Odette

The OFTP X.25 Over ISDN Recommendation

ORGANISATION DE DONNEES ECHANGEES
PAR TELETRANSMISSION EN EUROPE

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BY TELETRANSMISSION IN EUROPE

This document describes the recommendation of ODETTE Group 4 (1) for the use of OFTP (2) over X.25 over ISDN.

This document offers an introductory overview of a technical subject. It is structured to contain the ODETTE recommendation, together with introductory information for the person not familiar with ISDN ans also notes on the issues associated with the implementation of the recommendation.

The first section provides the detailed ODETTE recommendation which is followed by a general discussion. If you are not familiar with the terminology, please read the subsequent sections first.

How far an existing X.25 Line adapter may be replaced by an ISDN line adapter in an installation depends on the opportunities in view of connections (X.25 or ISDN) of the involved partners for file transfer.

Companies, which keep many connections to external partners (for example car manufacturing companies), may use the OFTP file transfer in view of compatibility, which must always be considered, anyway only in parallel to the X.25 network.

It is not the aim of this recommendation, to remove the OFTP file transfer generally from the X.25 network to the ISDN network. This will not always be possible for international connections because of technical reasons, and this does not always make sense for connections with a low size of data to be transmitted.

Certainly the use of ISDN, when exchanging a high volume of data (for example CAD/CAM files), is very much cheaper than the use of an X.25 network. For such cases this recommendation shall provide a cost effective possibility for file transfer.

(1) ODETTE Group 4 is responsible for the specification of Telecommunications standards and recommendations for use within the Automotive Industry.

(2) OFTP (ODETTE File Transfer Protocol) is the communications standard specified by ODETTE Group 4 designed for the transfer of both EDI and non-EDI data.

ODETTE ISDN Recommendation:	Defines the ODETTE recommendation in these terms.
Introduction to ISDN:	Introduces the ISDN environment to the unfamiliar reader.
Equipment Types:	Describes the various methods of connecting to ISDN.
Implementation:	Implementation issues

X.25:

Level 2 Protocol	ISO 7776
Level 3 Protocol	ISO 8208
Packet Size	128
Level 2 Window Size	7
Level 3 Window Size	7
First LCN	1
Number of LCNs	1
Facilities	Window Size and Packet Size negotiation **shall** be supported by everybody. Call User Data should not be required.
Calling NUA	Optionally provided by the call initiator.
Called NUA	Should be set to a value where the last 'n' digits can be specified by the called party.

ISDN: Apart from requesting a 64K unrestricted digital call, no ISDN features shall be required.

Timeout control: To avoid connections (B-Channels) within the circuit switched ISDN network remaining active but unused for a long time, the adapter should include a timeout control.

An ISDN connection (B-channel) should be released if no X.25 packets have been transmitted on this connection for a longer time. For flexibility a variable user definable timer should be incorporated into the adapter.

In the event of a timeout situation the adapter has to release the ISDN connection and notify the local OFTP by the transmission of a clear packet.

The pages that follow are informational
and do not form part of this recommendation

Introduction to ISDN

The use of digital encoding techniques over such high quality, error free, backbone networks has allowed the PTT′s to offer high bandwiths to the end user. The service is named ISDN (Integrated Service Digital Network).

The increasing need to transfer larger volumes os EDI data, in particular CAD/CAM drawings, has focused attention upon high speed, low cost, communication. The traditional X.25 over a Packet Switched Data Network (PSDN) has been a good general purpose communications sub-system. Unfortunately its cost and transfer speed make PSDN expensive for the new requirement.

X.25 over the new ISDN (Integrated Digital Data Services) provides both, the transfer speed and cost benefits to satisfy the new requirements.

Terminology: For use to make sense of ISDN and X.25 it is important that we use definitions precisely and avoid the abuses of past.

ISDN: Integrated Services Digital Network

X.25: X.25 is a communications protocol. It defines the structure of data packets that comprise the protocol and the manner in which they are used.

PSDN: A PSDN (Packet Switching Data Network) is a network over which the X.25 protocol is operated.

PSPDN: A PSPDN (Packet Switching Public Data Network) are PSDNs operated by the PTTs. PSPDNs are given Trade Names, such as PSS in the UK, Datex-P in Germany and Transpac in France.

BRI: Basic Rate Interface, also known as Primary Rate Access, defines an ISDN facility with 2 x 64K B-Channels.

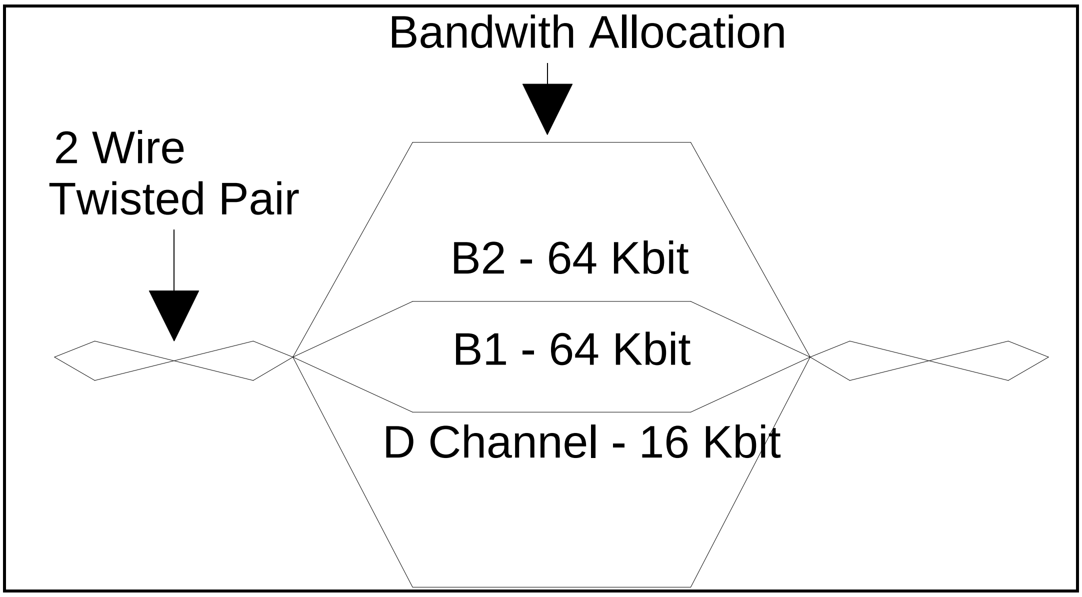
PRI: Primary Rate Interface, also known as Primary Rate Access, defines an ISDN facility with 30 x 64K B-Channels.

Channels: ISDN is typically brought into a consumer′s premises using a twisted pair of wire. Over this wire data can be transmitted in frequency bands. These frequency bands are allocated as channels.

B Channels: The B Channels are the data channels and operate at 64Kb. The two end users of a connection will communicate over a B Channel.

D Channel: Signaling an ISDN is performed over the D Channel. The signaling is used to setup and release connections of the B channels. In some countries the D channel can also be used for limited X.25 access to the PTTs PSDN.

The D channel operates at the lower speed of 16Kb as it is normally used only at the beginning and end of a connection.



The standard for the operation of the D channel is called ETSI and is used in most European countries. However some countries that started the introduction very early used proprietary standards e. g.

1TR6 Used in Germany
BTNR Used in UK

Although there are D channel variations, this will not affect communications over the B channels as the communication over the D channel is between the subscriber and the ISDN service provider.

However, the consumer′s equipment must be able to handle the channel D signaling operated by the ISDN service provider and so there may be a problem of equipment availability and certification.

All the PTTs have comitted to migrate to ETSI (3) and many are currently supporting both, their national variant and ETSI. It is advisable that in this situation the subscriber select the ETSI variant to avoid unnecessary equipment obsolescence.

Services: The high speed service is provided in two forms, Basic and Primary.

Basic: 2+D, the D 2B channel operates at 16 Kb. The Basic Rate access is normally provided to the subscriber over simple twisted pair cable.

Primary: 30B+D, the D channel operates at 64 Kb. Primary Rate access is normally provided to the subscriber over shielded coaxial cable. Note, that the bandwith for Primary is 2.048 Mbit/s.

Protocols: The B channel is a binary channel and is transparent to the flow of data. Therefore all of the currently available protocols can operate over a B channel. The most common protocols are:

X.25: The X.25 protocol is a primary protocol for open computer to computer communication.

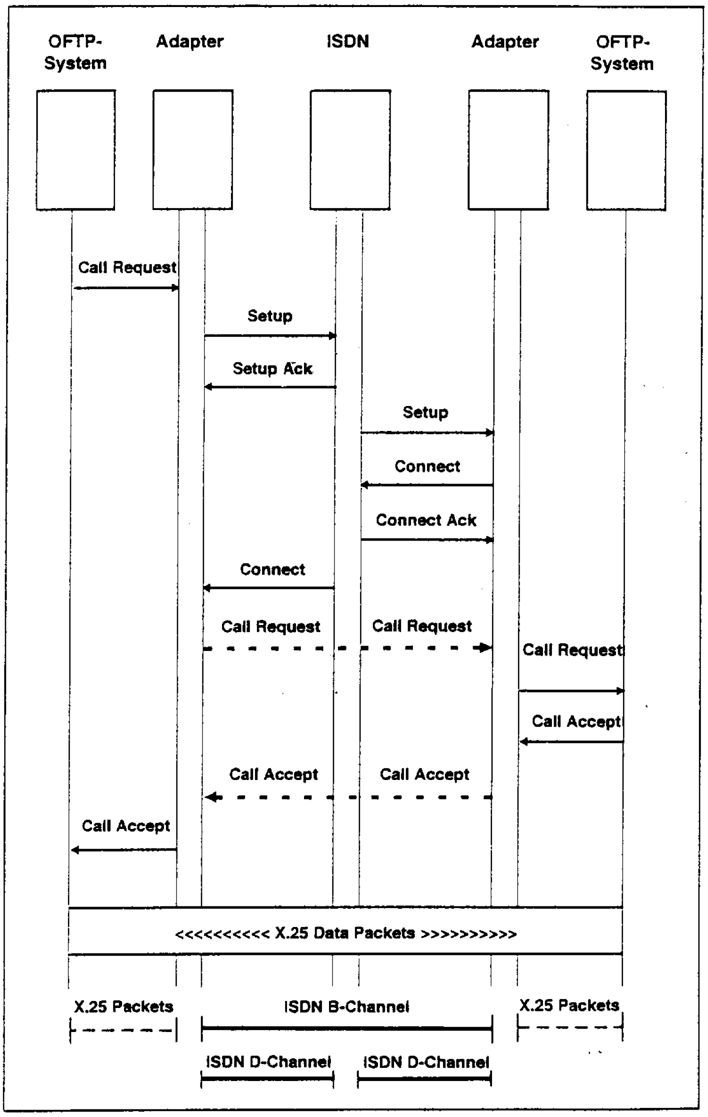
Passive Bus: It is possible to have an ISDN service enter a building and then have an 8 core cable layed within the building with multiple ISDN junction points, in the same way as one would have multiple telephone points (extensions) for a particular external telephone line.

(3) Also known as EURO-ISDN and as Q.931

Connection Setup:

The schematic below describes the call setup process when an X.25 call is made over ISDN.

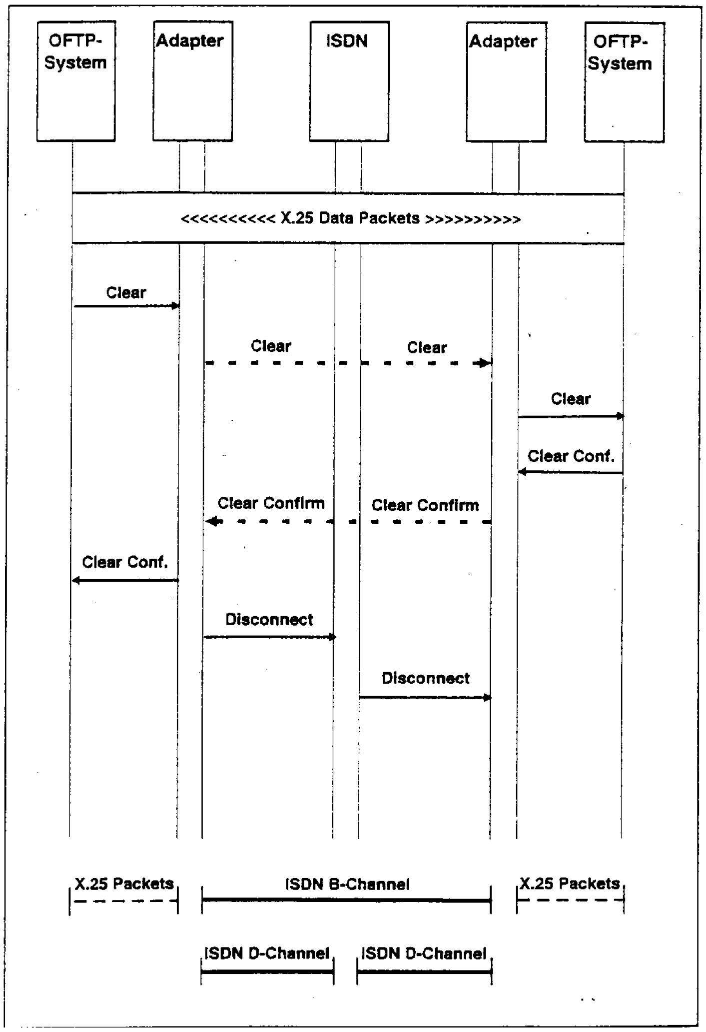
The adapter is responsible for analyzing the outgoing X.25 call request and making an ISDN call to a derived ISDN address, establishing a new X.25 level-2 and level-3; then propagating the X.25 Call Request Packet.



Connection Termination:

The termination phase of the X.25 call is made with a Clear Request and finalised with a Clear Confirmation. The recipient of the Clear Confirm should then closedown the ISDN connection.

The cleardown of the ISDN connection should only be made if there are no other SVC′s active on the ISDN connection; note that the usage of multiple simultaneous SVC′s is only by virtue of bi-lateral agreement.



Equipment Types

There are a number of ways in which ISDN/X.25 access can be made.

Integrated:

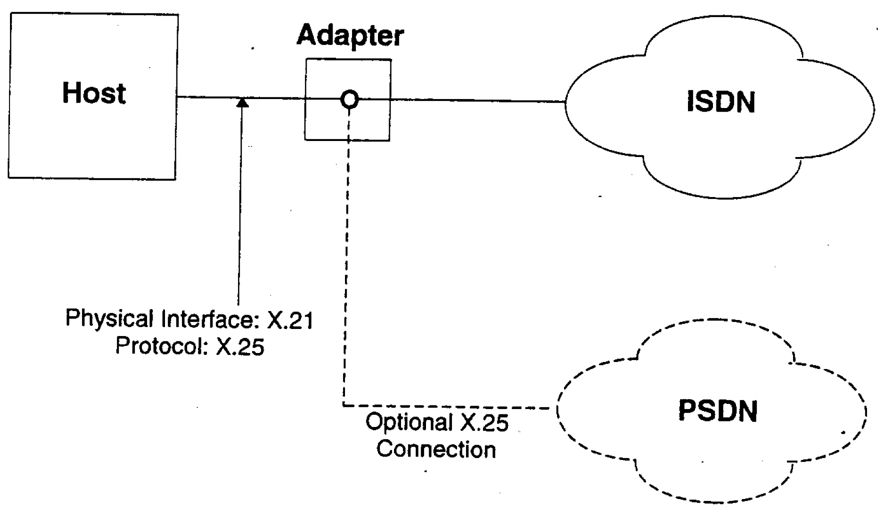
This is normally a PC based ISDN adapter inside a PC. It is normal in such an environment that the OFTP application has the ability to manipulate the ISDN and X.25 aspects of the session independently and therefore have complete control.

Equally important, is that the speed of communication between the adapter and the application are at PC BUS speeds. It is therefore more likely that the effective transmission speed will be nearer the 64K limit.

The other benefit of such a direct linkage, is that both 64K B channels may be used in parallel and both able to operate at 64Kb.

Elementary Terminal Adapter

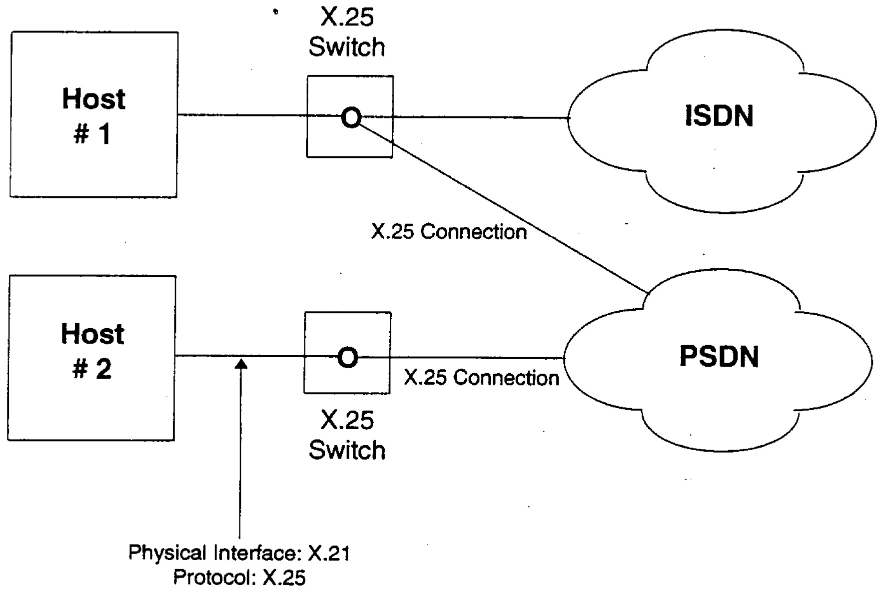
In this scenario, the computer has an integral X.25 adapter , communicating X.21 with a Terminal Adapter that fronts the ISDN network. This allows a host with a X.25 capability to interface to ISDN, normally on a one to one



The interface between the Terminal Adapter and the PC will typically only support one 64K B channel. This is obviously an inefficient usage of the ISDN service.

Because the linkage between the computer and the Terminal Adapter is only X.25, then some modification/configuration may be needed inside the Terminal Adapter when new users are added.

X.25 Switch: This solution is normally found inside the larger corporate where an internal X.25 network is operated or where dual X.25 and ISDN is required.



The main benefit of a switch is to support both PSDN and ISDN simultaneously. Also multiple X.21 lines may be implemented between the X.25 Switch and the computer.

This solution normally requires more effort to configure and may require obligations to be placed upon how incoming callers specify routing.

Implementation

Introduction:

The adoption of ISDN as an additional sub-system to support OFTP communications has associated implementation problems which can be categorized as below:

- > X.25/ISDN Addressing
- > Making a call
- > Receiving a call
- > Logical Channel assignment
- > Facilities Negotiation
- > ISDN call attributes
- > Homologation Issues
- > Performance
- > Growth

X.25/ISDN Addressing:

The original OFTP was orginally designed to work over the X.25 networks provided by the PTT′s (PSPDNs). The national X.25 networks were interconnected to provide a global X.25 network and a common addressing scheme was adopted by all. Although there were a few differences in addressing within a national network, the interface to other countries was quite rigid and normalized.

PSPDN Numbering:

The addressing scheme adopted in X.25 is a 15 digit number (Network User Address, NUA) where the first three identify the country, the fourth digit identifies the network within the country and the remainder specify the individual subscriber plus an option subaddress. In the UK whre a full X.25 numbering scheme is adopted, a NUA is e.g. 234221200170; where 2342 is the DNIC (Data Network Identification Code) and 21200170 is the subscriber number.

ISDN Numbering:

ISDN is an extension of the normal telephone system, consequently it adopts (or rather ***is***) the same numbering scheme as the telephone system (PSTN).

The Numbering Conflict:

The PSDN and PSTN numbering schemes are ***two totally different*** numbering schemes. There is no relationship between them. It is this conflict that is at the heart of the matter.

Making a Call:

It is as a consequence that the PSDN and PSTN are based upon different and unconnected numbering schemes that the key problem arises.

For X.25 to work over ISDN, three main methods of addressing are available:

Un-mapped: The X.25 called NUA is used as the PSTN number. Thus an X.25 call to 0733394023 will result in a PSTN call to 0733394023 and the call request that consequently flows will also be to 0733394023.

Manipulated: The X.25 called NUA is manipulated by the subtraction and/or addition of digits to derive a resultant PSTN number.

Thus 2394023 could be manipulated to derive a PSTN number of 00944733394023; where the prefix 2 is deleted and replaced by 00944733.

Mapped: The X.25 called NUA is used as a look-up into a table of PSTN numbers. Thus an X.25 call to 234221200170 could be mapped to and result in a PSTN call to 0733394023 and the call request that consequently flows will remain as 234221200170.

Un-mapped Calls:

Un-mapped calls are where the host specified X.25 NUA is converted directly to the corresponding ISDN number.

Thus an X.25 call issued by the host to X.25 NUA 0733394023 will result in an ISDN call to the PSTN number 0733394023. After the call has been established, then HDLC/X.25 protocol setup will be established after which an X.25 call request will be transferred with the NUA 0733394023.

When a PSTN call is made, the number of digits in the called number vary depending upon the location of the called party.

When a number is called, it may be local, national or international.

local: 394023

national: 0733 394023

international: 009 44 733 394023

Depending upon where a call originates, the corresponding X.25 NUA in the call request packet will vary dramatically.

Such variation of X.25 NUA, in particular the changing prefix, can be difficult to be accommodated by X.25 routing logic in many products.

When an international PSTN call is beeing made, then it is likely that the PSTN number exceeds 15 digits, which is the maximum length of an X.25 NUA. Therefore, using un-mapped addressing may make some international calls impossible to make.

Manipulated Calls:

The X.25 called NUA is manipulated by the subtraction and/or addition of digits to derive a resultant PSTN number.

Let as assume that by internal convention we have identified the prefix ‘2′ to indicate an international ISDN call. Thus an X.25 call request of 244733394023 could be manipulated to derive a PSTN number of 00944733394023; where the prefix ‘2′ is deleted and replaced by ‘009′ (the international prefix).

The X.25 call NUA would typically be left in it′s unmanipulated state. As individual internal conventions vary, the X.25 call NUA will vary, in the case above it would be 244733394023, but another installation might have the convention where a prefix of ‘56′ specifies the UK and so the NUA will be 56733394023 where the ‘56′ is deleted and replaced with ‘00944′ to derive the PSTN number.

Mapped Calls: The mapped method offers maximum flexibility in that:

The PSTN number can exceed 15 digits.

The X.25 NUA and PSTN number can be totally different.

The problem with mapped calls is administrative. IBM mainframes can′t handle X.25 over ISDN at all, let alone support mapping. For the mainframe solution to work an external X.25/ISDN router box is required and it is the responsibility of the external box to provide any mapping necessary.

This means that any changes or addition of OFTP partners over ISDN will require access to the Computer room or special configuration equipment to change the tables inside the external X.25/ISDN router box.

Receiving Calls:

We have seen from the previous section that the called X.25 NUA from an ISDN incoming call *may* vary considerably. If ISDN/X.25 is confined to a national boundary, then such variation will not be so great as most calls will have matching called X.25 NUA and PSTN numbers.

X.25 switches and X.25 adapters normally route/accept/reject calls based upon their X.25 called NUA. In particular, routing is made upon the X.25 called NUA sub-address.

To derive this subaddress there are 2 methods:

1) the last ‘n′ digits are analyzed.

2) the base X.25 NUA of the line is removed from the called NUA. E. g. if the called X.25 NUA is 23422120017010 and the PSDN subscriber NUA is 234221200170 then the subaddress derived from subtraction is 10.

Obviously, the second method will not work if the incoming NUA varies.

ISDN Features:

ISDN, like X.25, has a core set of features which are then enriched with options. In the original OFTP X.25 specification it was decided that the Q-bit and D-bit options were not commeon to all networks or applications, they were therefore positively excluded from the specification.

It is proposed that apart from the core ISDN features necessary to establish a call, no other features be used.

Subaddressing:

There are two forms of ISDN subaddressing, overdialled and specific.

The overdial method allows an ISDN number to be artificially extended. A typical case would be where a private exchange has been installed in a larger company. Assume that the base number is 394023 and the computer is on internal extension 1234, then by specifying an ISDN number of 3940231234, direct access may be made to the internal extension.

The problem with this method is that it extends to called number and may, especially for international access, exceed the ISDN numbering limits between countries.

The other method of sub-addressing is where a discret subaddress is placed in a specific field in the ISDN call setup.

The problem with this method, is that it requires the caller to place the sub-address in the ISDN call setup. Not all ISDN implementations will allow this insertion.

In conclusion, subaddressing of any kind should be avoided.

Logical Channel Assignment:

An X.25 dataline will have associated with it a number of logical channels.

The number of channels is a part of the greement between the PTT and the subscriber. The number of channels subscribed to is important; call failure and similar problems will result if the number of logical channels defined at the two remote ends are different.

If a DTE makes a call out, then the highest defined logical channel number will be selected, if the remote DCE does not have the same number of logical channels defined, then an invalid logical channel is being used from the perspective of the receipient DCE and the call will be rejected.

Facilities Negotiation:

In the PSPDN environment, it is possible to subscribe to negotiation of window size and packet size. Although this negotiation requested by the originator′s DTE may be propogated to the remote DTE at the discretion of the originator′s DCE, it is a local responsibility between the DTE and DCE pair.

In the ISDN scenario where it is a DTE-DTE type connection, the window size and packet size may be left at the default value and consequently the values may be omitted from the call request. If no values are specified then it is vital that both DTE′s have configured themselves to the recommended defaults.

The symptom of a window size mis-match is a hang situation without any informational error codes.

The symptoms of a packet size mis-match could work in some scenarios but would otherwise issue error codes indicating invalid packet sizes.

Window Size:

The CCITT X.25 window size has a default value of ‘2′, although subscribers may have other default window sizes, e.g. ‘7′, by virtue of agreement with the PTT.

Window size negotiation can be explicitly requested by specifying the requested window size in the Facilities fields in the Call Request packet.

Packet Size:

The CCITT X.25 packet size has a default value of ‘128′ octets, although subscribers may have other default values, e.g. ‘1024′, agreed with the PTT.

ISDN Call Setup:

The initial setup of an ISDN call is initiated with the transmission of a Q.931 SETUP command. Apart from requesting that a call be established, the SETUP command can optionally carry information about the calling party, the called party, routing information, the type of cicuit required (e.g. voice or data) and information about the protocols than are requested to be established.

Setup Parameters:

Bearer capability	Information transfer and access attributes
Called Party number	Destination′s network address
Called Party subaddress	Destination′s complete address
Calling Party number	Source′s network address
Low-layer compatibility	Layer 1-3 indication
High-layer compatibility	Layer 4-7 indication

Homologation:

Homologation procedures were adopted and vigorously enforced by the PTT′s with respect to the quality and conformance of communications equipment connected to the services provided by the PTT′s.

In particular, commercial X.25 products had to be tested and approved before they could be connected to the PTT′s PSPDN. The advantage of this to the subscriber was that there was very little chance of the approved equipment not working.

With ISDN, similar approval standards are still enforced. So the subscriber has the same configence in their ISDN equipment. Wrong I, the ISDN equipment it self is approved, but the X.25 protocol than operates on top of ISDN is now outside of the scope of approval services.

This means that quality of conformance to standards of X.25 over ISDN is subject to the variable quality procedures within the various ISDN equipment manufacturers.

Although it is likely that commercial reputation will place pressure upon the manufacturers with a programmatic bug to correct such errors, it still requires the subscribers that do not communicate well to put time and effort into finding the party with the error.

So far tests have shown a number of subtie errors, such as timing problems, that have taken many days to find, prove and fix.

Growth:

Primary Rate Access:

If a user decides to plan for growth from the beginning, then the Primary Rate Access (PRI) has apparent financial benefits. Such apparent savings are usually lost due to the increased cost of user hardware to support such an interface. The BRI for data usage is very common and cards/adapters are low in cost whereas the PRI cards/adapters are few and far between and consequently highly priced.

Basic Rate Access:

One way to grow with ISDN is to buy multiple BRI lines, increasing slowly in units of 2 x B channels. The PTT′s will be able to provide the same subscriber number for all the lines provided in a similar way to the traditional hunting group associated with PSTN type working.

Performance:

The obvious benefit of ISDN is speed; unfortunately the majority of computer systems in use today have a finite amount of computing power available. The attachment of multiple active high speed communication lines used in file transfer mode could take a significant amount of CPU resource to the detriment of other users on the system.

Connection an ISDN line with the default 2 B channels to your computer using an X.21 interface is going to give a consistent 64Kb throughput **only if one** of the B channels is active at any one time.

If there are two 64Kb channels active and contenting for a single 64Kb X.21 interface then effective throughput will be reduced significantly to just over 50 %.

Mainframe issues:

Users with a mainframe front-end are also going to find cost an issue. The scanners that scan the communications interfaces are based upon aggregate throughput. A 64Kb interface takes up a lot of cycles.

Determining 'DTE' or 'DCE' characteristics

The following section is an extract from the ISO/IEC 8208 (International Standards Organization, International Electrotechnical Commission) (1990-03-15) standard which is an ISO extension of the CCITT X.25 standard.

The restart procedure can be used to determine whether the DTE acts as a DCE or maintains its role as a DTE with respect to the logical channel selection during Virtual Call establishment and resolution of Virtual Call collision.

When prepared to initialize the Packet Layer, the DTE shall initiate the restart procedure (i.e. transmit a RESTART REQUEST packet). The determination is based on the response received from the DXE as outlined below.

a) If the DTE receives a RESTART INDICATION packet with a restarting cause code that is not ‘DTE Originated′ (i.e., it came from a DCE), then the DTE shall maintain its role as a DTE.

b) If the DTE receives a RESTART INDICATION packet with a restarting cause code of ‘DTE Originated′ (i.e., it came from another DTE) then the DTE shall confirm the restart an act as a DCE.

c) If the DTE receives a RESTART INDICATION packet with a restarting cause code of ‘DTE Originated′ (i.e., it came from another DTE) and it does not have an unconfirmed RESTART REQUEST packet outstanding (i.e., a restart collision), then the DTE shall consider this restart procedure completed but shall take no further action except to transmit another RESTART REQUEST packet after some randomly chosen time delay.

d) If the DTE issues a RESTART REQUEST packet that is subsequently confirmed with a RESTART CONFIRMATION packet, then the DTE shall maintain its role as a DTE.