5. Additional Hints for Implementation

5.1 Selected Topics in ISDN

5.1.1 Call Types and Bearer Capabilities

Bearer capabilities provide the means to convey information (speech, data, video, etc.) between users. Standards and Bellcore requirements documents identify call types associated with these bearer capabilities. In the catalog, abbreviated terms are used to indicate these call types. The following table illustrates the relationship between the terms used in the catalog for call types and identifies the associated bearer capabilities supported in National ISDN.

Catalog Term	Call Type	Bearer Capabilities
Voice	Voice & Voiceband Information	- Speech - Circuit-Mode 3.1-kHz Audio
Circuit-Data	Circuit Mode Data	- Circuit-Mode Unrestricted Digital Information (64 kbps) - Circuit-Mode Unrestricted Digital Information-Rate Adapted from 56 kbps to 64 kbps
Packet-Data	Packet Mode Data	- Packet-Mode Unrestricted Digital Information

5.1.2 Terminal Endpoint Identifiers (TEI s)

The Terminal Endpoint Identifier (TEI) is used along with the Service Access Point Identifier (SAPI) to identify a particular data link on an ISDN interface. While the SAPI specifies the functional part of the switch which the link is connected to, the TEI identifies the terminal.. In NI-1, Voice and Circuit-Data terminals may use a fixed TEI which is programmed into the terminal by the user, or they may request that the switch dynamically assign a TEI for Layer 2 signaling . In addition, D channel Packet-Data terminals are required to support Fixed TEIs. B channel packet terminals are not required to support dynamic or fixed TEIs under NI-1, but will need to support dynamic TEIs to support on-demand B channel packet calls as part of NI-2.

5.1.3 Service Profile Identifiers (SPIDs)

The Service Profile Identifier (SPID) is a string of from 3 to 20 numeric digits coded in ASCII which is assigned to the subscriber by the service provider. The user must program the SPID into the terminal. This allows the terminal to send it to the switch when the terminal initializes. When the switch receives the SPID, it knows that the terminal is connected and it processes calls to and from the terminal according to the parameters and features assigned for that terminal in the Terminal Service Profile (TSP) kept by the switch.

For BRI devices: Each Voice or Circuit-Data SPID value in each device must be accompanied by a distinct TEI value; that TEI value must be different from the TEI used by that device for D Channel Packet-Data calls.

For PRI devices: Each device should support a single TEI value of "0" for all D Channel signaling. This single TEI value should be used for all Voice, Circuit-Data, and Multirate Circuit-Data calls.

5.1.4 Rate Adaptation: V.110/ V.120

Some data devices, such as terminal adapters may require data terminal rate adaptation to connect data streams at rates lower than 64 kbps to the ISDN B channel(s). Rate adaptation is generally considered a user option and thus, usually takes place outside the network, and is carried transparently by the network. Rate adaptation (or rate adaption, as known within ITU-TSS (formerly CCITT) recommendations) means that some bits must be added to any lower rate stream to fill the B-channel slot in the ISDN transfer frame. Two CCITT rate adaptation techniques are available: V.110 bit repetition and positioning and V.120 statistical multiplexing of data streams in circuit-switched mode.

V.110 was originally specified to carry lower synchronous data rates (2400 and 9600 bps) over 56 kbps pre-ISDN channels. Asynchronous data support was added to V.110 in the 1988 CCITT Blue Books. Thus, the input from a terminal can be asynchronous, up to 19.2 kbps baud rate, or synchronous at 48, 56, or 64 kbps. Using V.110, multiple intermediate rate channels can be multiplexed together, or a single lower rate bit stream can be padded up to the 64-kbps ISDN B channel.

While V.110 supports multiple channel subrate multiplexing , this capability is not commonly available in a stand-alone terminal adapter, which is usually designed to connect directly to a single terminal. V.110 rate adaptation uses an 80-bit block structure which requires specialized hardware for implementation. Also, V.110 does not provide any error correction capabilities, which may be acceptable when the terminal adapter is used over low bit error rate ISDN lines.

Recommendation V.120 is a frame-oriented protocol which is based on LAPD. LAPD's inherent capability of aggregating logical channels using statistical multiplexing for V.120 rate adaptation may be used on ISDN B channels. V.120 has been adopted by the CCITT as an alternative to V.110.

Recommendation V.120 defines methods of mapping both synchronous and asynchronous data into LAPD frames to be sent over the ISDN B channels. Also, more than one low-speed data stream can be statistically multiplexed into a 64-kbps bit stream for transparent transmission over ISDN channels. Since ISDN terminals and terminal adapters already have Q.921 implemented, V.120 may not require any specialized software or hardware. Recommendation V.120, however, has many terminal compatibility features and thus, would require a standardized packaging of features to gain support from the terminal adapter vendors.

In terms of their relative merits, V.110 is considered more straightforward for synchronous communications whereas, V.120 provides a more natural fit for asynchronous terminal-to-host communications. Increased flexibility is achievable when end systems support all three V.120 modes: Asynchronous, Synchronous, and Bit Transparent. See Section 5.1.5 for Low Layer Compatibility-Information Element values.

5.1.5 Lower Layer Compatibility and Higher Layer Compatibility Information Elements

The Lower Layer Compatibility (LLC) and Higher Layer Compatibility (HLC) Information Elements may be used to enhance compatibility between end systems. Details on the coding of these information elements may be found in Sections 5.3.1 and 5.3.2 of SR-NWT-001953, *Generic Guidelines for ISDN Terminal Equipment on Basic Access Interfaces.* The LLC and HLC information elements, when available in a SETUP message, are forwarded to the called user in cases where the call is end-to-end ISDN. LLC and HLC are not delivered in instances where the call is not end-to-end ISDN and interworking occurs (e.g., the called user is non-ISDN, or in the case of an interswitch call for which Signaling System 7 is not available).

5.1.5.1 Videoconferencing

Typical LLC and HLC values for videoconferencing are:

Low Layer: CCITT H.221, H.230, & H.242

High Layer: Audio Visual (CCITT F.721)

5.1.5.2 Rate Adaptation - V.120

Using V.120 for the call rate of 56 kbps, the recommended Bearer Capability (BC) and Low Layer Compatibility (LLC) values for data rates less than 56 kbps are:

BC Layer 1 Protocol = CCITT V.110
LLC Layer 1 Protocol = CCITT V.120

5.1.5.3 Fax Applications

Typical LLC and HLC values which may be used for this application are:

For G3 FAX:
- Low Layer: Layer 1: CCITT G.711 µ-Law
- High Layer: Facsimile Group 2/3 (CCITT F.182)

For G3c FAX:
- Low Layer:
  - Layer 2: ISO / IEC 7776 DTE-DTE
  - Layer 3: ISO / IEC 8208 (X.25 PLP)
- High Layer: Facsimile Group 2/3 (CCITT F.182)

For G4 FAX:
- Low Layer:
  - Layer 2: ISO / IEC 7776 DTE-DTE
  - Layer 3: ISO / IEC 8208 (X.25 PLP)
- High Layer: Facsimile Group 4 (CCITT F.184)

5.1.6 Benefits of Out of Band Signaling

The common channel signaling network, otherwise known as Signaling System 7 (SS7), resides on separate switching processors to provide highly reliable fault tolerant signaling links whose protocols include built-in error detection and correction, facility rerouting, traffic congestion management, security and network management services. In ISDN, SS7 interworks with the D channel protocol (Q.931) to provide call control procedures that support interswitch and internetwork connections, and end-to-end supplementary services (e.g. Calling Number Identification Services).

The D channel and SS7 offer numerous advantages over the traditional in-band signaling of the POTS/PSTN. For example, the separate routing of the SS7 call control traffic reduces each calls setup and release time by 50 to 95%. Another benefit that is seen directly by the end user is increased bandwidth for circuit-data calling. Because interoffice trunks which use SS7 signaling have separate facilities for signaling and user data, the user data may make full use of the trunks by sending at 64 kbps. Those trunks which use inband signaling (pre-SS7) rob the eighth bit of every octet for signaling. This means the end user can only use 7/8 X 64 kbps or 56 kbps. Another advantage is gained by users with multiple network services provided over a PRI. The Call-by-Call Service Selection capability for multiple voice services such as 800, IN-WATS, FX, etc., can reduce trunking needs in the approximate range of 15 to 45%. Another advantage of using message-oriented out-of-band signaling on the D channel and SS7 is that it enables new and more sophisticated services. This type of signaling expands the capacity to signal information between users and the network , within a network, between a network and an external service provider, and between users on an end-to-end basis. The expanded capacity increases the intelligence of the network and it provides the underpinnings needed to support more sophisticated services (e.g., the intelligent network).

5.1.7 Multiline Hunt Group

Multiline Hunt Group (MLHG) is a network service which may be used to distribute incoming voice, circuit-data, and packet-data calls to respective devices on the same interface, or to similar devices with the same DN. Usually, the subscriber advertises a public Hunt Directory Number (DN), which receives incoming calls. The MLHG uses a hunt algorithm to distribute the calls to hunt terminals. The terminals may also have non-hunt DNs so that they may be called directly. In addition, MLHG provides features to manage the hunt group such as Stop Hunt and Make Busy.

5.1.8 Powering and Wiring of Customer Equipment

One critical, often overlooked element of ISDN deployment is that of wiring and powering for the end user equipment. Sections 5.1.8.1 through 5.1.8.5 provide some insight regarding powering arrangements. Section 5.1.8.6 provides some information regarding current wiring, powering and extension phone efforts.

5.1.8.1 Powering Methods

ANSI Standards T1.601 and T1.605 define the generic specifications for the power supplies and provide a number of options for power feeding at the S/T and U reference points. The following discussion provides an overview of possible powering configurations for BRIs consistent with ANSI standards. The conclusion points out the challenge for providing the powering of voice communications integrated within a personal computer.

The following terms are used within the ANSI standards to describe the various powering methods and provide a common terminology by which the powering requirements for ISDN terminals can be described.

Primary Power - This is the basic -48 VDC required to power both the NT1 and the Terminal Equipment. In the event of electric utility power failure, Primary Power will no longer be available and service will be interrupted if secondary power is not available. All terminal equipment needs Primary Power to operate.

Secondary Power - This refers to a battery-backed source that will continue to provide -48 VDC power to maintain service during an electric utility power failure. Secondary Power is required only when equipment operation is desired during electric utility power failures.

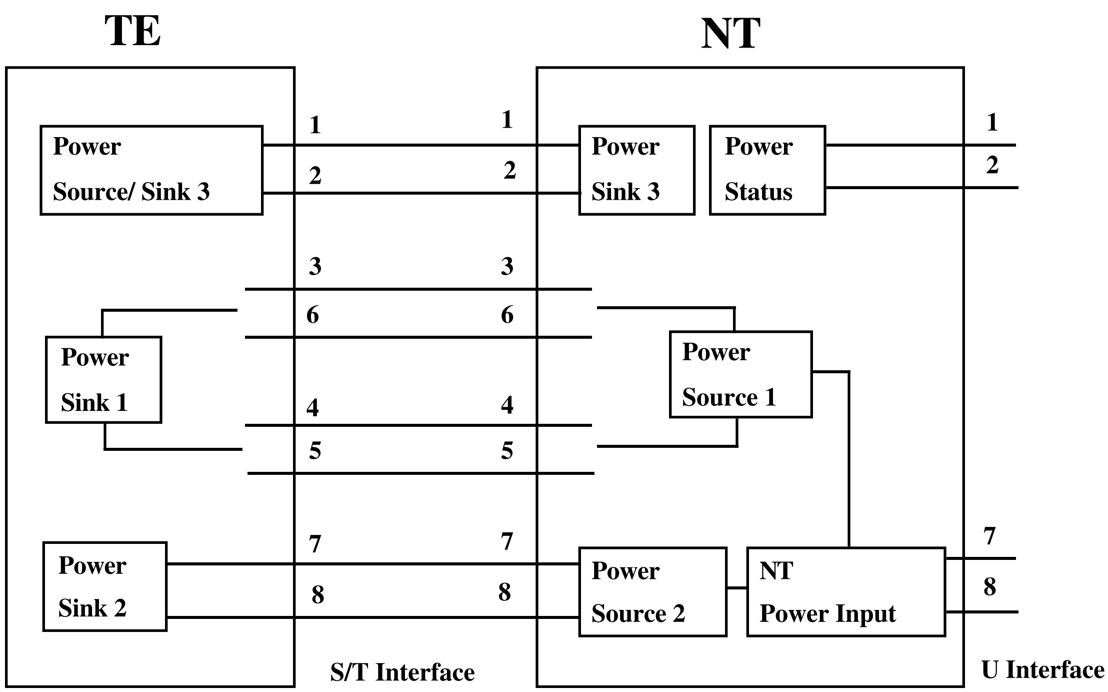
Both Primary and Secondary Power sources can be effectively a single, battery-backed power supply.

Restricted Power - This refers to a requirement that terminals operating on Secondary Power may be restricted in the amount of power they can draw. To comply with the requirement, the terminal must be able to recognize the loss of Primary Power and reduce its power consumption by disabling certain features. This is typically used to extend the runtime of the battery in the Secondary Power Source.

5.1.8.2 Alternative Power Source Wiring

To ensure a standard electrical interface for power feeding on all compliant equipment, the standard allocates certain pins for power and power status reporting.

The reference configuration for information transmission and power feeding is shown in the following figure for both the U and S/T interfaces.



As can be seen in the above figure, there are three alternatives defining where power can be sourced and these are associated directly with the access pins on the U and S/T interfaces.

Power Source 1 (PS1) - also known as Phantom Powering . With this configuration, the power feed to the terminals is supplied via the transmit and receive pairs (pins 4 & 5, 3 & 6). The advantage of this method is that it can utilize existing 2 pair (4 wire) customer premises wiring. There are, however, certain restrictions that limit the use of PS1 as the only power source:

To use PS1, it is necessary that both the terminal equipment and the NT1 are capable of operating in this mode, which, at this time, cannot be assumed.

The ANSI specification requires that the amount of Secondary Power drawn by the terminal from PS1 be less than that provided under Primary Power. In many cases this may be less than is needed typically for a fully configured terminal; therefore, the terminal must also recognize and implement a Restricted Power mode of operation. Recognition of restricted power is accomplished by sending a polarity reversal of the power source. (Note: While this limitation on Secondary Power may not be a factor for all terminal equipment, it is prudent to take account of it in any system design.)

Power Source 1 can derive its power either from a power supply integrated with the NT1 or from an external power supply inserted at the S/T reference point. The NT1 may also be powered locally using a direct connection to the local AC supply.

Power Source 2 (PS2) - This refers to any power source connected to pins 7 & 8 on the S/T interface that serves as an alternative or additional source of power for the terminal. The location of a power supply defined as PS2 can be at any convenient point on the S/T interface (Note: The majority of NT1s also provide a direct connection between pins 7 & 8 of the U and S/T interface connectors. This allows a power supply designated as PS2 to also power the NT1 and provide power for PS1.)

Power Source 3 (PS3) - This refers to any power source connected to pins 1 & 2 on the S/T interface that provides an optional source of power for the NT1 and a power source for additional Terminal Equipment. At this time, PS3 is implemented rarely.

Local Power - In addition to the powering options described above, the individual units can sometimes be locally powered using a plug-in transformer or stand alone power supply. Typically, local power, as supplied by the terminal equipment manufacturer, is Primary Power only.

5.1.8.3 The Vocabulary of Locations

For the purposes of describing the physical implementation of a power system, the following locations are defined.

Equipment Room - This room is considered as the primary location for telecommunications equipment and backbone facilities within a building. In some cases, this may be the only room provided and it will also function as the closet.

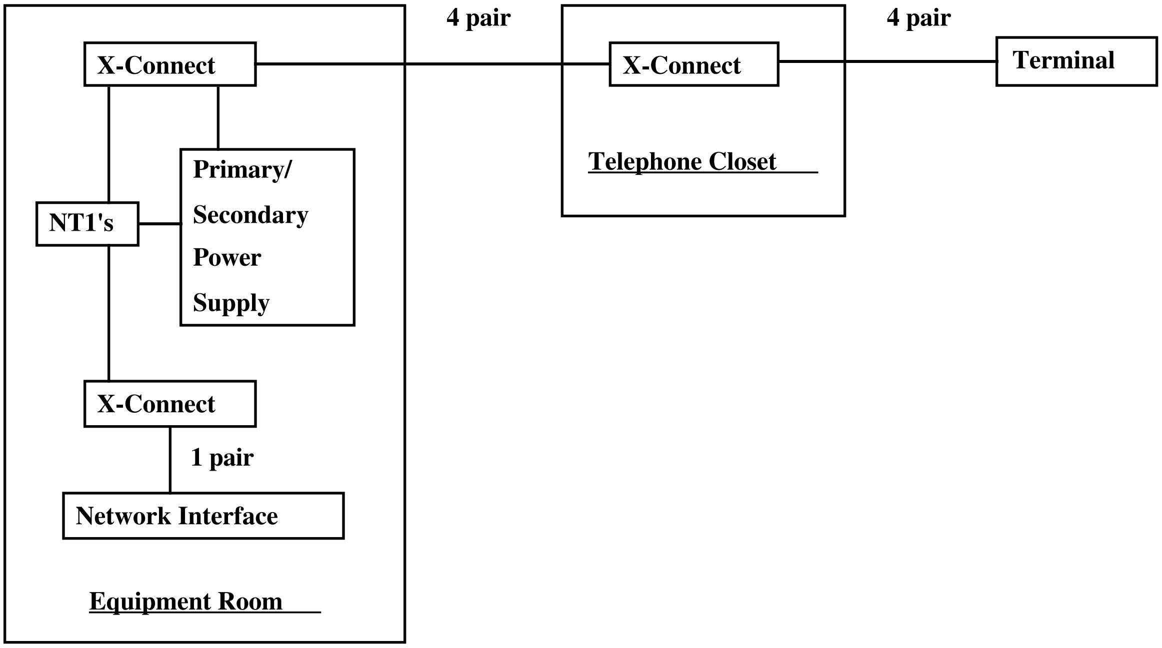
Telephone Closet - This room is where the cross-connect fields for station cables and backbone cables are installed.

Collocated - The situation in which the power equipment, NT1 and/or terminal are at one location.

5.1.8.4 Typical Powering Configurations

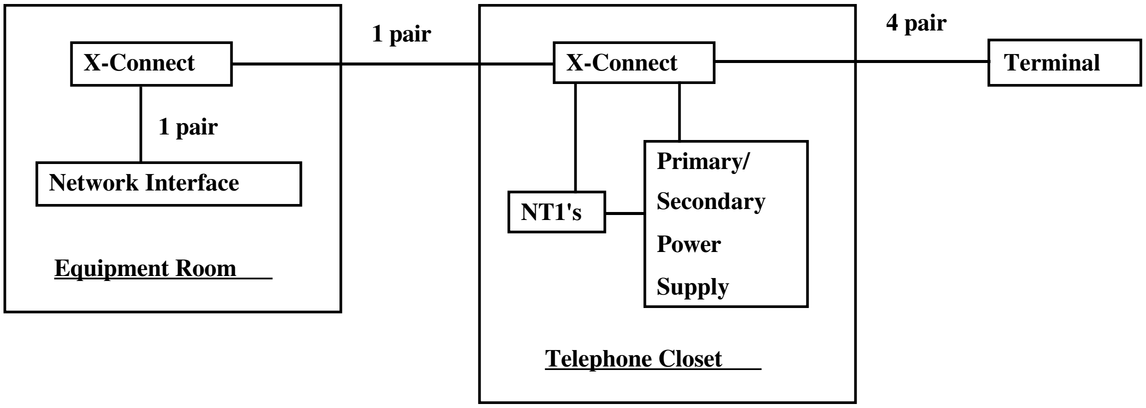
The following powering configurations are typical of what can be used to support the various wiring plans.

Configuration 1



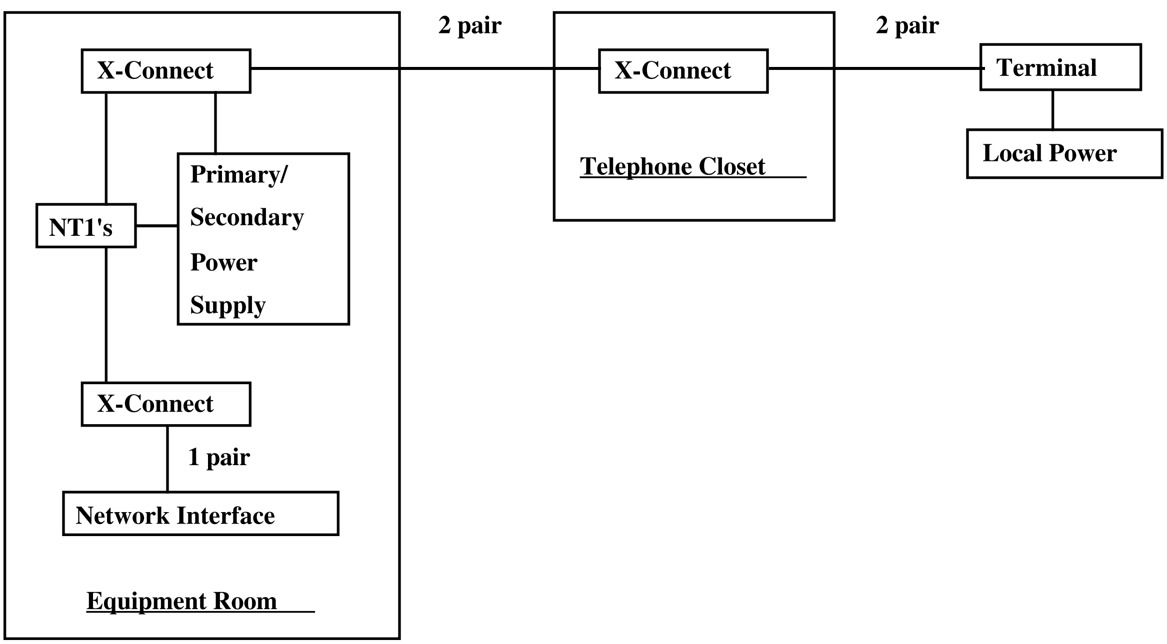
In this configuration the NT1s and Power Supply(ies) are located in the equipment room and require the use of 4 cable pairs per terminal from the equipment room to the terminal location. Although the combined Primary/Secondary Power Supply is capable of providing both PS1 and PS2 in this arrangement, PS1 would be used only if there was a cable fault that affected pins 7 & 8 or if the Power Supply was configured to provide PS1 only when supplying Secondary Power. The latter condition takes advantage of a feature of certain terminals that can use PS2 when available and revert to use Restricted Mode and PS1 when PS2 is removed. This technique can be used to establish which terminal remains active during power failure and thereby extend the backup time available from the battery. In this particular application, the distance from NT1 to terminal is limited by the maximum voltage drop between power supply and terminal that can be tolerated while still maintaining service. When planning an installation, the low battery voltage of the selected power supply should be used in the voltage drop calculation.

Configuration 2



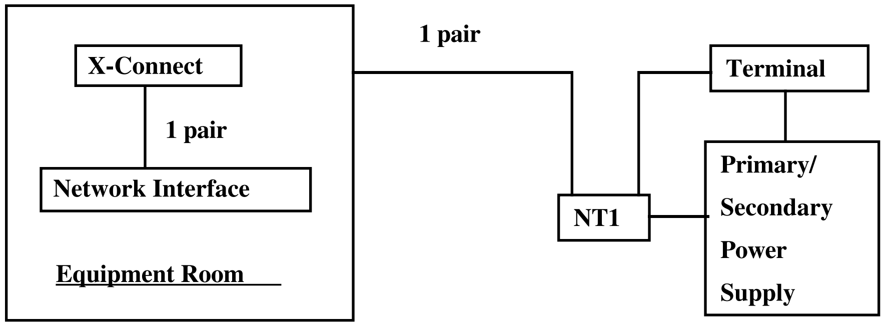
In this configuration, the NT1s and Power Supply are located in the telephone closet. The advantage of moving the equipment into the telephone closet is that the requirement for 4 pair cable is reduced to the horizontal wiring (in the figure) thereby reducing the number of pairs of wire used in the backbone cable. Both PS1 and PS2 are available in this configuration.

Configuration 3



This configuration will typically be used where the building wiring does not support 4 pairs per terminal. With this configuration, the terminals are locally powered and the only secondary power available is PS1. This requires the terminal to operate in the Restricted Power mode.

Configuration 4



In this final configuration, the NT1s, terminals and Power Supply are collocated at the workplace; it is typical of a small business application. The end user equipment could be locally powered using the Primary Power Supply provided with the equipment but it will operate only while electric utility power is present. To provide Secondary Power, a separate, battery-backed Power Supply is required.

5.1.8.5 The Challenge of Powering Voice Terminals Integrated with Personal Computers

In addition to the terminal equipment described above, there are various other types of terminal adapters and plug-in personal computer cards currently available to work with the ISDN. Although primarily used for data applications, some of these units also provide an auxiliary voice capability which may be the principal phone service in that particular installation. The problem in providing secondary power for these units is that stand alone terminal adapters and the plug-in cards for personal computers do not use -48 VDC. They more typically require 12 or 24 VDC derived from a local AC outlet. This means that voice service could not be supported from a Secondary Power Supply as defined in the ANSI standard. To provide continuous service under these circumstances, it will be necessary to use a small AC UPS system to power each Terminal Adapter.

As can be appreciated from this overview of ISDN powering, the importance of a properly designed and installed system is critical to a successful implementation. The main points to remember are:

- Keep the design simple and, where possible, use standard configurations to improve the maintainability of the system.
- Ensure that the power systems comply with the ANSI standards and avoid non-standard, proprietary solutions.
- Design the system so as to allow maximum flexibility in the selection and placement of end user equipment.
- Where extended battery run time is required, investigate the use of power shedding to remove non-essential loads. This will minimize the size of battery required.

5.1.8.6 Wiring, Powering and Extension Phones Working Group

An ad hoc wiring, powering and extension phone (WPE) working group was formed at the June 1993 NIU meeting under the auspices of the ISDN CPE and Software Developers Workshop (ICSW) which is, in turn, under the auspices of the ISDN Implementors Workshop (IIW). A draft paper covering many of the WPE issues was presented at the June 1993 meeting as a starting point for the group's work. The purpose of the ad hoc WPE working group is to provide public domain descriptive/tutorial material regarding residence and small business wiring, powering and extension phone issues. The resulting material would be intended to provide information to anyone involved in the WPE issues, from a technically inclined homeowner to an electrician or other professional telecommunications installer. An underlying assumption of the effort is that professional installers who work with large businesses will have capabilities and/or information sources provided by professional organizations that are beyond the reach of homeowners and small business installers.

The intention is that any documents developed by the WPE working group will be made available through yet undetermined channels for dissemination at reasonable cost and from sources readily available to the public. The overall philosophy of the effort is that the more people who understand how to properly provide wiring and powering for ISDN terminal equipment, the more successful will be the penetration of ISDN into homes and small businesses.

5.1.9 Configurations for High Bandwidth Applications

5.1.9.1 Overview

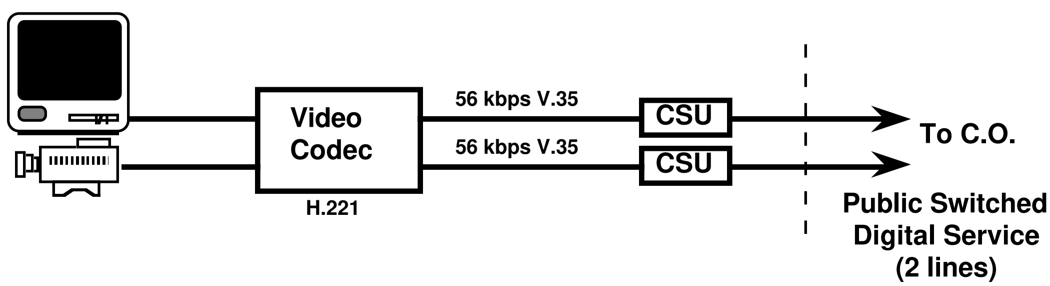
Many ISDN applications require circuit-data bandwidth greater than 64 kbps. These applications may be implemented using PRI, or a number of BRIs. The fundamental issue in implementing these applications involves combining the B channels used for the call, whether PRI or BRI. Synchronization may be provided by the network, (using Multirate ISDN as shown in Section 5.1.9.6) or by equipment at the endpoints such as video codecs and Inverse Multiplexers. This section provides configuration options for such applications using the example of videoconferencing. This example was chosen because it is expected to be a leading use of high bandwidth, switched digital service. The configurations diagrammed below are also used for applications such as LAN interconnection, imaging, and file transfer.

5.1.9.2 Historical Perspective

Switched 56 service is a data service that provides users with an on-demand switched digital connection capable of transmitting and receiving data at a 56 kbps rate. This service was introduced by local and interexchange carriers in the mid 1980s. Switched 56 service is also known as Public Switched Digital Service (PSDS).

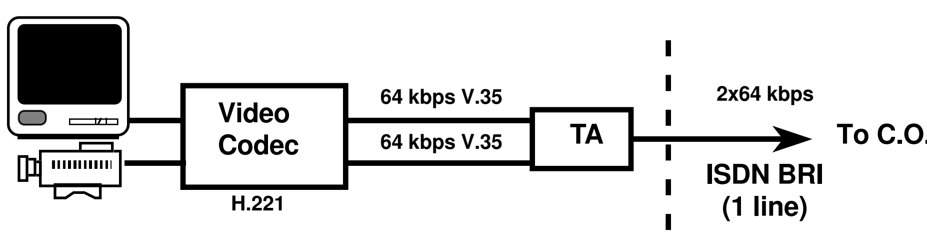
Switched 56 service is typically offered using one of three vendor proprietary solutions. Because of this, users should be careful and purchase or lease a 56 kbps digital data set that is compatible with the service offered in their local area (sometimes more than one proprietary solution may be available). This data set is called a Data Service Unit /Channel Service Unit (DSU /CSU). One DSU/CSU is needed for each 56 kbps circuit.

The widespread availability of PSDS has helped make videoconferencing much more practical. Typically, a videoconferencing codec will make use of two 56 kbps circuits, thus many codecs have two V.35 interfaces. Most codecs support the H.221 recommendation for synchronizing the two data calls and for allocating the video and audio portions of the conference. Because of widespread availability, Switched 56 is still often used for videoconferencing.

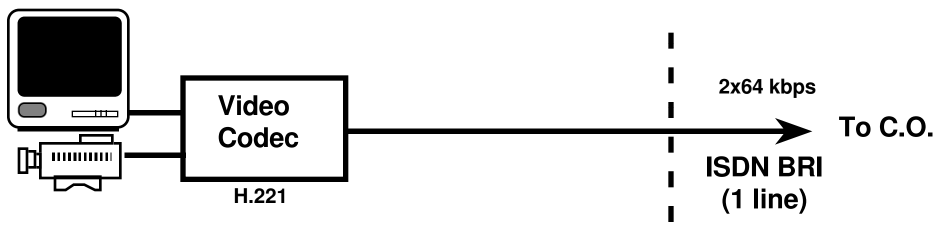


5.1.9.3 128 kbps Using BRI

With the introduction of ISDN, most telephone companies are migrating their data networks to handle 64 kbps data calls, sometimes referred to as "64 clear." The same video codec used in the previous example may be easily connected to an ISDN BRI using a terminal adapter (TA) with two V.35 interfaces. Again, the synchronization is performed by the H.221 function of the codec. While the diagram below shows the use of 64 kbps data calls, this configuration could also place 56 kbps data calls for backwards compatibility with systems using Switched 56.

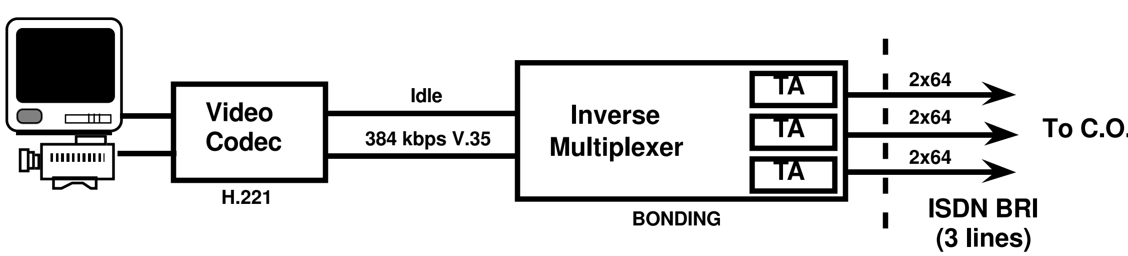


Many video codecs are built with direct BRI connections and do not require a terminal adapter. BRI video codecs have two significant advantages over codecs connected through V.35 interfaces. The codec's direct connection to the D channel enables suppliers to provide simpler and more responsive user interfaces for call control. In addition, these codecs are typically able to place and accept voice calls as well as data calls. Many of these systems are Personal Computer-based.

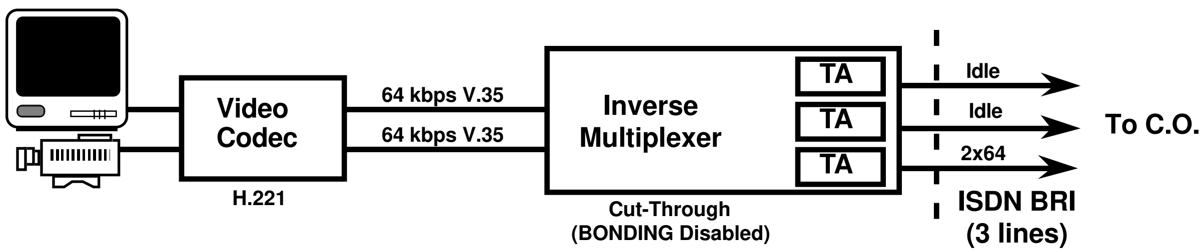


5.1.9.4 Speeds Greater than 128 kbps using BRI

While H.221 allows the synchronization of up to 6 B channel calls (and will be extended to include more), most video codecs can only synchronize two. For this reason, videoconferencing at speeds above 128 kbps typically requires the use of an external Inverse Multiplexer (IMUX). These devices are available from many companies and may be used with ISDN BRI and PRI, as well as T1, Switched 56, and other access methods. Note that in the configuration shown, the IMUX is connected to the codec by a single V.35 link running at 384 kbps. The IMUX synchronizes the six circuit-data calls using the specifications agreed upon by the Bandwidth On Demand Interoperability Group (BONDING). The BONDING agreement was developed by a group of IMUX manufacturers to promote interoperability between their products. To the codec, it appears that a single 384 kbps call has been established. H.221 is still used in this configuration to multiplex the video and audio information onto the "single" 384 kbps data stream. Note that the IMUX in the figure below provides synchronization, and also the call control functionality provided in the previous example by the ISDN terminal adapter.

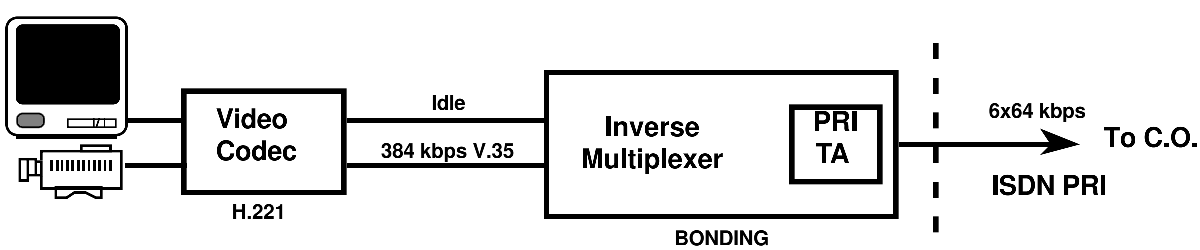


When the equipment is set up in this configuration, 112 or 128 kbps calls may be placed to locations which don't have higher capacity communications lines. To maximize compatibility with existing systems, most Inverse Multiplexers have a "cut-through" mode. Cut-through mode disables BONDING functions and makes the Inverse Multiplexer appear transparent to the video codec. In other words, the codec uses both V.35 ports at 56 or 64 kbps as if it were directly connected to an ISDN terminal adapter.



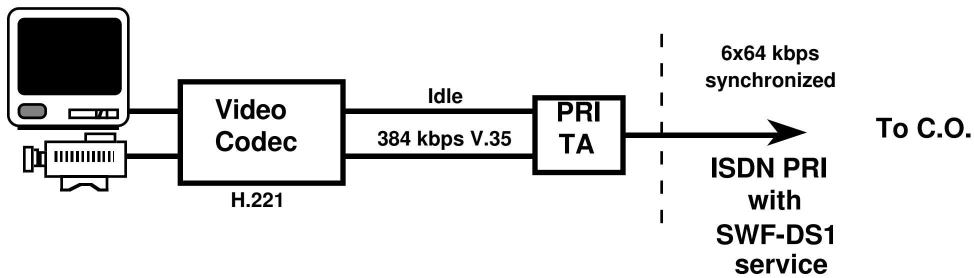
5.1.9.5 Using PRI with Synchronization Equipment

Large ISDN installations may receive their service using PRI interfaces. Many IMUXes support the PRI interface and may be configured similarly to the BRI case. Because PRI has so much capacity, it is unlikely that the line will be used solely for videoconferencing. For this reason, the IMUX shown below is most likely a function integrated into a general purpose access controller, and not a stand-alone device as shown in the previous example. Again, the cut-through mode may be used to place 112 or 128 kbps calls.



5.1.9.6 SWF-DS1

SWF-DS1 , also known as Multirate ISDN or n x 64 service, provides inverse multiplexing capability within the network. This service will be offered on PRI interfaces by many service providers within the year. Because SWF-DS1 actually places one high bandwidth call instead of combining multiple calls, it provides several advantages to the user including faster call setup time, guaranteed synchronization, and a single charge on the user's bill. While the diagram below shows a PRI TA to demonstrate that an IMUX is not necessary, the configuration in reality is probably more complex for the same reasons as the previous example. The ability to dial SWF-DS1 calls may be integrated into IMUXes as an alternative to BONDING. In this way, the user could select which synchronization method to use based on the capabilities of the system at the far end.



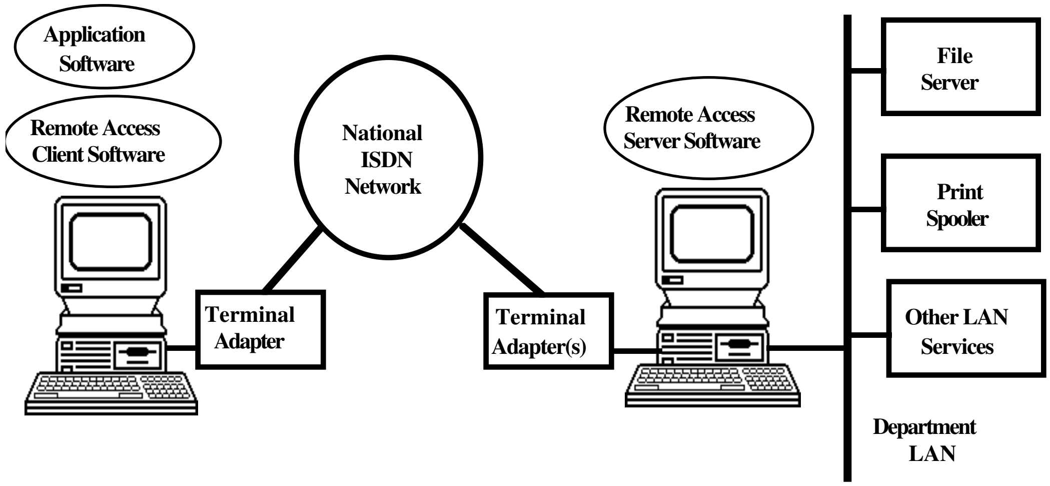
5.1.10 Communications Server Alternatives

5.1.10.1 Overview

Throughout the guides in Section 3 of this document, the term "Communications Server" is used as a general term. This is because in most cases a single piece of equipment does not provide all the necessary functionality. The exact functionality required depends on the equipment and software used, both applications and networking. For this reason, assembling a real-world "Communications Server" can require a substantial amount of knowledge. The following sections contain several possible real-world configurations. While these configurations do not represent all possible types of equipment that may be used, they do provide useful examples and are intended to help those interested in implementing ISDN solutions better understand the functionality of different types of communications devices.

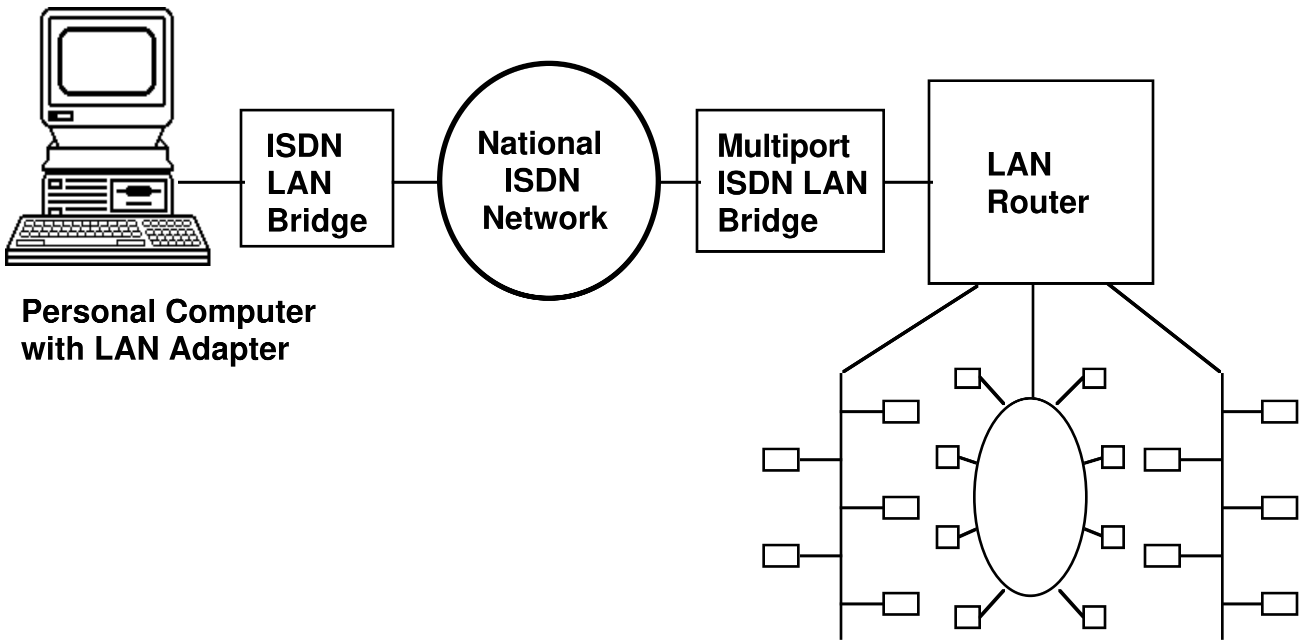
5.1.10.2 Remote Access to Department LAN

In this situation, a relatively small number of people need remote access to a LAN. This architecture is sufficient for checking email, or copying small files to a local hard drive. Typically, a Personal Computer is added to the LAN as a dedicated remote access server. This computer runs software which exports the Network Operating System (NOS) to remote users. The server in this case will connect to external Terminal Adapters using a serial interface (e.g. RS-232 or a V.35 card) or will use internal ISDN Adapters. Remote users dial into the remote access server and run the remote access client software. The remote users then appear to be on the LAN. This type of solution is usually sold as a package and tends to be fairly easy to install. Because they are packaged, these systems are usually fairly inflexible and may not be very expandable.



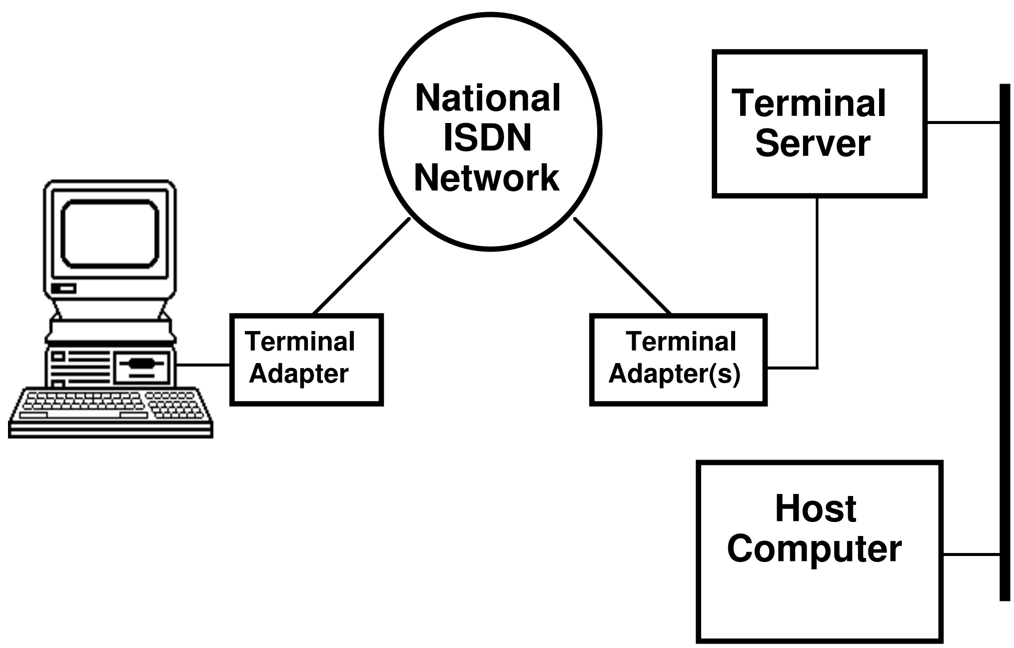
5.1.10.3 Remote Access to LAN Backbone

A number of the guides in Section 3 use an ISDN LAN Bridge to access corporate or campus computing resources. The Bridge is capable of dialing and dropping B channel calls to a pre-programmed number according to traffic on the link. Because these devices use B channel circuit-data calls to communicate with the central site, that site must have enough ports to handle the incoming calls. An advantage of this system is that the operation of the ISDN LAN Bridge hides the communication from the user. The user runs the same applications they use at work and when necessary, the bridge automatically connects to the LAN equipment at the central site. Although the diagram below shows the ISDN access and LAN bridging functions implemented as a separate device, these functions may be performed by the router .



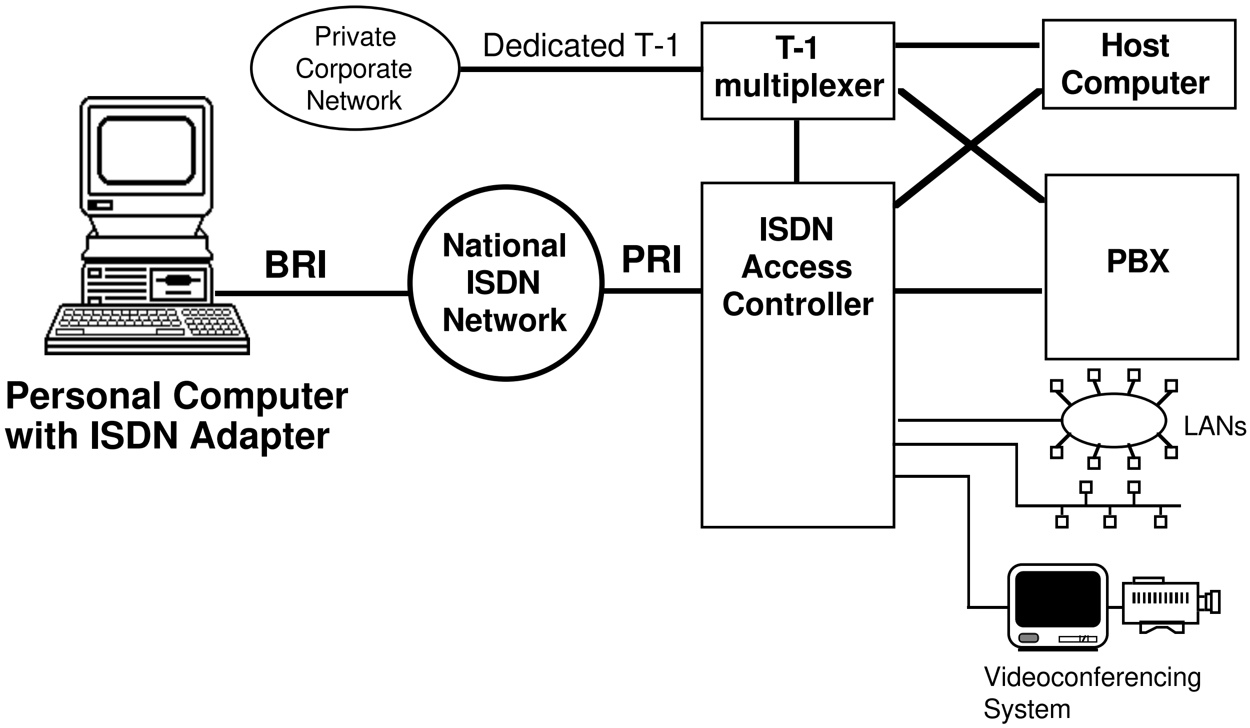
5.1.10.4 Remote Access to Terminal Server

In the diagram below, the remote user establishes a connection with the terminal server and runs terminal emulation software. The terminal server then establishes a session on the host computer. The terminal server is depicted as LAN-attached to the host computer, but it may also be channel-attached. To the host, the remote user appears to be directly connected. Because host computer applications tend to be screen-based and take some time for the user to read, there is no noticeable performance degradation for remote users.



5.1.10.5 *Integrating ISDN into Large Private Voice and Data Networks*

Large corporations and universities may use private networks to carry their internal voice and data traffic. PRI may be used to provide access to public network users. In the example below, the user dials into the ISDN Access Controller, which contains a LAN router function, in order to reach the department LAN on the right of the diagram.



5.1.11 *NIUF ISDN Interface Groups (NIIGs) and Parameter Groups (NIPGs)*

NIIG s and NIPGs provide a simple means of ordering interface configurations and features/capabilities for National ISDN. Together, the NIIGs and NIPGs are flexible building blocks from which services/applications can be constructed. They focus on single line ISDN service in the residence and small business market, served by a National ISDN 1 and 2 Basic Rate Interface (BRI). A selection of NIIG(s) and NIPG(s), as appropriate to support a customer's application(s), can replace parameter-by-parameter requests for service.

Twenty nine NIIGs have been developed by the NIUF Ad Hoc Group on the Simplification of ISDN Ordering, Provisioning, and Installation. The NIIGs, named NIIG 1 through NIIG 29, delineate and number the particular National ISDN 1 interface configurations. The NIIGs are classified according to the number and types of channels in the BRI used for passing information between users, and indicate which call types (or combinations of call types) can be used on each channel.

Ten NIPGs have also been developed by the NIUF Ad Hoc Group The NIPGs are groupings of ISDN features and capabilities, and contain ISDN subscription parameters and their settings. The NIPGs are named NIPG 1.0 - 10.0:

• NIPG 1.0 - 5.0	Voice features/capabilities
• NIPG 6.0	Circuit-switched data features/capabilities
• NIPG 7.0 - 8.0	D-channel packet features/capabilities
• NIPG 9.0 - 10.0	B-Channel packet features/capabilities

The ordering process using the NIIGs and NIPGs would proceed as follows:

- As part of the BRI Selection Process, the customer first selects an NIIG, according to customer needs and telco tariffs. Other information that must be negotiated as part of the BRI Selection Process, such as the access configuration of the customer's equipment (number of terminals, type of terminals, etc.), as well as the number of Directory Numbers, is outside the scope of the current NIIGs, and must be negotiated separately. Some customers' communications needs will be fulfilled by the services inherent in the NIIG (i.e., the BRI and its call types), in which case no NIPGs need to be specified.

- If additional features/capabilities are required, a customer may then specify the NIPG(s) that he or she needs.

- Certain "a la carte" ISDN features/parameters (non-grouped ISDN features available in National ISDN-1), e.g., Additional Call Offering, Calling Number Identification Services, as well as non-ISDN features, may be requested separately from NIPGs.

Customers will still be able to negotiate their entire service order on a parameter-by-parameter basis if they do not wish to use the NIIG/NIPG approach.

Thus, using the NIIGs and NIPGs, applications can be provisioned as follows (for each interface):

NIIG + NIPG(s) + a la carte features

Customers may learn about what NIIG/NIPG(s) they need for their applications, and what NIIGs/NIPGs their equipment supports, from equipment manufacturers or service providers. Some of this information is also provided in this document:

- For each BRI solution described in Sections 3.1 and 3.2, information is provided concerning how to order that solution using the NIIG/NIPG approach.

- For each piece of equipment described in Section 4.2, information is provided concerning which NIIG(s) and NIPG(s) the equipment supports.

The NIIGs are listed in Section 5.1.11.1. More details on the NIIGs can be found in the document *North American ISDN Users' Forum ISDN Interface Groups (NIIGs): Phase 2 Simplification*, North American ISDN Users' Forum Ad Hoc Group on the Simplification of

ISDN Ordering, Provisioning, and Installation, Issue #91-007.6 (160007.0), Working Group Stable Draft, June 25, 1993.

The NIPGs are listed in Section 5.1.11.2. This listing provides a shortened form of the NIPGs; a complete listing of the NIPGs is included in the document *North American ISDN Users' Forum ISDN Parameter Groups (NIPGs): Phase 1 Simplification*, North American ISDN Users' Forum Ad Hoc Group on the Simplification of ISDN Ordering, Provisioning, and Installation, Issue #91-007.6 (160007.0), June 25, 1993.

If you need further information on the NIIGs or NIPGs, please contact the NIUF Secretariat at (301)975-2937.

5.1.11.1 NIUF ISDN Interface Groups (NIIGs)

		CALL TYPE & INTERFACE CONFIGURATION		
NIIG NUMBER	INFORMATION	B	B	D
1	0B + D	x	x	P
2	1B	V	x	-
3		C	x	-
4		V/C	x	-
5		SBP	x	-
6	1B + D	V	x	P
7		C	x	P
8		V/C	x	P
9		SBP	x	P
10	2B	V	V	-
11		V	C	-
12		V	V/C	-
13		V	SBP	-
14		C	C	-
15		C	V/C	-
16		C	SBP	-
17		V/C	V/C	-
18		V/C	SBP	-
19		SBP	SBP	-
20	2B + D	V	V	P
21		V	C	P
22		V	V/C	P
23		V	SBP	P
24		C	C	P
25		C	V/C	P
26		C	SBP	P
27		V/C	V/C	P
28		V/C	SBP	P
29		SBP	SBP	P

KEY:

V = Circuit-Switched Voice
C = Circuit-Switched Data
V/C = Alternate Circuit-Switched Voice and Data
SBP = Semi-Permanent B Channel Packet Connection
P = Packet-Switched Data
x = Not Applicable
- = Signaling Only

NOTES:

1. Not every NIIG Grouping is available from each telco.

2. NIIG Grouping applies to both NI-1 and NI-2, with the exception of on-demand B Channel packet data.

5.1.11.2 NIUF ISDN Parameter Groups (NIPGs)

NIPG 1.0 Call Forwarding feature for Voice

- One Directory Number Appearance
- Call Forwarding Variable
  - Reminder Notification Sent to Base DN
  - Establish Courtesy Call:

    For NI-1: No Answer Required (if supported by switch); otherwise Answer Required

    For NI-2: No Answer Required

NIPG 2.0 Advanced Call Forwarding features for Voice

NIPG 2.0 contains everything in NIPG 1.0 PLUS additional Call Forwarding and Message Indicator features.

- One Directory Number Appearance
- Call Forwarding Variable
  - Reminder Notification Sent to Base DN
  - Establish Courtesy Call:

    For NI-1: No Answer Required (if supported by switch); otherwise Answer Required

    For NI-2: No Answer Required
- Call Forwarding Interface Busy
  - Do Not Establish Courtesy Call
- Call Forwarding Don't Answer
  - Do Not Establish Courtesy Call
- Message Waiting Indicator

NIPG 3.0 Flexible Calling features for Voice

- Three Directory Number Appearances
- Flexible Calling
  - Hold/Retrieve (for individual call or conference)
  - Three-Way Conference Calling
  - Add On:

    For NI-1:

    Add Previously Held Conference to Call

    Add Previously Held Call to Conference (if supported by switch)

    For NI-2:

    Add Previously Held Conference to Call

    Add Previously Held Call to Conference

- Drop Last Call
- Transfer

  For NI-1: Explicit (if supported by switch); otherwise Implicit

  For NI-2: Explicit
- Consultation Hold

NIPG 4.0 Basic Electronic Key Telephone Set (EKTS) features for Voice

NIPG 4.0 is based on the Basic EKTS service.

- Basic EKTS
- Multiple DN/Terminal
- User Bridging
- Manual Privacy (Manual Bridged Call Exclusion)
- Hold/Retrieve; DN Bridging; Call Transfer
  - Hold/Retrieve (for individual call or conference)
  - DN Bridging (Three-Way Conference Calling)
  - Add On:

    For NI-1:

    Add Previously Held Conference to Call

    Add Previously Held Call to Conference (if supported by switch)

    For NI-2:

    Add Previously Held Conference to Call

    Add Previously Held Call to Conference
  - Drop Last Call
  - Transfer

    For NI-1: Explicit (if supported by switch); otherwise Implicit

    For NI-2: Explicit
  - Consultation Hold

NIPG 5.0 Advanced EKTS features for Voice

NIPG 5.0 is based on the Call Appearance Call Handling EKTS service.

- Call Appearance Call Handling (CACH) EKTS
- Multiple Virtual Lines (Multiple DN Appearances)
- Intercom Calling
- Multiple DN/Terminal
- User Bridging
- Manual Privacy (Manual Bridged Call Exclusion)

- Hold/Retrieve; DN Bridging; Call Transfer
  - Hold/Retrieve (for individual call or conference)
  - DN Bridging (Three-Way Conference Calling)
  - Add On:

    For NI-1:

        Add Previously Held Conference to Call

        Add Previously Held Call to Conference (if supported by switch)

    For NI-2:

        Add Previously Held Conference to Call

        Add Previously Held Call to Conference
  - Drop Last Call
  - Transfer

    For NI-1: Explicit (if supported by switch); otherwise Implicit

    For NI-2: Explicit
  - Consultation Hold

NIPG 6.0 Advanced Call Forwarding features for Circuit-Switched Data

- One Directory Number Appearance
- Call Forwarding Variable
  - Do Not Establish Courtesy Call
- Call Forwarding Interface Busy
  - Do Not Establish Courtesy Call
- Call Forwarding Don't Answer
  - Do Not Establish Courtesy Call

NIPG 7.0 Basic D-Channel Packet features

- Switched Virtual Call Service
- 1 logical channel (can be User-Specified up to 15)
- Packet window size: 2
  - D-Bit Modification: No
- Throughput class: 9.6 kbps
- Maximum user data field: 128 octets
- Reverse charge: Yes
- Reverse charge acceptance: No
- Fast select: Yes
- Fast select acceptance: Yes

- Negotiation services
  - Flow Control Parameter Negotiation (Window Size and Packet Size): No
  - Throughput Class Negotiation: No
- RPOA selection: Yes

NIPG 8.0 Advanced D-Channel Packet features

- Switched Virtual Call Service
- 1 logical channel (can be User-Specified up to 15)
- Packet window size: 2
  - D-Bit Modification: No
- Throughput class: 9.6 kbps
- Maximum user data field: 256 octets
- Reverse charge: Yes
- Reverse charge acceptance: Yes
- Fast select: Yes
- Fast select acceptance: Yes
- Negotiation services
  - Flow Control Parameter Negotiation (Window Size and Packet Size): Yes
  - Throughput Class Negotiation: Yes
- RPOA selection: Yes

NIPG 9.0 Basic B-Channel Packet features

- Switched Virtual Call Service
- 8 logical channels (can be User-Specified from 1 - 127)
- Packet window size: 2
  - D-Bit Modification: No
- Throughput class: 9.6 kbps
- Maximum user data field: 256 octets
- Reverse charge: Yes
- Reverse charge acceptance: Yes
- Fast select: Yes
- Fast select acceptance: Yes
- Negotiation services
  - Flow Control Parameter Negotiation (Window Size and Packet Size): Yes
  - Throughput Class Negotiation: Yes
- RPOA selection: Yes

NIPG 10.0 Advanced B-Channel Packet features

- Switched Virtual Call Service
- 8 logical channels (can be User-Specified from 1 - 127)
- Packet window size: 2
  - D-Bit Modification: No
- Throughput class: 19.2 kbps
- Maximum user data field: 256 octets
- Reverse charge: Yes
- Reverse charge acceptance: Yes
- Fast select: Yes
- Fast select acceptance: Yes
- Negotiation services
  - Flow Control Parameter Negotiation (Window Size and Packet Size): Yes
  - Throughput Class Negotiation: Yes
- RPOA selection: Yes

5.1.12 Additional Information Applicable to Many ISDN Solutions

5.1.12.1 Getting the Most from Voice Features

Several of the Data applications in this document use a Voice phone (in addition to computers that support PMD and CMD) but do not require any Voice services to operate. Though generally not required for data applications, the following Services are generally useful for Voice phones and Voice DNs, since they provide additional capabilities to Voice users:

- Call Forwarding
- • Call Forwarding Variable (CFV)
- • Call Forwarding Busy (CFB)
- • Call Forwarding Don't Answer (CFDA)
- Call Pickup (in Group Applications)
- Call Hold
- Additional Call Offering

- Flexible Calling (Call Transfer, Call Conference)
- Automatic Callback
- Calling Number Delivery, Redirecting Number Delivery

Note that these additional services may also be useful for Voice applications in this document, even though they are not explicitly required for each Voice application.

If a Voice Phone and Voice DN are also subscribed for
- Low Layer Compatibility (LLC) Information Transfer and
- High Layer Compatibility (HLC) Information Transfer,

then the most likely LLC and HLC values for a Voice application are:
- Low Layer: CCITT G.711 μ-Law
- High Layer: Telephony.

5.1.12.2 Getting the Most From Packet Mode Features

Since the PMD configuration and usage of the calling and called devices are generally not the same, the likelihood of X.25 call completion will be higher if these devices and their PMD DNs also support Throughput Class Negotiation & Flow Control Parameter Negotiation.

In cases where data exchanges between devices (e.g. Station to Controller, Station to Host) involve 128 octets or less in each direction, Fast Select can be used instead of a complete X.25 call. If Fast Select is used, the PMD DNs on the relevant device interfaces must also be subscribed to the Fast Select and Fast Select Acceptance features.

Closed User Group (CUG) can also be used to provide the various PMD devices with access security for PMD calls. Since one calling device may need to access these multiple secure called devices, the caller's PMD DN will have to belong to multiple CUGs (e.g., one CUG for each secure called device), and will have to support CUG Selection so that the caller can specify the individual called party CUG on a per-call basis. In addition, the caller can designate a "Preferential CUG" which is used for security when no CUG is selected on a per-call basis. (This would typically be the CUG of the called device that is most frequently accessed by the caller.) The relevant CUG subscription parameters for the caller's PMD DN are given below, assuming that there are three separate secure called devices that the caller needs to access.

Closed User Group (CUG): Yes

CUG Membership: DN Must Belong to

Same CUG as First Secure Device's DN,

Same CUG as Second Secure Device's DN, &

Same CUG as Third Secure Device's DN.

CUG Selection: Yes, with Three Indices:
1: First Secure Device's CUG,
2: Second Secure Device's CUG, &
3: Third Secure Device's CUG.
Preferential CUG : Same CUG as First Secure Device (If Needed)

Note also that the called devices may use Calling Party Address and the Call User Data from the Fast Select service in addition to CUG to enforce data access security.

Note also that the called party may be willing to accept the ISDN charges for incoming calls on behalf of the calling party. If this is the case, and the calling party wishes to make these Reverse Charged calls, the calling party's PMD DN should be subscribed to Reverse Charging, and the called party's PMD DN(s) should be subscribed to Reverse Charging Acceptance.

5.1.12.3 Electromagnetic Interference

The Federal Communications Commission (FCC) requires that communications/computing devices for home use meet the standards for a Class B computing device, as specified in Subpart J of Part 15 of the FCC Rules. These specifications are designed to provide protection against radio-frequency interference in a residential installation. These specifications also apply to the ISDN terminal devices.

5.1.12.4 Interworking With Non ISDN Endpoints or Networks

NI-1 service uniformity may be affected by interworking situations involving different trunking arrangements, options or types of inter-office facilities. Particularly, circuit switched interworking from ISDN to non-ISDN stations, or even ISDN-to-ISDN stations (where SS7/64CCC is not provisioned for uniform bearer capability routing end-to-end) may cause some NI-1 supplementary services to be blocked. Alternatively, it may cause terminal management procedures to be invoked in order to ensure some level of transmission service end-to-end even if it is only POTS. For packet-switched interworking from ISDN to non-ISDN stations using X.25, users should not encounter difficulties as long as internetwork access is supported by the service provider. System integrators should resolve such matters directly with the concerned service providers since they are outside the scope of this Catalog.

5.1.13 Conformance Testing

Conformance testing is designed to verify how closely equipment adheres to a particular protocol specification. It is intended as a first step towards interoperability of equipment, but does not guarantee interoperability. This section is intended to provide information on the status and availability of ISDN test suites for conformance testing for NIUF and National ISDN-1 specifications.

5.1.13.1 Abstract Test Suites for Conformance Testing for NIUF

The test suites listed in this section were developed in the ISDN Conformance Test (ICOT) working group in NIUF to verify the protocol implementations based on Implementation Agreements (IA). They will be published as part of a series of NIST Special Publications (NIST SP). NIST Special Publications are available from:

National Technical Information Services (NTIS)
5285 Port Royal Road
Springfield, VA 22161
phone: (703)487-4650 or (800)553-6847
fax: (703)321-8574

The status of each test suite is provided along with the NIST SP number and NTIS order number, if available.

ISDN Conformance Testing - Introduction, This volume discusses the basic concepts of conformance testing and the development of abstract test specifications for conformance testing of ISDN protocols. [NIST SP 823-1, NTIS# PB92-181015]

ISDN Conformance Testing - Layer 1 - Physical Layer Part 1, *Basic Rate S/T Interface, User Side* describes a set of test specifications which verify conformance of Terminal Equipment and Network Termination equipment to the ISDN Physical Layer Basic Access at the S/T reference point, as defined in ANS T1.605-1989 and NIU 90-105. [NIST SP 500-194, NTIS# PB92-102201]

ISDN Conformance Testing - Layer 1 - Physical Layer Part 2, *Basic Rate U Interface, User Side* describes a set of test specifications which verify equipment implementation conformance to the ISDN Physical Layer Basic Access at the U interface, as defined in ANS T1.601-1988 and NIU 90-101. [NIST SP 823-2, NTIS# PB92-181114]

ISDN Conformance Testing - Layer 1 - Physical Layer Part 3, *Primary Rate Interface, User Side* describes a set of test specifications which verify equipment implementation conformance to the ISDN Physical Layer Primary Access at the S, T, and U interface, as defined in ANS T1.408-1990. [Approved in NIUF; will be published soon]

ISDN Conformance Testing - Layer 2 - Data Link Layer, *Link Access Procedure on the D Channel (LAPD) Part 1 Basic Rate Interface, User Side* defines the abstract test specifications to verify equipment implementation conformance to the Layer 2 of an ISDN at the user-network interface, for basic access arrangements, as defined in ANS T1.602-1989 and NIU 90-210. [NIST SP 823-4; not yet available from NTIS]

ISDN Conformance Testing - Layer 2 - Data Link Layer, *Link Access Procedure on the D Channel (LAPD) Part 2 Primary Rate Interface, User Side* will define the abstract test specifications to verify equipment implementation conformance to the Layer 2 of an ISDN at the user-network interface, for the Primary Rate Interface access arrangements, as defined in ANS T1.602-1989 and NIU 90-210. [under development in ICOT]

ISDN Conformance Testing - Layer 3 - Network Access Layer, Part 1 Basic Rate Interface Circuit Switch Call Control, User Side defines the abstract test specifications to verify equipment implementation conformance to the Layer 3 of an ISDN basic access at the user-network interface for the Basic Call Control Procedures, as defined by ANS T1.607-1990 and NIU 90-301.[Approved in NIUF, in NIST editorial review process prior to publication]

ISDN Conformance Testing - Layer 3 - Network Access Layer, Part 2 Primary Rate Interface Circuit Switch Call Control, User Side defines the abstract test specifications to verify equipment implementation conformance to the Layer 3 of an ISDN Primary Rate Interface at the user-network interface for the Basic Call Control Procedures, as defined by ANS T1.607-1990 and NIU 90-302. [ICOT Working Group Stable June 1993]

ISDN Conformance Testing - Layer 3 - Network Access Layer, Part 3 Packet Switched Call Control will define the abstract test specifications to verify equipment implementation conformance to the Layer 3 of an ISDN at the user-network interface for the Packet Switched Call Control Procedures, as defined by ANS T1.608-1990 and NIU 90-320. [Under development in ICOT. Work started 6/93; target date 1Q94]

ISDN Conformance Testing - Supplementary Services, This test suite will define the abstract test specifications to verify implementation conformance to the Supplementary Services at the user-network interface, as defined in ANS T1.610, NIU 90-311, and other appropriate ANS documents and their corresponding NIU-Forum Implementation Agreements. [ICOT work is pending development of IAs in the Signaling and Supplementary Services Working Group in NIUF]

ISDN Conformance Testing - Packet Mode Bearer Services Control Procedures, This test suite will define the abstract test specifications to verify implementation conformance to the Packet Mode Bearer Services Control Procedures. [Under development in ICOT. Work started 6/93; target date 1Q94]

ISDN Conformance Testing - Terminal Adaption , This test suite defines the abstract test specifications to verify equipment implementation conformance to the ISDN Circuit-Mode Data Terminal Adaption using Statistical Multiplexing, as defined by ANS T1.612-1990 and the corresponding NIU-Forum Implementation Agreement. [Under development in NIST - 1st draft ready for ICOT review]

Frame Relay Conformance Testing - Permanent Virtual Connection, This test suite defines the abstract test specifications to verify equipment implementation conformance to Frame Relay as defined in ANS T1.617 Annex D - Permanent Virtual Connection (PVC) [ICOT Working Group Stable June 1993 ICOT document #ICOT-93-03 (ACTFR - 92-026.06)]

5.1.13.2 Abstract Test Suites for Conformance Testing for National ISDN-1

The test suites for Layer 3 basic call control and supplementary services in this section have been developed to verify ISDN terminal equipment implementing the Bellcore National ISDN-1 specification SR-NWT-001953. They were developed by a conformance testing task force under the Corporation for Open Systems (COS). Most of the task force members also participated in the ICOT group for Layers 2 & 3. Information about the availability of the test suites may be obtained by calling Robert Blackshaw at COS at (703) 205-2746. The following NI-1 test suites have been completed by the NI-1 Task Force and made available to COS.

- National ISDN-1 Basic Rate Interface Circuit-switched Network Layer Conformance Test Suite (Basic Call Control)
- National ISDN-1 Call Forwarding Conformance Test Suite
- National ISDN-1 Call Hold Conformance Test Suite
- National ISDN-1 Call Pickup Conformance Test Suite
- National ISDN-1 Calling Line Identification Conformance Test Suite
- National ISDN-1 Additional Call Offering Conformance Test Suite
- National ISDN-1 Display Conformance Test Suite
- National ISDN-1 Multiline Hunt Conformance Test Suite
- National ISDN-1 Message Service Conformance Test Suite
- National ISDN-1 Flexible Calling Conformance Test Suite
- National ISDN-1 Automatic Callback Conformance Test Suite
- National ISDN-1 Electronic Key Telephone Service (EKTS) Group Intercom Conformance Test Suite
- National ISDN-1 EKTS DN Bridging Conformance Test Suite
- National ISDN-1 EKTS Call Hold Conformance Test Suite
- National ISDN-1 EKTS Shared DN Conformance Test Suite
- National ISDN-1 EKTS Bridging Conformance Test Suite
- National ISDN-1 EKTS Station Ring Transfer Conformance Test Suite
- National ISDN-1 EKTS Bridged Call Exclusion Conformance Test Suite

5.1.13.3 NIUF/NI-1 Test Suite Guidelines for Conformance Testing

A guidance document was developed to provide information to equipment vendors and testing groups to implement the Layer 3 call control specifications in a manner which would allow it to pass both the NI-1 and NIUF conformance tests. This paper will be available at the NIUF meeting in October 1993.