A NEW ISDN PACKET HANDLER INTERFACE

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ABSTRACT

Public packet switching services are widely available today. These services are offered on Packet Switch Public Data Networks (PSPDNs) and are based on Recommendation X.25, the mature standards developed by the International Telegraph and Telephone Consultative Commitee (CCITT).

The access procedures for supporting X.25 packet services on Integrated Services Digital Network (ISDN) are specified in CCITT Recommendation X.31. This paper describes the attributes of a Packet Handler Interface (PHI). The PHI links the ISDN exchange with a Packet Handler (PH) function that resides on the PSPDN which supports X.31 packet services for ISDN users.

1. INTRODUCTION

Today, almost every network operator is involved with ISDN. Within the next five years ISDN will be commercially available in most countries. European countries, for example, have already signed a Memorandum of Understanding committing them to deploy ISDN services beginning in 1992.

Several benefits offered by ISDN make it attractive. In particular ISDN consolidates telecommunications access for multiple services. This is especially true for ISDN packet services where numerous packet terminals can connect to a single ISDN access line. This configuration makes it possible to provide economical packet services. As a result, packet terminals on ISDN may become commonplace.

Many network operators that plan to deploy ISDN packet services have already established Packet Switch Public Data Networks (PSPDNs) offering mature X.25 packet services nationwide. In Switzerland, for example, the Swiss PTT has been offering its commercial packet service "Telepac" since 1983 and "Swissnet", the Swiss PTT's ISDN network, has intentions of deploying ISDN packet services beginning in 1992. The Swiss PTT has also recognised the significant benefits of extending existing X.25 capability on the PSPDN to ISDN users.

These benefits are twofold. Firstly, they allow operating companies to provide consistent nationwide packet services regardless of whether ISDN or traditional access methods are used. Secondly, they translate into the economic advantages of using existing common equipment and service personnel to support both ISDN and PSPDN packet services. The challenge, however, is to find an efficient mechanism for coupling the two networks.

This paper discusses the attributes of using Packet Handler Interface (PHI) that connects a Packet Handler (PH) on the PSPDN to an ISDN exchange. The interface is based largely on existing ISDN standards, so that it can be used in a multi-vendor environment. Thus, the ISDN service provider has the flexibility of using products from different manufacturers, choosing those best suited to meet varying requirements.

2. REFERENCE CONFIGURATION

X.31 defines two types of services, Case A and Case B. In Case A, an ISDN user can have packet services on the B channel by accessing an ISDN port on the PSPDN. In Case B, an ISDN user can deploy packet services on the B or Dchannel.

Figure 1 shows the PHI reference configuration based on X.31. Two distinct functions are identified, the CRF (Connection Related Function) and the PH. The Packet Handler Interface is between the ISDN exchange and the PH and is defined to support both X.31 Case A and Case B services. For Case A the PH assumes the role of the Access Unit (AU) while for Case B the PH supports both B and D channel packet mode bearer services and interconnects with the PSPDN via X.75 or a proprietary protocol in accordance with X.31.

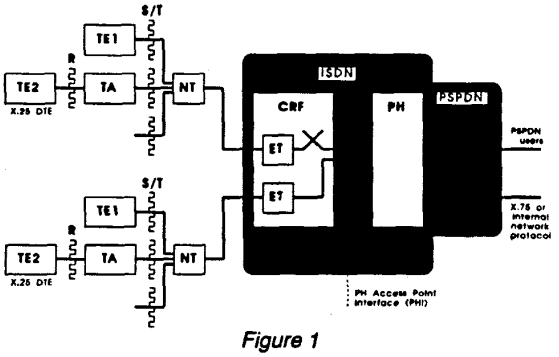

Figure 1

3. X.31 PACKET SERVICES

The Packet Handler Interface can support the following X.31 services and service options (the layer 3 service in all cases is based on CCITT Recommendation X.25 Packet Layer Protocol):

3.1 Semipermanent B channel Service

This service applies to both Case A and Case B services. The subscriber is registered with the PH and, thus, can be given a customised service profile. The B channel facility between the packet terminal and the PH is provisioned at subscription time.

3.2 Semipermanent D channel Service

For this service the subscriber is registered with the PH and can have a customised service profile. There is a semipermanent logical connection (at layer 2) between the packet terminal and the PH which is established at subscription time.

3.3 On Demand B Case A Service

For this service, a switced B channel connection is established in either the incoming or outgoing directions on a demand basis. The subscriber need not be registered with the PH and will then obtain a default service profile.

Q.931 signalling is used to indicate switched B channel circuit mode bearer service, and the port address on the PH needs to be specified when establishing a B channel in the outgoing direction.

3.4 On Demand B Case B service

This is identical to the on-demand B Case A offering except that the bearer service is packet mode and there is no need to specify the port address of the PH in the call setup message.

3.5 On Demand D channel Service

In this case, the subscriber need not be registered with the PH and will then obtain a default service profile. The layer 2 association between the D channel packet terminal and the PH is dynamically established as required. The link will be automatically removed by the terminal or by the PH after the last X.25 virtual circuit is cleared.

3.6 Incoming Call Offering

These service options apply to incoming calls that have to be delivered to the packet terminals.

The *No Notification* class applies to semipermanent B and D channel services. It could also apply to user-initiated on-demand B connections. Incoming X.25 calls are always delivered on the established connection.

The *Conditional Notification* class applies to the on-demand B and D channel services. The incoming call will first be delivered on an established connection, if one exists already. However, if it does not exist, the user is notified of the incoming call via Q.931 signalling. In this case, only the called address and, if present, the called address extension in the X.25 packet needs to be mapped into the Q.931 message. The network may offer this as a D channel only, B channel only, or B/D channel call depending on subscriptionoptions. In the last case, the user has the choice of indicating the desired channel; however, the European Memorandum of Understanding does not include this option.

The *Unconditional Notification* class requires the network to notify the user of every incoming call and the user selects the desired channel on each occasion. In general, all X.25 facilities that have a corresponding Q.931 information elements have to be mapped into the Q.931 setup message. Further study is required for such a need on the PHI.

Note that users may have a combination of services, e.g., semipermanent D with on-demand B or D.

4. BASIC INTERFACE STRUCTURE

The PHI is based on the ISDN Primary Rate Access (PRA, Recommendation I.431). The channel structure is "nB+D", where n is 30 for one PRA or larger for multiple PRAs. The D channel is reserved for signalling between the PH and the ISDN exchange. The B channels can be configured to be either Bb or Bd channels as described below (c.f. figure 2).

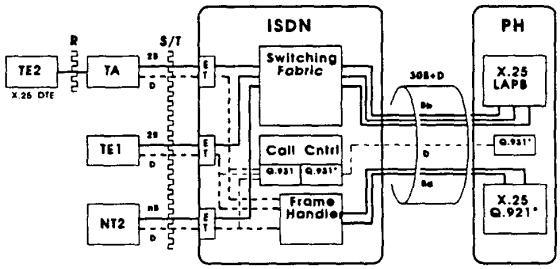

Figure 2

4.1 D Channel

The D channel structure is identical to that of standard PRA, and is used for the signalling of on-demand services. The signalling is based on Q.931 where the PH assumes the "user" side. However, only a subset of the Q.931 procedures is needed to support X.31 services, and some minor changes are needed to existing Information Elements. This is indicated as Q.931* in the diagram in figure 3 to distinguish it from standard Q.931. These enhancements can be accommodated within Q.931 using either the "User-User" information element or the code set escape mechanism (c.f. figure 3).

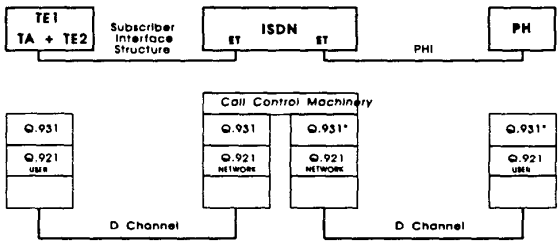

Figure 3

4.2 Bb Channel

Bb channels are used to support X.31 packet services on the B channel (Case A and Case B). This is a transparent circuit connection between the packet terminal and the PH. The Bb channel is provisioned at subscription time for semipermanent services and dynamically established for on-demand services. Standard LAPB and X.25 packet layer procedures (PLP) are used at layers 2 and 3 respectively (c.f. figure 4).

4.3 Bd Channel

Bd channels are used to support D channel packet services (Case B). Data packets from several D channel terminals on one or more ISDN subscriber lines are statistically multiplexed onto the Bd channel. This multiplexing function which is done at the layer 2 level is performed by the Frame Handler within the ISDN exchange. The implementation of this Frame Handler can be either according to a *frame switching* or a *frame relaying* prin-

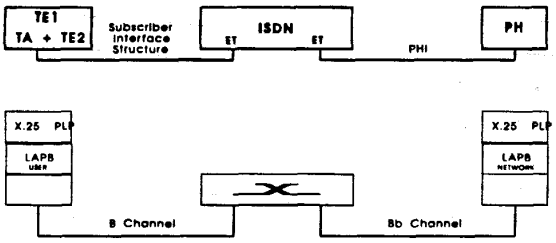

Figure 4

ciples. There is a unique association between a layer 2 data link on a D channel packet terminal and a data link (on a Bd channel) that is terminated on the PH. The layer 2 protocol procedures are in accordance with Recommendation Q.921 (c.f. figure 5).

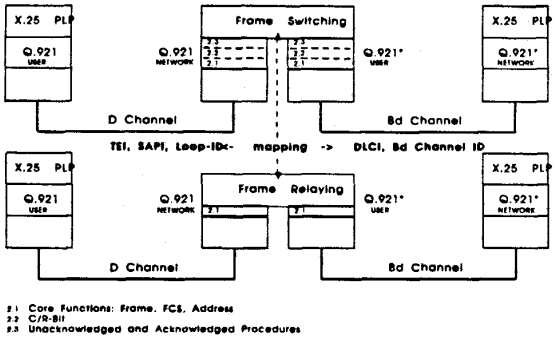

Figure 5

Packet terminals on the D channel have their layer 2 Q.921 links identified by SAPI and TEI (with SAPI = 16). Since terminals on different ISDN lines may have the same SAPI-TEI value pair, there is a need to uniquely identify them on the Bd channel. This is achieved by using a Data Link Connection Identifier (DLCI). The DLCI is an extension of the existing address field of Q.921 to four octets. The first octet takes on the value of SAPI=16 while the remaining 3 octets can be used to uniquely identify layer 2 packet data connections.

The DLCI is pre-assigned for semipermanent services and dynamically assigned for on-demand D channel services.

In summary, the basic interface structure of the PHI is based largely on the ISDN PRA interface where the PH takes on the role of the user. The key functional difference is that the PHI supports a new channel structure tosupport multiplexed D channel packet data. Some additional signalling is necessary to facilitate ease of management, e.g., the dyanamic allocation of DLCIs between the ISDN exchange and the PH for on-demand D channel services.

5. PHI SIGNALLING

Without going in too many details, figures 6 and 7 show signalling diagrams indicating possible procedures for some X.31 service options.

Figure 6 shows the signalling associated with an outgoing call for an on-demand B channel service. Three stages in the call setup can be observed:

① Establishment at layer 1.
A B channel connection between the subscriber and the PH is established by deploying regular ISDN signalling mechanisms.

② Establishment of the data link at layer 2.
Regular LAPB procedures as defined in recommendation X.25 are deployed.

③ Establishment of the virtual circuit at layer 3.
The packet layer procedures as defined in recommendation X.25 are deployed.

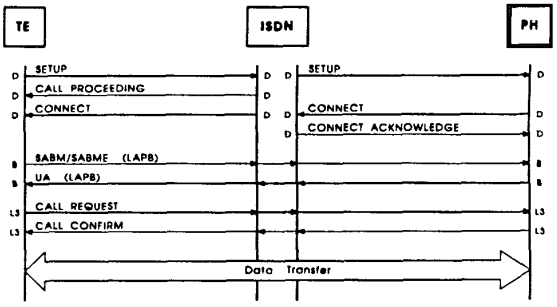

Figure 6

In contrast to the above, figure 7 shows the signalling associated with an outgoing call for an on-demand D channel service. At the subscriber interface, only two stages in the call setup can be observed as each subscriber disposes of a potential direct connection between its D channel and the PH whenever SAPI value 16 is used:

① Establishment of the data link at layer 2.
LAPD procedures as defined in recommendation Q.921 are deployed.

② Establishment of the virtual circuit at layer 3.
The packet layer procedures as defined in recommendation X.25 are deployed.

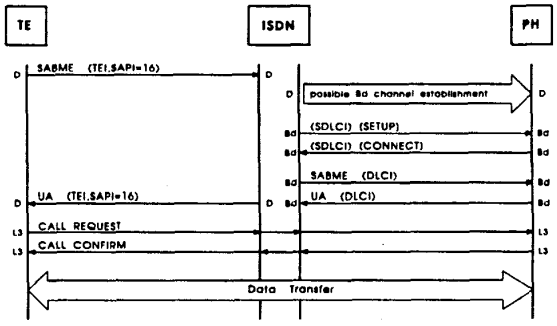

Figure 7

At the PHI, up to four stages can be observed. This is due to the fact that it would be disadvantageous to allocate Bd channels permanently; their capacity would have to be engineered for the peak traffic. It is forseen that Bd channels are allocated dynamically depending on the current demand for data link data transfer necessity:

① Establishment at layer 1.
If no Bd channel between the ISDN exchange and the PH exists, the ISDN establishes such a Bd channel using standard common channel signalling procedures within the network and common ISDN signalling across the PHI.

② Negotiation of a DLCI value for a new data link.
A DLCI value is negotiated between the ISDN and the PH using a simplified version of the ISDN signalling on a special "signalling data link" in the Bd channel. This signalling data link has a preassigned DLCI value (with SAPI = 0) and is indicated by "SDLCI" in figure 7.

③ Establishment of the data link at layer 2.
LAPD procedures with an extended address field (4 octets), containing the negotiated DLCI value, as defined in recommendation Q.921 are deployed.

④ Establishment of the virtual circuit at layer 3.
The packet layer procedures as defined in recommendation X.25 are deployed. However, the ISDN is no longer involved in the setup of this connection as it passes any information form the subscribers portion of the data link to the data link on the Bd channel and vice versa.

6. DEPLOYMENT ALTERNATIVES

There are several deployment options for the PHI:

① The PH could be part of the PSPDN and support multiple ISDN exchanges via multiple PHIs.

② Multiple PHs supporting multiple ISDN exchanges could form a subnetwork which could connect to the PSPDN via X.75.

③ The PH could support both local and remote ISDN exchanges via the same PHI.

④ The remote ISDN exchanges could be supported via colocated PH concentrators which connect to the mother PH via normal packet trunks.

7. NUMBERING AND INTERWORKING

The numbering plan for X.31 packet terminals will be based on E.164.Interworking with X.121 packet terminals will be in accordance with X.122, E.166, and E.165. The digit "0" is used to escape from one numbering plan to the other.

Note that in the case of semipermanent or Case A services the X.121 numbering plan may be used.

8. STANDARDIZATION

The European Telecommunications Standards Institute (ETSI) has recently developed a standard for such a PHI. As the representatives from many countries (from ISDN operators and from industry) have realized the importance of such an interface for the timely provisioning of packet services in the ISDN, the standardization effort took not much more than one year. That a consensus could be found in such a short time frame and despite the many options and possibilities how such a PHI can be implemented is mainly due to the faith of all delegates that the effort will be successful and the unwavering effort put forward by every delegate to reach the common goal.

9. SUMMARY

Many of the network operators who are planning to deploy ISDN packet services already have established Packet Switch Public Data Networks (PSPDNs) offering mature X.25 packet services nationwide. This situation exists in Switzerland where the Swiss PTT has been offering its commercial packet service "Telepac" since 1983 and expects to deploy ISDN packet services on "Swissnet" beginning in 1992. The Swiss administration has also recognised the significant benefits of extending existing X.25 capability on the PSPDN to ISDN users.

The Packet Handler Interface (PHI) makes this extension possible. It allows ISDN users to have packet services that are consistent with those available on PSPDNs. This means that both networks can coexist smoothly to the benefit of both the end user and the network provider. Existing PSPDN equipment and service personnel may be used to support packet services in ISDN resulting in significant cost reduction in deploying ISDN.

The PHI prevents fragmentation of packet switched services into island ISDN nodes each with its own packet handler that is interconnected via X.75 connections to the PSPDN. This breakup would result in a discontinuity in network wide features (such as call redirection and hunt group), performance (such as throughput and reliability) and network administration (such as the provisioning of permanent virtual circuits and closed user groups).

This paper discussed the attributes of the PHI which links an ISDN exchange to the PSPDN and, thus, extends the benefits common in a single PSPDN to ISDN packet service users.