenged party or the challenged party is out-of-order.

Note 2 - Depending on whether or not ID and/or SIG are recognized as correct by the DCE. When Negative DIAG, go to q11 until the retry limit has been reached.

A.2.2 DCE acting as the challenged party

The DCE acts as the challenged party for security grade 1 when it identifies itself to the DTE via the XID or registration DCE identification method with grade 1 authentication. Four states are defined for describing the procedures the DCE uses:

a) c11 - Initial challenged (grade 1)

This is the initial state of the DCE identification process. It is entered after the switched connection is established, and, when the registration procedure DCE identification method is used, after the link level is set up. In this state, the DCE transmits the ID (and possibly SIG) element(s) to the DTE.

b) c12 - Waiting for DIAG (grade 1)

In this state, the DCE expects to receive the DIAG element which has as its value the acceptability or not of the DCE identity.

c) c13 - DCE Identification successful (grade 1)

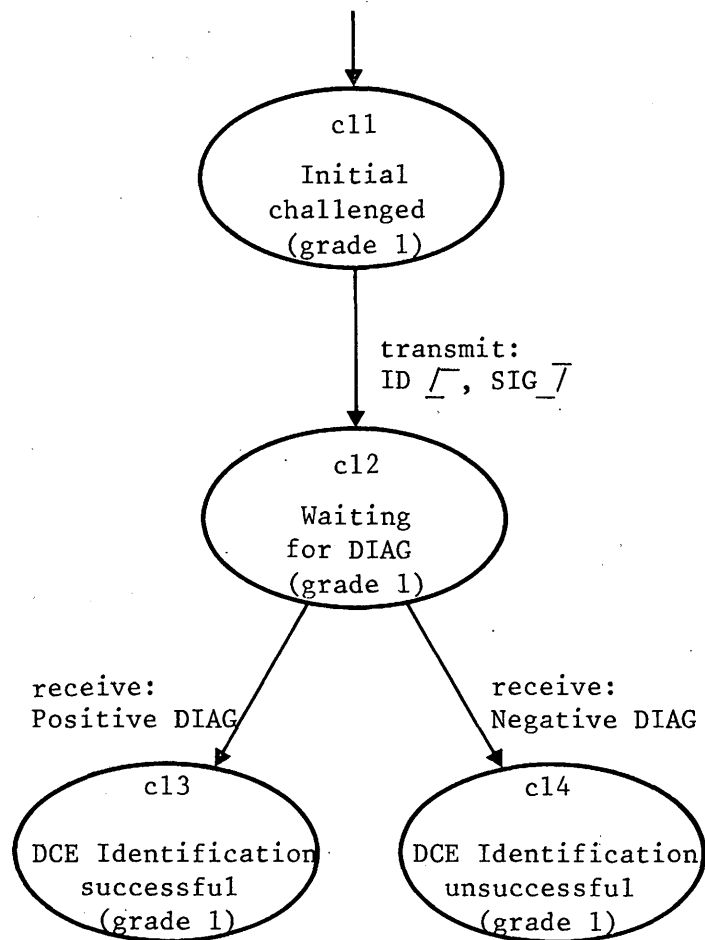
In this state, the DCE has completed its identification successfully. The DCE remains in this state until the switched connection is disconnected.

d) c14 - DCE Identification unsuccessful (grade 1)

The DCE enters this state when the DCE identification attempt has failed. The DCE remains in this state until the switched connection is disconnected.

Figure A-2/X.32 provides the state diagram for the DCE acting as the challenged party in the case of security grade 1 identification.

The actions to be taken by the DCE as the challenged party for security grade 1 identification, when one of the listed events occurs, are indicated in Table A-2/X.32.



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FIGURE A-2/X.32

Diagram of states for DCE acting as challenged party
for security grade 1 identification

TABLE A-2/X.32

Actions taken by the DCE as the challenged party (security grade 1)

<div>State of the DCE acting as the challenged party</div> <div>Protocol element received by the DCE or decision by the DCE</div>	c11 Initial challenged (grade 1)	c12 Waiting for DIAG (grade 1)	c13 DCE identification successful (grade 1)	c14 DCE identification unsuccessful (grade 1) (see Note 1)
DCE decides it wants to be identified	ID [, SIG]→12	//////////////// ////////////////	//////////////// ////////////////	//////////////// ////////////////
Positive DIAG	NORMAL→c13 or c14 (see Note 2)	NORMAL→c13	DISCARD→c13	DISCARD→c14
Negative DIAG	NORMAL→c14	NORMAL→c14	DISCARD→c13	DISCARD→c14

Note 1 - In this state, the DCE shall disconnect the switched access path.

Note 2 - c13 or c14 depending on whether or not the DCE wants to be identified.

A.3 Security grade 2 identification

A.3.1 DCE acting as the questioning party

The DCE acts as the questioning party for security grade 2 when it offers identified or customized DTE service via the XID or registration DTE identification method with grade 2 authentication. Six states are defined for describing the procedures the DCE uses:

a) q21 - Waiting for ID [, SIG] (grade 2)

This is the initial state of the DTE identification process. It is entered after the switched connection is established and, when the registration procedure DTE identification method is used, after the link level is set-up. In this state, the DCE expects to receive the ID (and possibly SIG) element(s) from the DTE.

b) q22 - Evaluating ID [, SIG] (grade 2)

In this state, the DCE begins determining whether or not the DTE identity that was presented in the ID (and possibly SIG) element(s) is acceptable. If the DTE identity is acceptable or the acceptability is not fully determined in this state, the DCE generates the value for the RAND element and transmits it to the DTE. If the DTE identity is unacceptable, the DCE transmits to the DTE the DIAG element with a negative value.

c) q23 - Waiting for SRES

In this state, the DCE expects to receive the SRES element from the DTE. The DCE may continue to evaluate the ID (and possibly SIG) element(s) and, if the DTE identity is unacceptable, the DCE transmits to the DTE the DIAG element with a negative value.

d) q24 - Evaluating SRES

In this state, the DCE determines if the value presented in the SRES element is correct for the DTE identity. If the evaluation of the ID [, SIG] element(s) has not already been completed, it is completed in this state. The results of the SRES check (and the last of the ID [, SIG] check) is transmitted by the DCE to the DTE as the value of the DIAG element.

e) q25 - DTE Identification successful (grade 2)

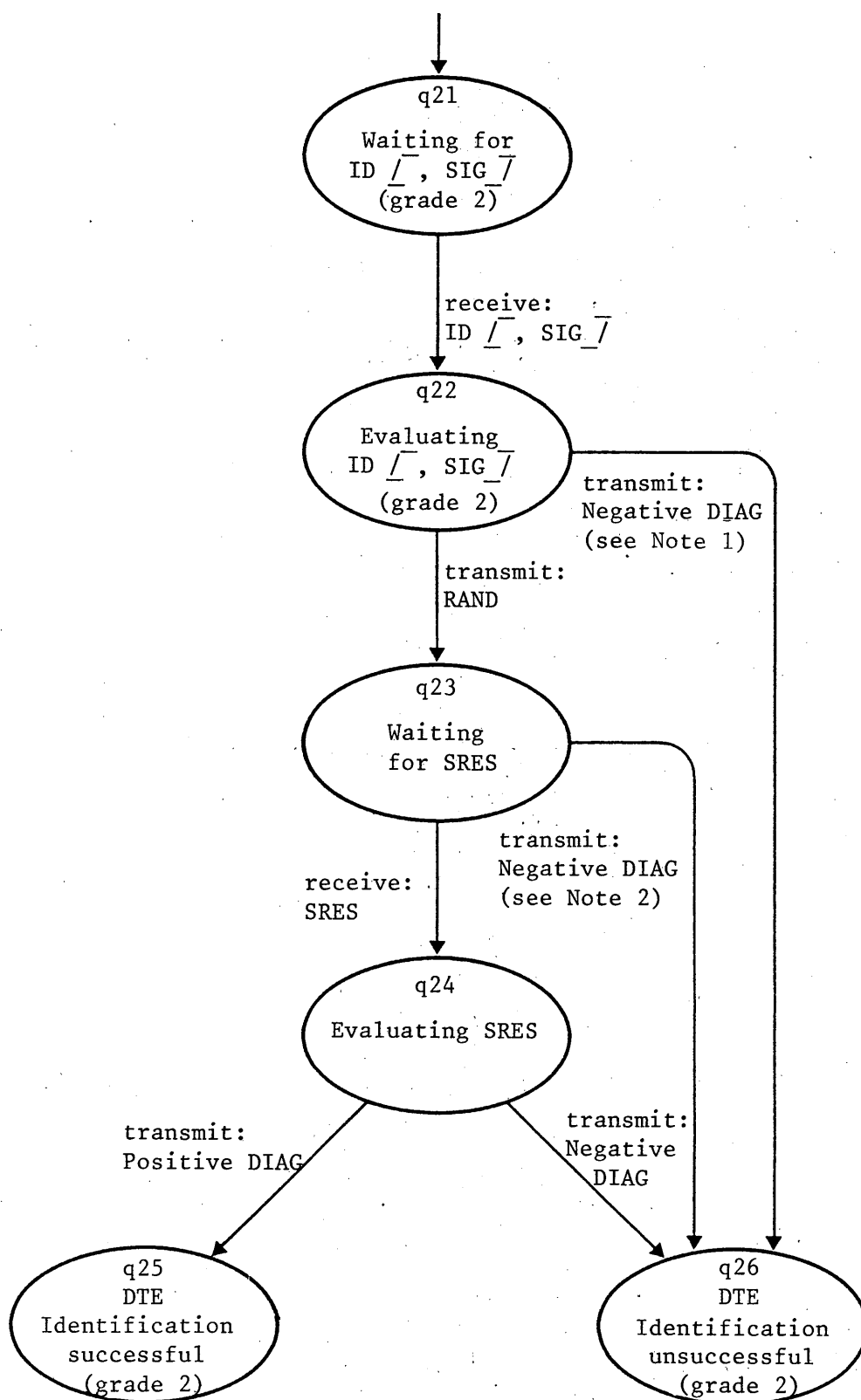
In this state, the DCE provides the identified or customized DTE service to the identified DTE. The DCE remains in this state until the switched connection is disconnected.

f) q26 - DTE Identification unsuccessful (grade 2)

In this state, the DCE does not provide the identified or customized DTE service (unless NUI is used on a per virtual call basis for the identified DTE service) but may provide the nonidentified DTE service if it is supported. The DCE remains in this state until the switched connection is disconnected.

Figure A-3/X.32 provides a state diagram for the DCE acting as the questioning party in case of security grade 2 identification.

The actions to be taken by the DCE as the questioning party for security grade 2 identification, when one of the listed events occurs, are indicated in Table A-3/X.32.



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Note 1 - If an error in the ID and/or SIG is found before RAND is transmitted.

Note 2 - If an error in the ID and/or SIG is found after RAND is transmitted.

FIGURE A-3/X.32

Diagram of states for DCE acting as the questioning party for security grade 2 identification

TABLE A-3/X.32

Actions taken by the DCE as the questioning party (security grade 2)

[illegible]

Note 1 - When in this state, the DCE should disconnect the switched access path when it is sure that the DIAG element has been received by the challenged party or the challenged party is out-of-order.

Note 2 - A negative DIAG is sent if the DCE has detected ID [, SIG] as incorrect. RAND is sent if the DCE has detected ID [, SIG] as correct or if it has not yet checked ID [, SIG].

Note 3 - After having transmitted RAND, if the DCE detects that the ID [, SIG] received when in state q21 was incorrect, it transmits a negative DIAG and goes into state q26. Otherwise, the DCE continues with the normal process of waiting to receive the SRES element.

Note 4 - q25 or q26 depending on whether or not the SRES is recognized as correct by the DCE.

A.3.2 DCE acting as the challenged party

The DCE acts as the challenged party for security grade 2 when it identifies itself to the DTE via the XID or registration DCE identification method with grade 2 authentication. Six states are defined for describing the procedures the DCE uses:

a) c21 - Initial challenged (grade 2)

This is the initial state of the DCE identification process. It is entered after the switched connection is established, and, when the registration procedure DCE identification method is used, after the link level is set up. In this state, the DCE transmits the ID (and possibly SIG) element(s) to the DTE.

b) c22 - Waiting for RAND

In this state, the DCE expects to receive the RAND element. If the ID (and possible SIG) are not acceptable to the DTE, the DCE may receive the DIAG element with a negative value.

c) c23 - Calculating SRES

Using the value of the RAND element, the DCE calculates the value for the SRES element and transmits it to the DTE. If the DTE has continued to evaluate the ID (and possibly SIG) and determined that it is not acceptable, the DCE may receive the DIAG element with a negative value.

d) c24 - Waiting for DIAG (grade 2)

In this state, the DCE expects to receive the DIAG element which has as its value the acceptability or not of the DCE identity and SRES value.

e) c25 - DCE Identification successful (grade 2)

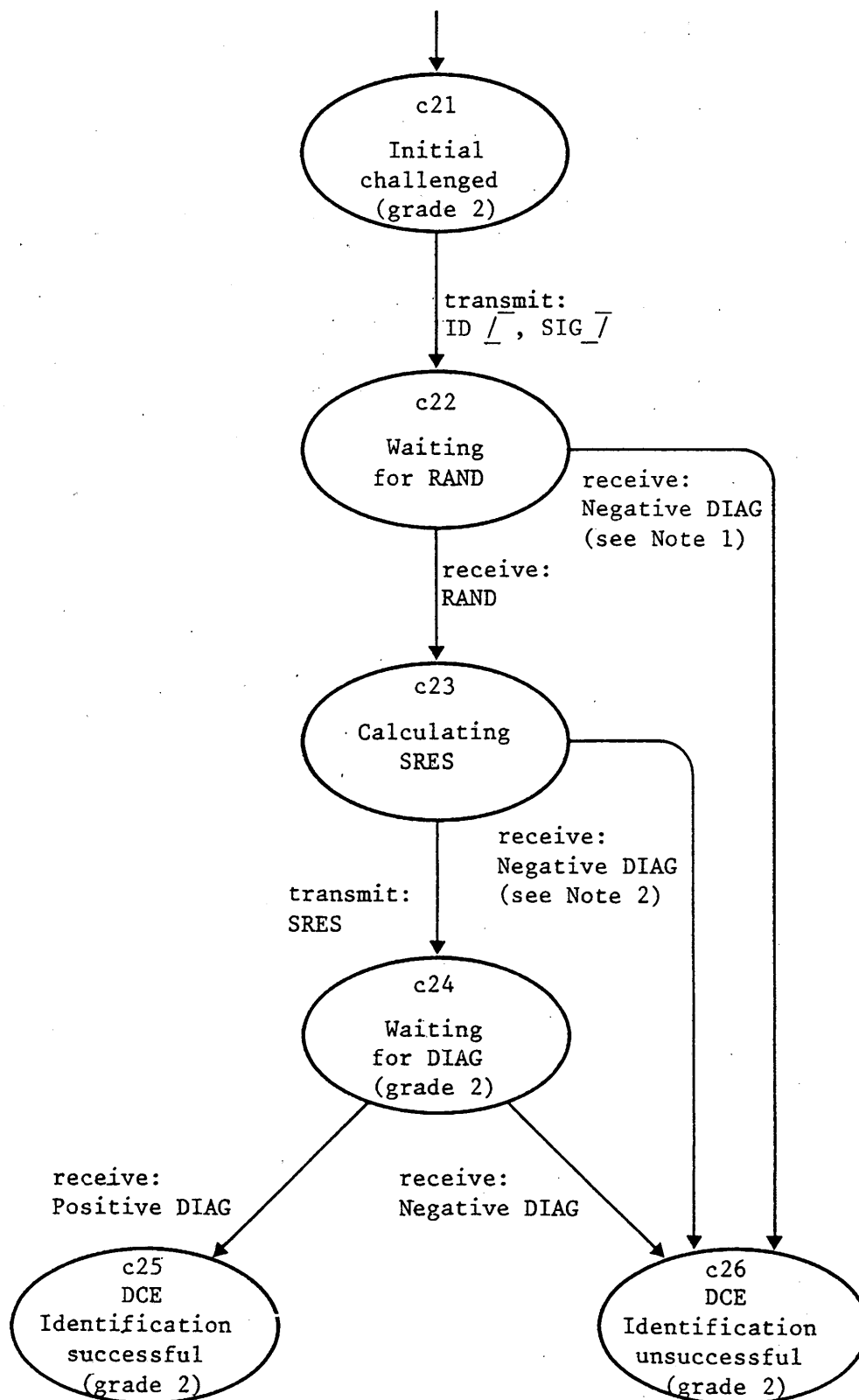
In this state, the DCE has completed its identification successfully. The DCE remains in this state until the switched connection is disconnected.

f) c26 - DCE Identification unsuccessful (grade 2)

The DCE enters this state when the DCE identification attempt has failed. The DCE remains in this state until the switched connection is disconnected.

Figure A-4/X.32 provides a state diagram for the DCE acting as the challenging party in case of security grade 2 identification.

The actions to be taken by the DCE for security grade 2 identification, when one of the listed events occurs, are indicated in Table A-4/X.32.



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Note 1 - If an error in the ID and/or SIG is found before RAND is transmitted.

Note 2 - If an error in the ID and/or SIG is found after RAND is transmitted.

FIGURE A-4/X.32

Diagram of states for DCE acting as the challenged party for security grade 2 identification

TABLE A-4/X.32

Actions taken by the DCE as the challenged party (security grade 2)

<div>State of the DCE acting as the challenged party</div> <div>Protocol element received by the DCE or decision by the DCE</div>	c21 Initial challenged (grade 2)	c22 Waiting for RAND	c23 Calculating SRES	c24 Waiting for DIAG (grade 2)	c25 DCE Identification successful (grade 2)	c26 DCE Identification unsuccessful (grade 2) (see Note 1)
DCE decides it wants to be identified	ID [, SIG] → c22	////////////////////////////////////	////////////////////////////////////	////////////////////////////////////	////////////////////////////////////	////////////////////////////////////
RAND	DISCARD → c26	NORMAL → c23	DISCARD → c23	DISCARD → c24	DISCARD → c25	DISCARD → c26
DCE calculation of SRES from RAND is complete	////////////////////////////////////	////////////////////////////////////	SRES → c24	////////////////////////////////////	////////////////////////////////////	////////////////////////////////////
Positive DIAG	DISCARD → c26	NORMAL → c25 or c26 (see Note 2)	DISCARD → c26	NORMAL → c25	DISCARD → c25	DISCARD → c26
Negative DIAG	DISCARD → c26	NORMAL → c26	NORMAL → c26	NORMAL → c26	DISCARD → c25	DISCARD → c26

Note 1 - In this state, the DCE shall disconnect the switched access path.

Note 2 - c25 or c26 depending on whether or not the DCE wants to be identified.

ANNEX B

(to Recommendation X.32)

Abbreviations

ADM	Asynchronous disconnected mode
AVAIL-BAS	Available on all networks
AVAIL-NS	Available and selected by the network
AVAIL-OPT	Available on some networks
AVAIL-RQ	Available on some networks and must be requested
BA	Class of HDLC
CSPDN	Circuit switched public data network
CUSTOM	Customized
DCE	Data circuit-terminating equipment
DIAG	Diagnostic element
DISC	Disconnect
DM	Disconnected mode
DNIC	Data network identification code
DSE	Data switching equipment
DTE	Data terminal equipment
FI	Format identifier
HDLC	High-level data link control
HDTM	Half-duplex transmission module
ID	Identity element
ISDN	Integrated services digital network
ISO	International organization for standardization
k	Number of outstanding I frames
LAPB	Link access procedure B
LAPX	Link access procedure - Half-duplex
MT...	Parameter...

N...	Parameter...
ND	Network default
NN	National number
NTN	Network terminal number
NUI	Network user identification
PDN	Public data network
PSN	Public switched network
PSPDN	Packet switched public data network
PSTN	Public switched telephone network
RAND	Random number element
REJ	Reject
RPOA	Recognized private operating agency
RR	Receive ready
RSA	Rivest, Shamir, Adleman algorithm
SABM	Set asynchronous balanced mode
SABME	Set asynchronous balanced mode extended
SIG	Signature element
SRES	Signed response element
TCC	Telephone country code
T...	Timer...
UA	Unnumbered acknowledge
UTC	Coordinated universal time
XC...	Counter...
XID	Exchange identification (Unnumbered Format)
XT...	Timer...

APPENDIX I

(to Recommendation X.32)

Implementation of LAPX

I.1 Introduction

Considerations are given here for defining the signals needed between the HDTM and the LAPB and physical level modules in implementing LAPX.

I.2 Control and status functions

The following logical functions describe interactions between LAPB and the HDTM:

- control [TERM]
LAPB has entered the disconnected phase.
- control [CONCLUDE]
LAPB has finished transmitting one or more frames.
- status [OP-T]
Enable LAPB to send frames.
- status [INOP-T]
Inhibit LAPB from sending frames.

If the idle channel state condition detection mechanism of LAPB is not disabled, then the HDTM needs to protect LAPB from the use of idle channel state condition in turning around the line. This protection is done by having the HDTM present constant flags to LAPB except in the Half-duplex receiving state (state 3). It may be desirable to define additional logical functions in doing this.

The following logical functions describe interactions between the HDTM and the physical level:

- control [SEIZE]
The HDTM has stopped waiting for data to be received and is waiting to transmit data.
- control [RELEASE]
The HDTM has stopped sending data and is requesting the physical level to release the right to transmit.
- control [DISCON]
The HDTM is requesting the physical level to disconnect the physical connection because LAPB is disconnected.

- status [CALLING]

The physical connection originated by this DTE/DCE is established.

- status [CALLED]

The physical connection originated by the other DTE/DCE is established.

- status [UNCON]

There is no physical connection.

- status [XMT]

The physical connection is able to transmit data.

- status [REMOTE]

This is an optional function used if the physical level, instead of the HDTM, detects the indication that the remote DTE/DCE accepts the right to transmit (remote is in the Half-duplex sending state).

- status [LOCAL]

This is an optional function used if the physical level, instead of the HDTM, detects the request for change in the direction of transmission that gives the local DTE/DCE the right to transmit (remote is in the Wait for receiving state).

The forms of these interactions are not defined. However, an example of the HDTM physical level interactions is given in §§ 5.6.7 and 5.6.8.

I.3 Table of transitions between states

Table I-1/X.32 shows the events that cause a state transition and the resulting action(s). This provides a generalized description of operation of the HDTM.

TABLE I-1/X.32

Description of state transitions

Present state	Transition name		New state
	Event	Action	
0	Initialize calling DTE/DCE		4
Idle state	Calling DTE/DCE: data circuit established (e.g. data set ready, ready for data) (i.e. status [CALLING])	Do function control [SEIZE]	Wait for sending state
0	Initialize called DTE/DCE		2
Idle state	Called DTE/DCE: data circuit established (e.g. data set ready, ready for data) (i.e. status [CALLED])	Start timer XT1.	Wait for receiving state
1	Send right to transmit		2
Half-duplex sending state	Conclusion of transmission (i.e. control [CONCLUDE])	Send request that remote DTE/DCE enter the half-duplex sending state (see Note 1). Start timer XT1. Do function status [INOP-T] (see Note 2). Do function control [RELEASE].	Wait for receiving state
1	Disconnect sending DTE/DCE		0
Half-duplex sending state	LAPB has entered a disconnected phase (i.e. control [TERM], see Note 3)	Do function control [DISCON].	Idle state
2	Receive confirmation		3
Wait for receiving state	Reception of indication that the remote DTE/DCE has entered the half-duplex sending state (see Note 4) (i.e. status [REMOTE])	Stop timer XT1.	Half-duplex receiving state

2 Wait for receiving state	Seize right to transmit		4 Wait for sending state
	Expiry of timer XT1 or has frame to send (i.e. a LAPB/HDTM transmit data function) (see Note 5)	Do function control [SEIZE].	
3 Half-duplex receiving state	Receive right to transmit		4 Wait for sending state
	Reception of notification that the remote DTE/DCE is requesting a change in the direction of transmission (i.e. status [LOCAL]) (see Note 6)	Do function control [SEIZE].	
3 Half-duplex receiving state	Receive right to transmit		2 Wait for receiving state
	Reception of notification that the remote DTE/DCE is requesting a change in the direction of transmission (i.e. status [LOCAL]) (see Note 6)	Start timer XT1.	
3 Half-duplex receiving state	Disconnect receiving DTE/DCE		0 Idle state
	LAPB has entered a disconnected phase (i.e. control [TERM], see Note 3)	Do function control [DISCON].	
4 Wait for sending state	Send confirmation		1 Half-duplex sending state
	Indication of availability of the physical level for transmission (i.e. status [XMT])	Send indication to the remote DTE/DCE that the half-duplex sending state has been entered. Do function status [OP-T] (see Note 7)	
Any	Reset from any state		0 Idle state
	Physical level has no circuit to a remote DTE/DCE (i.e status [UNCON])	Do function status [INOP-T].	

Note 1 - HDTM uses the idle data link channel state indication (at least 15 continuous 1s) for requesting that the remote DTE enter the half-duplex sending state.

Note 2 - Status [INOP-T] indicates to LAPB that the sending of frames is inhibited.

Note 3 - Control [TERM] indicates that LAPB has entered the disconnected phase (equivalent to ADM of HDLC).

Note 4 - Reception of a flag or detection of carrier ON (circuit 109 = 1) is this indication.

Note 5 - One timer XT1 expiration must occur before a frame may be sent.

Note 6 - HDTM uses the idle data link channel state indication (at least 15 continuous 1s) or detection of carrier OFF (CIRCUIT 109 = 0) for detecting that the remote DTE is requesting a change in the direction of transmission.

Note 7 - Status [OP-T] indicates to LAPB that the sending of frames is enabled.

I.4 HDTM/physical level control and status functions expressed in terms applicable to a modem interface

Continuing the example of § 5.6.7, the HDTM/physical level logical functions may be described as shown below as they apply to the use of the HDTM with a V-series modem interface:

- control [SEIZE]

Request turning circuit 105 ON and, if necessary, releasing circuit 103 from binary 1 condition.

- control [RELEASE]

Request holding circuit 103 in the binary 1 condition and turning circuit 105 OFF.

- control [DISCON]

Request turning circuit 107 OFF and, if necessary, turning circuit 105 OFF.

- status [CALLING]

As the calling DTE/DCE, report circuit 107 ON.

- status [CALLED]

As the called DTE/DCE, report circuit 107 ON

- status [UNCON]

Report circuit 107 OFF.

- status [XMT]

Report circuit 106 ON.

- status [REMOTE]

Report carrier ON

- status [LOCAL]

Report carrier OFF.

APPENDIX II

(to Recommendation X.32)

RSA public key algorithm

The Rivest, Shamir, Adleman (RSA) algorithm defines a public key cryptography system. Each subscriber to an RSA cryptosystem generates a public modulo key (n), a public exponential key (e), and a secret exponential key (d) which conform to certain consistency rules to be subsequently described. The subscriber can publish and disclose its public keys (n, e) but it will never reveal its secret exponential key (d). The exchange of information via the RSA algorithm involves the successive transformations of encryption and decryption. The form of the encryption and decryption transformations are mathematically identical but differ only in the values of the exponential keys used. Each RSA transformation is of the form:

$$\underline{X'} = \underline{X}^k \text{ (modulo } \underline{n}\text{)}$$

where

X is the integer to be transformed

X' is the transformed integer

n is the public modulo key

k is the exponential key which is either the public exponential key e, or the secret exponential key d.

The RSA keys for a subscriber are generated subject to the following two constraints:

$$\underline{n} = \underline{p} \cdot \underline{q} \text{ (p and q are large prime numbers)}$$

$$(\underline{d} \cdot \underline{e}) \text{ modulo } [\underline{p}-1] \cdot [\underline{q}-1] = 1$$

The encryption operation can use either e or d as the exponential key. However, the decryption operation must use the exponential key (d or e) that was not used in the encryption process. Both processes must use the same modulo key, n.

As applied to the security grade 2 identification process described in § 7.1.2, the challenged party will generate SRES by encrypting RAND using its secret exponential key, d, so that the questioning party can decrypt SRES using the public keys of the challenged party (e and n).

APPENDIX III

(to Recommendation X.32)

Relationship of timer T14 to the different methods of DTE identification

Figure III-1/X.32 illustrates the points in the general sequence of events defined in this Recommendation at which timer T14 is started or stopped.

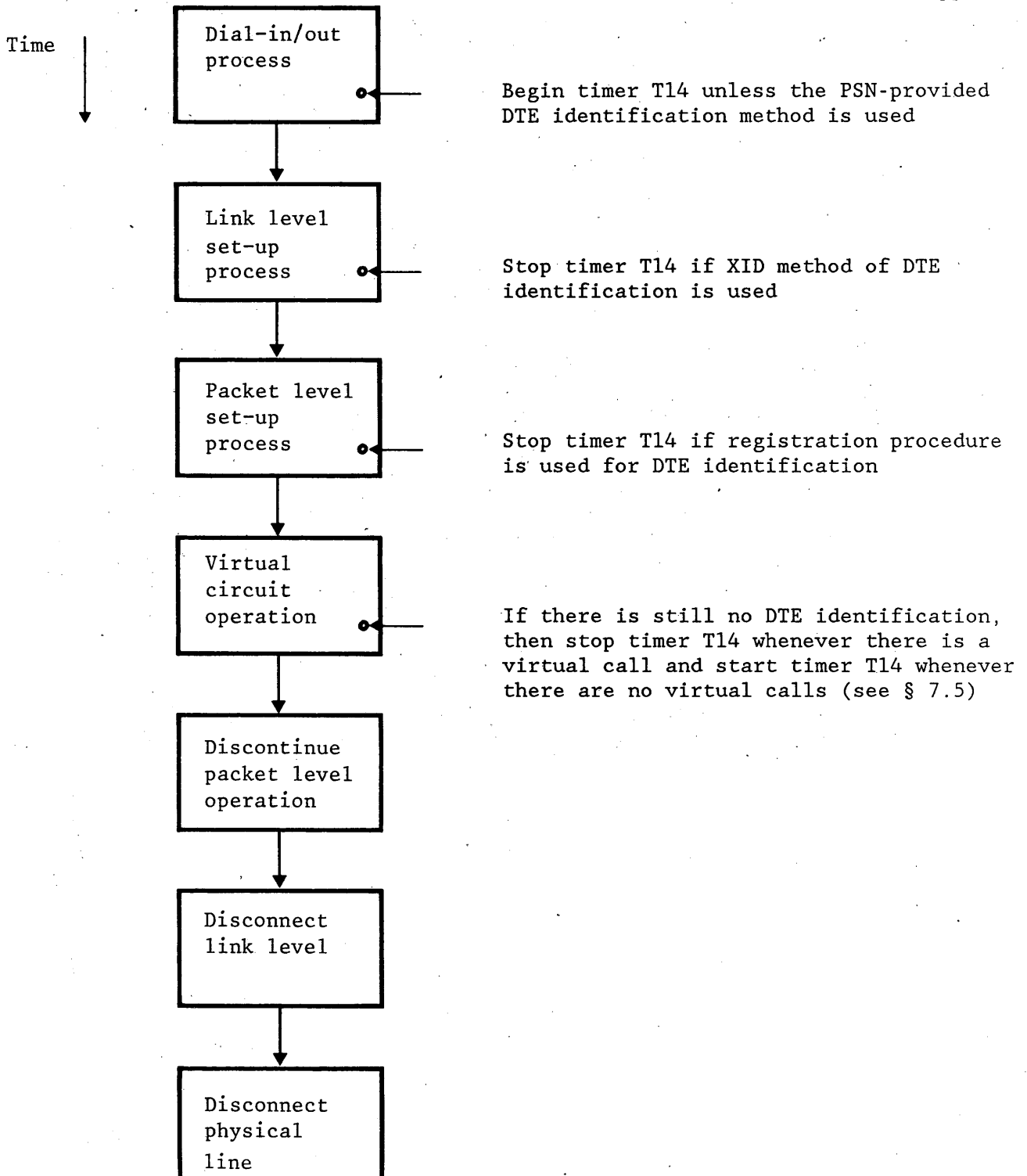


FIGURE III-1/X.32

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Relationship between timer T14 and DTE identification methods

APPENDIX IV

(to Recommendation X.32)

List of terms

The following terms are contained in this Recommendation. References to definitions, implicit or explicit, are included where appropriate and where available.

A

Authentication:

cont. in X.32, impl. def. in X.32

C

Challenged party:

cont. in X.32, impl. def. in X.32

Closed User Group:

cont. in X.32, impl. def. in X.25

Counter:

cont. in X.32, impl. def. in X.32

Customized DTE service:

cont. X.32, impl. def. in X.32

D

Data Network Identification Code:

cont. in X.32, impl. def. in X.121

Dial-in-by-the-DTE:

cont. in X.32, impl. def. in X.32

Dial-out-by-the-PSPDN:

cont. in X.32, impl. def. in X.32

DCE identity:

cont. in X.32, impl. def. in X.32

DTE identity:

cont. in X.32, impl. def. in X.32

DTE profile:

cont. in X.32, impl. def. in X.32

DTE service type:

cont. in X.32, impl. def. in X.32

E

Exchange Identification:

cont. in X.32, impl. def. in X.32

F

Failure detection:

cont. in X.32, impl. def. in X.21
impl. def. in X.21bis

H

Half-duplex transmission module:

cont. in X.32 impl. def. in X.32

High-level Data Link Control:

cont. in X.32, impl. def. in X.25

I

Identified DTE service:

cont. in X.32, impl. def. in X.32

Identification:

cont. in X.32, impl. def. in X.32

Interface characteristics:

cont. in X.32, impl. def. in X.32

International Numbering Plan:

cont. in X.32, impl. def. in X.121

L

Link access procedure:

cont. in X.32, impl. def. in X.32

Link level address assignment:

cont. in X.32, impl. def. in X.32

L

Local Charging Prevention:
cont. in X.32, impl. def. in X.25

Logical channel assignment:
cont. in X.32, impl. def. in X.25

M

Modem characteristics:
cont. in X.32, impl. def. in V-Rec

Modem selection:
cont. in X.32, impl. def. in X.32

Multilink:
cont. in X.32, impl. def. in X.75

N

Nonidentified DTE service:
cont. in X.32, impl. def. in X.32

NUI override permission:
cont. in X.32, impl. def. in X.32

O

On-line facility registration:
cont. in X.32, impl. def. in X.32

Optional user facility:
cont. in X.32, expl. def. in X.15

P

Permanent virtual circuit:
cont. in X.32, impl. def. in X.25

Q

Questioning party:
cont. in X.32, impl. def. in X.32

R

Registered PSN number:
cont. in X.32, impl. def. in X.32

Registration procedure:
cont. in X.32, impl. def. in X.25

RSA public key algorithm:
cont. in X.32, impl. def. in X.32

S

Secure dial-back:
cont. in X.32, impl. def. in X.32

Security grade:
cont. in X.32, impl. def. in X.32

T

Temporary location:
cont. in X.32, impl. def. in X.32

Test loops:
cont. in X.32, impl. def. in X.150
impl. def. in V.54

Timer:
cont. in X.32, impl. def. in X.32

U

User class of service:
cont. in X.32, expl. def. in X.15

V

Virtual call:
cont. in X.32, impl. def. in X.25

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