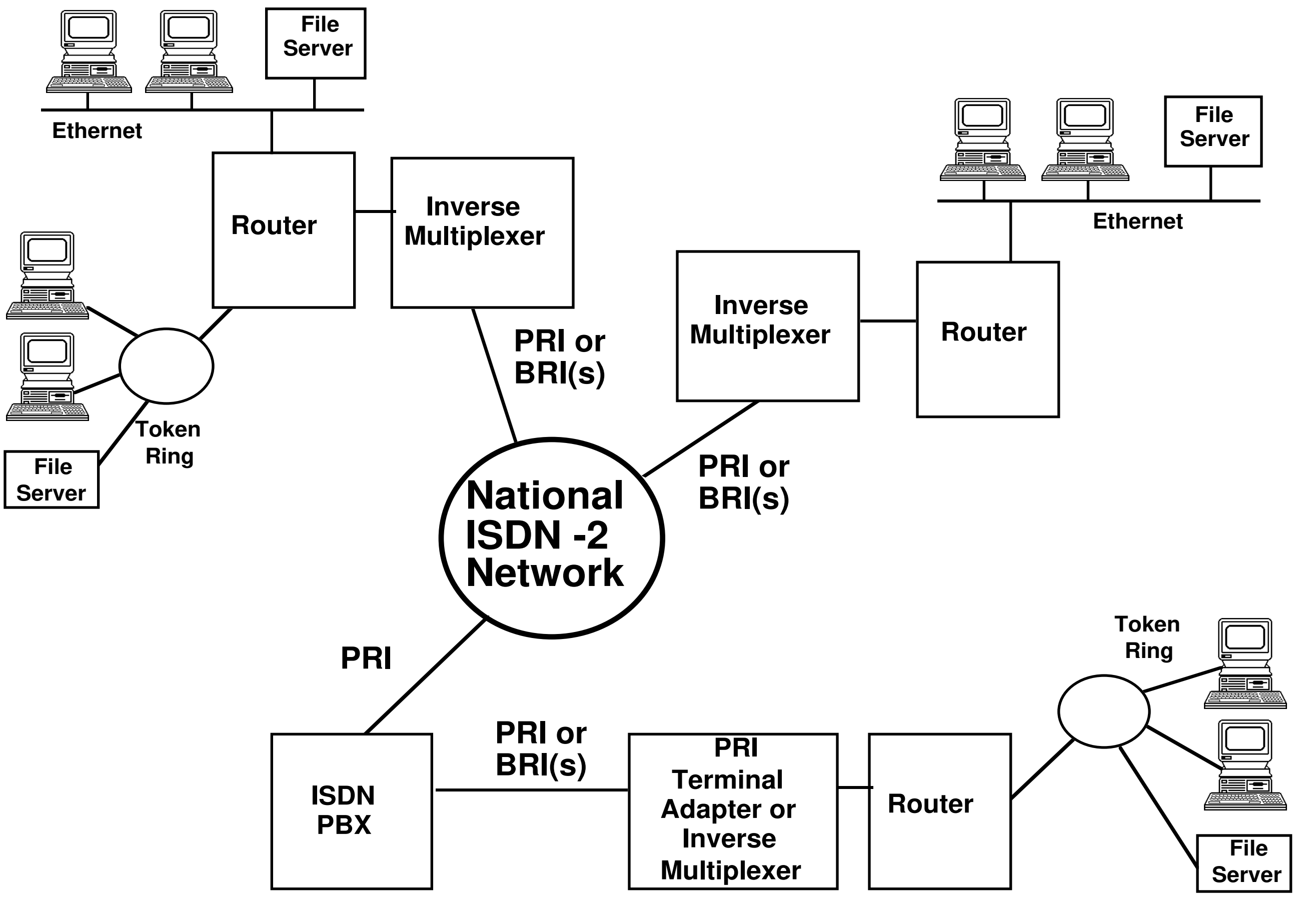
3.3.1 Local-area network interconnection

The ISDN primary rate interface can provide a high speed (up to 1.54 Mbps) interconnection of two LANs. Using the dial-up capabilities of PRI allows you to connect only the number of B channels that are needed. Thus, it eliminates the need for an under-utilized high speed leased line. This capability is especially important in interconnecting large LANs that have the occasional need to transfer very large amounts of information while meeting severe response time requirements.

Configuration:



How it Works:

Based on destination LAN address, the local router places one (to 23) 64 kbps circuit-data calls to the remote router. The number of calls is based on throughput requirements. After the connections are established, routers use inverse multiplexing to synchronize the individual B channels to provide an N x 64 kbps data channel to end systems. The router at either end can store the destination LAN addresses and ISDN directory numbers to provide a dial out capability to other routers on an "as needed" basis. Alternatively, the router can connect to the network through a PRI Terminal Adapter and PBX using SWF-DS1 (Multirate ISDN). The channel synchronization is performed by the SWF-DS1 functionality.

Obtain Equipment with These Capabilities

Router/Bridge

- Compatible interfaces with Local LANs (e.g., Ethernet, Token Ring).
- Router (or Bridge) functions compatible with LAN Operating Systems and personal computer communications software.
- Automatic dialing of peer Router based on destination address from LAN protocol.
- High speed serial interface (e.g., V.35) at 384 kbps.

Inverse Multiplexer/PRI Terminal Adapter

- Inverse multiplexing function to form N x 64k (56k) channel from N individual 64k (56k) circuit-data calls. Calls can be over PRI or multiple BRIs. Alternatively, place SWF-DS1 (Multirate ISDN) calls on a PRI at speeds greater than 64 kbps.
- The Inverse Multiplexer or TA can connect to the network through a PBX, Multiplexer, or other private network equipment.
- Support one or more directory number values for use with circuit-data calls.
- Support Calling Number Identification Services for circuit-data calls.

Private Branch Exchange (PBX)

- Support simultaneous voice and redundant data access to the network by offering BRI and/or PRI interfaces to Inverse Multiplexers or PRI Terminal Adapters.

Request These Capabilities From ISDN Service Provider

Network Interface to Inverse Multiplexer or Terminal Adapter (PRI)

- One 23B+D PRI.
- Directory Numbers (DNs) as required by application.
- B channels with:
  Circuit-data.
  SWF-DS1 (Multi-rate ISDN).
- **Features for Circuit-Data**
  - None required.
  - Optional Calling Number Identification Services.

Network Interface to Inverse Multiplexer - BRI

Network Services Required:

- One or more BRI. (2B)

For each BRI:

- Two B channels for circuit-data calls. If using NI-1, this requires two circuit-data DNs and SPIDs.
- Circuit-Data Features:
  - None required. (See Technical Note)
  - Optional Calling Number Identification Services.

Subscription or Ordering Information:

- This interface is configured for two simultaneous circuit-data calls (NIIG 14). Other NIIGs which have this functionality include 15, 17, 24, 25, and 27.
- Parameter Groups for Circuit-Data Features:
  - None required. (See Technical Note)
  - A la carte: Calling Number Identification Services (Optional)

Network Interface to PBX

- One 23B+D PRI.
- Directory Numbers (DNs) as required by Inverse Multiplexing or SWF-DS1 equipment.
- B channels with:
  - Voice
  - Circuit-Data
  - SWF-DS1 (Multirate ISDN)
- Features for Voice, Circuit-data, & SWF-DS1:
  - None required
  - Optional Calling Number Identification Services.

Technical Notes

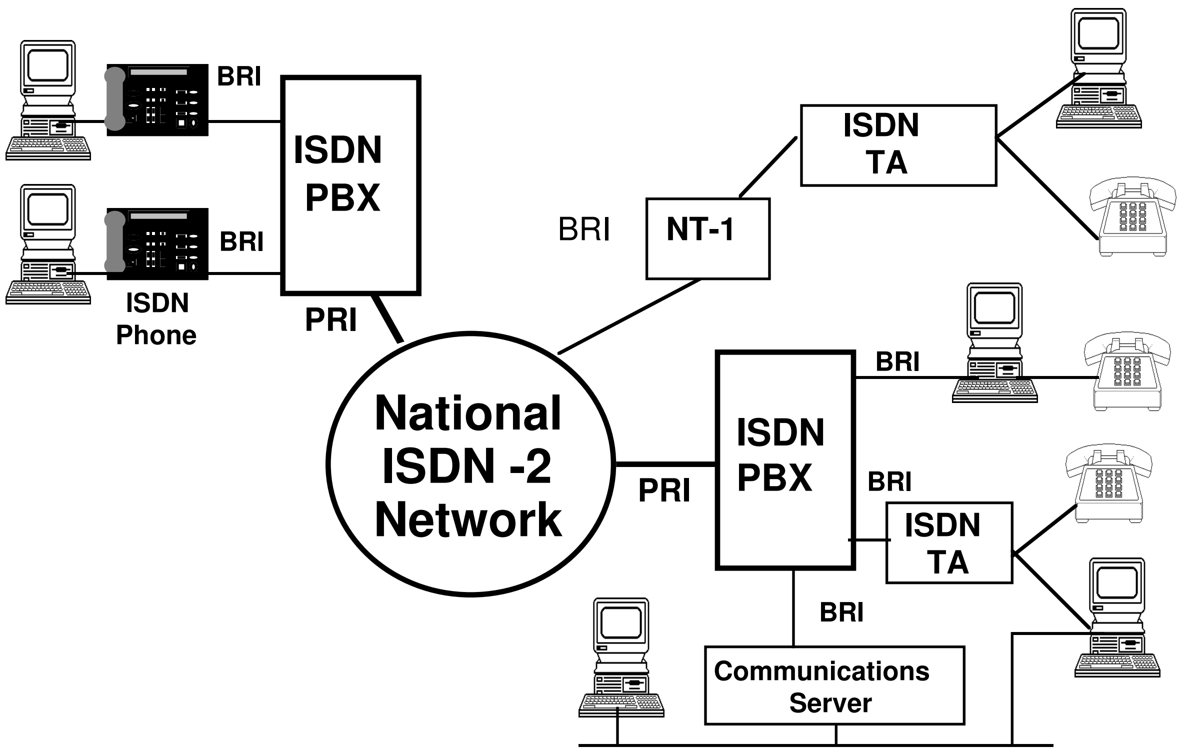
The inverse multiplexers can utilize a PRI or multiple BRI lines network access. The choice will depend chiefly on the total required bandwidth and economics of the services and related CPE (NT-1's, CSU, etc.) -- the services are functionally identical in this application.

- By using PRI with SWF-DS1 (Multirate ISDN), the router can (through a PBX, Multiplexer or communications controller) use a single nx64 channel provided by the network. More information on high bandwidth configurations may be found in Section 5.1.9.
- The Router with Inverse Multiplexer needs to use compatible protocols for framing MAC layer packets (e.g., Ethernet packets) onto ISDN circuit-data, and compatible protocols for inverse multiplexing.
- If the information transferred from the LAN is greater than 1536 kbps, (i.e., 10 Mbps Ethernet, 16 Mbps token ring, etc.) an inverse Multiplexer may be used to combine channels from PRI(s) or multiple BRIs. The Inverse Multiplexer is typically connected to the router using a high-speed serial interface such as HSSI.
- LAN administrators at each end should configure their routers with an association of destination LAN addresses with ISDN Directory Number(s) of peer router(s).
- ISDN Supplementary Services: Calling Number Identification may be used to provide additional security to the network.
- Significant Router options:
  - Ability to dynamically add or drop B channels from connection as needed by inter-LAN traffic load
  - Ability to dial out to other router locations simultaneously. For example, the 23 B+D interface allows the local router to simultaneously dial out to one remote at H0 = 384 kbps and to another remote at H11 = 1536 kbps.
  - Security screening functions, used to verify identity of peer router based on its calling or redirecting number
- For detailed signaling flow diagrams, see Sections 5.2.1.5 (Circuit-data Call Setup), 5.2.1.6 (Circuit-data Call clearing), 5.2.3.4 (Circuit-data Call Setup), 5.2.3.7 (Multirate Call Setup), and 5.2.3.8 (Call clearing).

3.3.2 File transfer and LAN access in a PBX environment

A company with PBXs at two locations wants to make it easier for workers at the different sites to work together. By bringing ISDN to the desktop for voice and data integration, people can exchange draft memos, spreadsheets, and presentations without the cost and inconvenience of faxes. By keeping work in electronic form, its easy to make changes and customize results. With ISDN's bandwidth and low error rates, files can be transferred quickly. Whether inside the organization or between companies, users can move information easily with widely available file transfer programs.

Configuration:



How It Works:

Each PBX uses an ISDN PRI trunk for access. Users on the PBX have BRIs for voice and data. To transfer files, the user places a circuit-data call from his/her personal computer to the second user's computer. For access to the corporate network from outside, the user dials a 64 (or 56) kbps circuit-data call to the communications server (gateway), and logs in though their terminal emulation program.

Obtain Equipment with These Capabilities

Private Branch Exchange (PBX)

- Support PRI.
- Line side 2B+D BRIs for each user, with simultaneous voice and circuit-data calling.

Personal Computers

- File transfer and communications software compatible with far end.
- Serial connection to Terminal Adapter (e.g., RS-232, RS-449, V.35).

ISDN Terminal Adapter

- B channel capabilities:
  - Voice calling on a single B channel.
  - Circuit-data calling on a single B channel.
  - Alternate voice and circuit-data calling on a single B channel.
  - If using NI-2 (or NI-1), support for one Directory Number (DN) and Service Profile ID (SPID) will be needed.
  - Support rate adaptation for rates lower than 64 kbps. For example, asynchronous communications may be rate adapted using V.120.
- Physical interfaces:
  - For TA, analog phone jack.
  - Serial connection to Personal Computer (e.g., RS-232, RS-449, or V.35).
  - RJ-45 connector to NT-1, or integrated NT-1

Communications Server

- Application software compatible with communication software and with far end.
- Accounting and security features that use the calling number.
- Multiple BRIs to meet network traffic requirements.
- B channel capabilities for each BRI:
  - Simultaneous circuit-data calling on two B channels.
  - Support for the circuit-data features listed under "Network Interface to Communications Server".
- Physical interfaces:
  - Local LAN (e.g., Ethernet or Token Ring).
  - RJ-45 connector to NT-1, or integrated NT-1.

Request These Capabilities From ISDN Service Provider

Network Interface to PBX

- One 23B+D PRI.
- Directory Numbers (DNs) as required by application.
- B channels with:
  - Voice.
  - Circuit-data.
- Features for Voice and Circuit-Data:
  - Calling Number Information Services.

Network Interfaces to ISDN Terminal Adapter

Network Services Required:

- One BRI. (2B)
- If using NI-2, a single DN and SPID.
- One B channel for voice calls, with (if NI-1) voice DN and SPID.
- One B channel for circuit-data calls, with (if NI-1) circuit-data DN and SPID.
- Voice Features:
  - None required.
- Circuit-Data Features:
  - None required.

Subscription or Ordering Information:

- This interface is configured for simultaneous voice calls and circuit-data calls (NIIG 11). Other NIIGs which have this functionality include 12, 15, 17, 21, 22, 25, and 27.
- Parameter Groups for Voice Features:
  - None required.
- Parameter Groups for Circuit-Data Features:
  - None required.

Network Interface to Communications Server

Network Services Required:

- One or more BRI. (2B)

For each BRI:

- If using NI-2, a single DN and SPID.
- Two B channels for circuit-data calls, with (for NI-1) circuit-data DNs and SPIDs.
- Circuit-Data Features:
  - Multiline Hunt Group.
  - Calling Number Identification Services.

Subscription or Ordering Information:

- This interface is configured for two simultaneous circuit-data calls (NIIG 14). Other NIIGs which have this functionality include 15, 17, 24, 25, and 27.
- Parameter Groups for Circuit-Data Features:
  - A la Carte: Multiline Hunt Group.
  - Calling Number Identification Services.

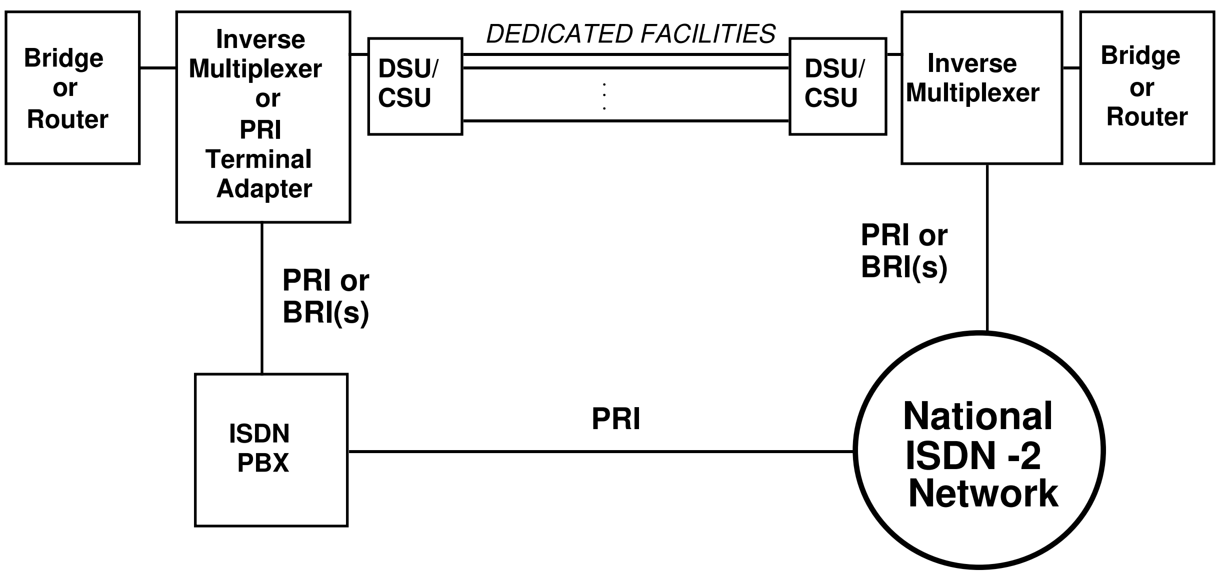
Technical Notes

- Calling number delivery can be used for screening when calling the communications server.
- An existing communications server (dial-up router, or terminal server) can be adapted to support ISDN access. Change out modems or CSU/DSUs for Terminal Adapters.
- The Lower Layer Compatibility Information Element (LLC-IE) can communicate rate-adaptation details end-to-end. For details on V.120 rate adaptation, and the use of the LLC Information Element for circuit-data calls, see Sections 5.1.4 and 5.1.5.
- For details on subscription and ordering information using NIUF ISDN Interface Groups (NIIG) and NIUF Parameter Groups (NIPG) , see Section 5.1.11.
- For detailed Signaling Flow Diagrams for this application, see Sections 5.2.1.4 (Voice Call Setup), 5.2.1.5 (Circuit-data Call Setup) and 5.2.1.6 (Voice and Circuit-data Call Clearing).
- For detailed signaling flow diagrams, see Section 5.2.3.4 (Circuit-Data Call Setup), 5.2.3.7 (Multirate Call Setup), and 5.2.3.8 (Call Clearing)..

3.3.3 Private lines overflow and disaster recovery

Certain wide area networks (WANs), due to sustained traffic volume, may justify the use of full-time dedicated lines. ISDN costs are generally based on usage and in some instances may not be cost effective as a replacement of the full-time dedicated facilities. However during peak usage periods, ISDN can be used to expand bandwidth. Also, in the event of a failure of the dedicated facilities, ISDN can be used as an automatic back-up WAN connection. Thus, ISDN is a low cost alternative to adding redundancy to dedicated facilities.

Configuration:



How It Works:

The configuration provides for the dedicated lines overflow and a disaster recovery mechanism when the dedicated lines become inoperative. In addition, a sufficient ISDN access (either ISDN PRI or multiple ISDN BRI's) is embedded in the design to meet the additional requirements of peak-load traffic periods or hot back-up situations. LAN packets are continuously identified by the bridge/router as either local traffic or as remote traffic for transmission via the inverse multiplexer to a remote location. The packets are sent by the inverse multiplexer exclusively over the dedicated facilities until; (1) the limit of the dedicated lines throughput capacity is exceeded - the inverse multiplexer then establishes circuit switched data connections which are inverse multiplexed with the dedicated facilities. As the traffic level decreases, the inverse multiplexer releases circuit switched data connections; or, (2) the dedicated facilities fail - the inverse multiplexer then establishes circuit switched data connections as needed to support the current remote traffic. As traffic levels decrease, or the dedicated facilities come back into service, the Inverse Multiplexer will release circuit switched data connections. The application can also be provided via an ISDN PBX with a PRI Terminal Adapter using SWF-DS1 (Multirate ISDN) calls. The SWF-DS1 service provides the user designated bandwidth via network-based multiplexing on a call-by-call basis.

Obtain Equipment with These Capabilities

Bridge or Router

- Compatible interfaces with Local LANs (e.g., Ethernet, Token Ring)
- LAN bridging and/or routing functions compatible with Network Operating System and application software.
- Automatic dialing of peer Bridge/Router based on destination address from LAN protocol
- High speed serial interface (e.g., V.35) at 384 Kbps.

Inverse Multiplexer/PRI Terminal Adapter

- Supports connection to dedicated facility via V.35 to external CSU/DSU, channel bank, T1-MUX , etc.
- Distributes remote traffic across multiple circuit switched data connections and the dedicated facility (e.g., n x 56/64 kbps + 224/256 kbps , respectively) and reassembles data streams at the destination. The multiple connections must support different data rates.
- Inverse multiplexing function to form N x 64k (56k) channel from N individual 64k (56k) circuit-data calls. Calls can be over PRI or multiple BRIs. Alternatively, place SWF-DS1 (Multirate ISDN) calls on a PRI at speeds greater than 64 kbps.
- The Inverse Multiplexer or PRI TA can connect to the network through a PBX or other private network equipment.
- Support one or more directory number values for use with circuit-data calls
- Support Calling Number Identification Services for circuit-data calls

Private Branch Exchange (PBX)

- Support simultaneous voice and redundant data access to the network by offering BRI and/or PRI interfaces to Inverse Multiplexers and PRI Terminal Adapters.

Request These Capabilities From ISDN Service Provider

Network Interface to Inverse Multiplexer or Terminal Adapter - PRI

- One 23B+D PRI
- Directory Numbers (DNs) as required by Inverse Multiplexing or SWF-DS1 equipment.
- B channels with:
  - Circuit-Data
  - SWF-DS1 (Multirate ISDN)
- Features for Circuit-Data
  - None required
  - Optional Calling Number Identification Services.

Network Interface to Inverse Multiplexer - BRI

Network Services Required:

- One or more BRI. (2B)

For each BRI:

- Two B channels for circuit-data calls. If using NI-1, this requires two circuit-data DNs and SPIDs.
- Circuit-Data Features:
  - None required. (See Technical Note)
  - Optional Calling Number Identification Services.

Subscription or Ordering Information:

- This interface is configured for two simultaneous circuit-data calls (NIIG 14). Other NIIGs which have this functionality include 15, 17, 24, 25, and 27.
- Parameter Groups for Circuit-Data Features:
  - None required. (See Technical Note)
  - A la carte: Calling Number Identification Services (Optional)

Network Interface to PBX

- One 23B+D PRI.
- Directory Numbers (DNs) as required by Inverse Multiplexing or SWF-DS1 equipment.
- B channels with:
  - Voice
  - Circuit-Data
  - SWF-DS1 (Multirate ISDN)
- Features for Voice, Circuit-data, & SWF-DS1:
  - None required
  - Optional Calling Number Identification Services.

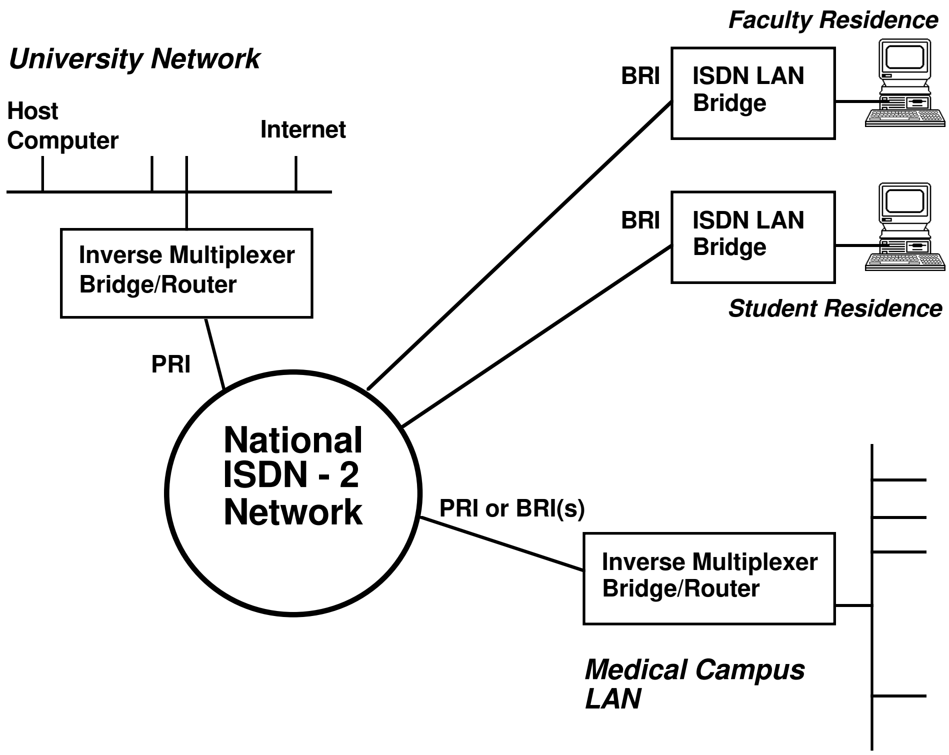
Technical Notes

- The Inverse Multiplexer can utilize a PRI or multiple BRI line network access for backup. The choice of interface will depend chiefly on the total required bandwidth and economics of the services and related CPE (NT-1's, CSU, etc.) -- the services are functionally identical in this application.
- By using PRI with SWF-DS1 (Multirate ISDN), the router can (through a PBX, multiplexer or communications controller) use a single nx64 channel provided by the network. More information on high bandwidth configurations may be found in Section 5.1.9.
- ISDN Bridge/Router Inverse Multiplexers need to use compatible protocols for framing MAC layer packets (e.g., ethernet packets) onto ISDN circuit-data, and compatible protocols for inverse multiplexing.
- Multiple remote locations (LANs) can be supported simultaneously with additional ISDN and/or dedicated interfaces.
- ISDN Supplementary Services: Calling Number Identification may be used to provide additional security to the network.
- Existing bridge and router networks can be modified to support ISDN back-up and overflow with the addition of an external Inverse Multiplexer supporting a V.35 interface to the bridge/router. The user will have circuit-data and dedicated bandwidth aggregated together <u>only if</u> the Inverse Multiplexer has both capabilities.
- Inverse multiplexing equipment on Basic Rate Interfaces may require a la carte feature ordering to allow callers to place multiple circuit-data calls using a single DN as shown in 3.1.11.
- For detailed signaling flow diagrams, see Sections 5.2.1.5 (Circuit-data Call Setup), 5.2.1.6 (Circuit-data Call clearing), 5.2.3.4 (Circuit-data Call Setup), 5.2.3.7 (Multirate Call Setup), and 5.2.3.8 (Call clearing).

3.3.4 ISDN Concentrator for Campus Connectivity

The extensive computing resources on University campuses have created a growing need for remote connectivity at the residences of faculty and students as well as other university computer users in proximity to the Campus. As applications have advanced, simple terminal to host access has become insufficient to meet the demand for increased bandwidth. Interconnected LANs provide the best architecture for today's client-server and distributed computing environments. Use of inverse multiplexing (or SWF-DS1) and ISDN LAN Bridge or Router technology provides an easy-to-manage high performance solution.

Configuration:



How It Works:

Central computing resources (super-computers, mainframes, workstations.) reside on a backbone campus LAN with gateways to other networks and computing facilities. A bridge/router inverse multiplexer with multiple BRI lines or a PRI line also resides on the backbone network. Individual remote users or small clusters of remote users also have personal computers with LAN interfaces or small remote LANs. At each remote location, a bridge/router inverse multiplexer or small BRI ISDN LAN Bridge can initiate or respond to access from another location. Routers and ISDN LAN Bridges have compatible framing protocols. On receipt of a packet intended for a distant site, the inverse multiplexer establishes one or more circuit switched data connections to the remote location. Alternatively, SWF-DS1 (Multirate ISDN) can be used. The appropriate DN(s) are determined from routing tables and addressing information. Based on the traffic volume, the inverse multiplexer establishes additional circuit switched data connections and multiplexes them to provide one logical connection with an aggregate bandwidth of all the circuit switched channels. As traffic levels decrease the inverse multiplexer will release circuit switched data connections.

Obtain Equipment with These Capabilities

Bridge/Router Inverse Multiplexer (Hub and medium sized LAN location)

- Interface to LAN (AUI, 10BaseT, etc.) Filters local addresses, and associates remote addresses with various locations. Each location is associated with one or more Directory Numbers (DNs).
- Bridge/Router Inverse Multiplexer is compatible with ISDN LAN Adapter for ethernet/ISDN framing and inverse multiplexing.
- Supports either ISDN PRI or multiple ISDN BRI ports (RJ-45) for connection to NT-1 (BRI) or Extended Super Frame (T1-ESF) CSU (PRI). Interface is at the S/T reference point.
- Automatically establishes circuit switched data connections to the appropriate remote DNs using LAN addressing and routing information.
- Distributes remote traffic across multiple circuit switched data connections (e.g., n x 56/64 Kbps circuit-data) and reassembles data stream at the destination. The multiple connections must support different data rates.
- Alternatively, the router can interface to SWF-DS1 (Multirate ISDN) on a PRI, placing a 6x64 Kbps call.

Personal Computer with LAN Interface

- Application software compatible with communications software and far end .
- LAN interface (e.g., Ethernet, Token Ring) compatible with ISDN LAN Bridge

ISDN LAN Bridge (Individual user and small LAN location)

- Filters local addresses, and associates remote addresses with various locations. Each location is associated with one or more Directory Numbers (DNs).
- Compatible with the Hub protocol for framing and inverse multiplexing.
- Automatically establishes circuit switched data connections to the Hub location.
- Distributes remote traffic across one or two circuit switched data connections (e.g., n x 56/64 circuit-data) and the Hub reassembles data stream.
- LAN bridge functions compatible with far end and local LAN (e.g., Ethernet or Token Ring).
- B channel capabilities:
  - Simultaneous circuit-data calling on two B channels.
  - If using NI-2, support for one Directory Number (DN) and Service Profile ID (SPID) will be needed.
  - Optionally combine two 64 kbps signals to/from the BRI into 128 kbps signal in a way that is compatible with far end. .
- Physical interfaces:
  - Local LAN (e.g., Ethernet or Token Ring).
  - RJ-45 connector to NT-1, or integrated NT-1.

Request These Capabilities From ISDN Service Provider

Network Interface to Bridge/Router Inverse Multiplexer (PRI)

- One 23B+D PRI.
- Directory Numbers (DNs) as required by application.
- B channels with:
  - Circuit-data.
  - Multi-rate circuit-data.
- Features for Circuit-Data:
  - None required.
  - Optional Calling Number Identification Services.

Network Interface to Bridge/Router Inverse Multiplexer (BRI)

Network Services Required:

- One or more BRI. (2B)
- Two B channels for circuit-data calls, with one circuit-data DN and SPID
- Circuit-Data Features:
  - None required.

Subscription or Ordering Information:

- This interface is configured for two simultaneous circuit-data calls (NIIG 14). Other NIIGs which have this functionality include 15, 17, 24, 25, and 27.
- Parameter Groups for Circuit-Data Features:

  None required.

Network Interface to ISDN LAN Bridge

- One BRI. (2B)
- Two B channels for circuit-data calls, with one circuit-data DN and SPID
- Circuit-Data Features:
  - None required.
- Subscription or Ordering Information:
  - This interface is configured for two simultaneous circuit-data calls (NIIG 14). Other NIIGs which have this functionality include 15, 17, 24, 25, and 27.
  - Parameter Groups for Circuit-Data Features:

    None required.

Technical Notes

- The Hub inverse multiplexer can utilize a PRI or multiple BRI lines network access. The choice will depend chiefly on the total required bandwidth and economics of the services and related CPE (NT-1's, CSU, etc.) -- the services are functionally identical in this application.
- By using PRI with SWF-DS1, the router can (through a multiplexer or communications controller) use a single nx64 channel provided by the network.
- ISDN LAN Bridges and Bridge/Router Inverse Multiplexers need to use compatible protocols for framing MAC layer packets (e.g., ethernet packets) onto ISDN circuit-data, and compatible protocols for inverse multiplexing.
- Many Multiport LAN Bridges and Routers can utilize a PRI or multiple BRI lines for network access.
- Some ISDN LAN Bridges and Routers support data compression, so effective data throughput may be higher. See Section 4 for products.
- Connections to multiple remote locations (LANs) are supported simultaneously with association of LAN addressing and routing information to multiple DNs.
- Calling Number Identification may be used to provide additional security to the network.
- For details on subscription and ordering information using NIUF ISDN Interface Groups (NIIGs) and NIUF ISDN Parameter Groups (NIPG), see Section 5.1.11.
- For detailed signaling flow diagrams, see Sections 5.2.1.5 (Circuit-Data Call Setup), 5.2.1.6 (Circuit-Data Call clearing), 5.2.3.4 (Circuit-data Call Setup), 5.2.3.7 (Multirate Call Setup), and 5.2.3.8 (Call clearing).