3745 Communication Controller Model A
3746 Nways Multiprotocol Controller
Models 900 and 950

Planning Series:

Serial Line Adapters

GA27-4235-01

3745 Communication Controller Model A
3746 Nways Multiprotocol Controller
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GA27-4235-01

Note!

Before using this information and the product it supports, be sure to read the general information under “Notices” on page xiii.

Second Edition (September 2000)

This edition applies to the 3745 Communication Controller Models A and 3746 Nways® Multiprotocol Controller Models 900 and 950.

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For more information, refer to:

`http://www.ibm.com/year2000`

The 3745 and 3746 controllers require a certain level of microcode to be Year 2000 ready. For more detailed information, access the URL listed above and click **Product Readiness**.

What Is New in This Edition

This book has been revised to include the addition of two new parameters for the X.25 ODLC controlled by the Network Control Program (NCP):

- Packet level protocol (PLP) piggy-backing disabling support (PLPPIGGYB=NO)
- NETTYPE3 support (NETTYPE=3)

The technical changes and additions are indicated by a vertical line (|) to the left of the change.

About this Guide

The *3745/3746 Planning Series* is designed to help you plan the installation and configuration of the IBM 3745 Communication Controller Models A and IBM 3746 Nways® Multiprotocol Controller Models 900 and 950. The *Planning Series* also describes the information you must gather to install and integrate 3746 Controllers into Advanced Peer-to-Peer Networking®/High-Performance Routing (APPN®/HPR) and Internet Protocol (IP) environments.

The *3745/3746 Planning Series* consists of a set of Planning Guides that replace, update and obsolete the *Planning Guide*

Important:

1. If you already use the existing *Planning Guide*, IBM recommends that you read the new *Planning Series* to learn about new features and to become familiar with the new structure in which planning information is presented.
2. When planning the installation and configuration of 3746 controllers you must use the *IBM 3745 Communication Controller Models A, IBM 3746 Nways Multiprotocol Controller, Models 900 and 950: Overview* along with the *3745/3746 Planning Series* to have all required information.
3. The 3745/3746 documentation is updated periodically in response to your needs and to reflect product evolutions. Because of the time delay necessary to update hard media (books that are printed and available on CD-ROM), it is highly recommended that you check periodically the IBM 3745/3746 documentation on the Web for the latest versions of the documents (see "Additional Information on the Web" on page xxiii).

Refer to the appropriate Planning Guide for the parameters to be customized for the installation and operation of:

- 3745 Communication Controller Models A
- 3746 Nways Multiprotocol Controller Models 900 and 950
- Network Node Processor (NNP)
- Multiaccess Enclosure (MAE)
- Service processor
- Distributed Console Access Facility (DCAF) and TME® 10 remote consoles
- Java™ Console
- Network management

When you define 3746 resources controlled by NCP, record the information in the worksheets provided for the Controller Configuration and Management application.

The *3745/3746 Planning Series* consists of the following planning guides:

Overview, Installation, and Integration

Starts with a general overview of 3746 planning and then explains the various 3745 and 3746 installation and upgrade scenarios.

The guide also explains the options available for the basic integration of the controller and its service processor into your network. There are MOSS-E worksheets for these options, which are to be filled out for the IBM service representative who does the actual controller installation or upgrade. The appendixes:

- Shows the panels of the MOSS-E service processor customization function
- Support offered by each level of the 3746 Licensed Internal Code.

ESCON Channels

After an overview of ESCON® and the adapters, the guide explains the configuration and tuning. This can be done with either the ESCON Generation Assistant (EGA) tool or the Controller Configuration Management (CCM) tool.

The guide also includes examples of various types of ESCON configurations.

Note: For information about using ESCON adapters on the MAE, refer to the *Multiaccess Enclosure Planning* guide.

Token Ring and Ethernet

Helps you with the configuration and definitions of your 3746 Network Node token-ring adapters (TRAs) for APPN/HPR-, IP-, and NCP-controlled traffic.

There are MOSS-E worksheets for the token-ring information needed by the IBM service representative to install or update your machine.

Although no longer available from IBM, the guide explains 3746 Ethernet support and Ethernet adapter configuration.

The token-ring (IEEE 802.5) and Ethernet (IEEE 802.3) standards are discussed in the appendixes.

Note: For Multiaccess Enclosure Ethernet information, refer to the *Multiaccess Enclosure Planning* guide.

Serial Line Adapters

Starts with an overview of the serial line adapters. Next X.25, frame-relay, PPP, and SDLC support are covered.

The two ways that the 3746 supports ISDN (LIC16 adapter[1] and terminal adapters) are explained, including how ISDN lines can be used as backups for other types of lines.

There is an appendix that gives the frame-relay support in each NCP level since frame relay was introduced in NCP Version 6.

Note: For Multiaccess Enclosure ISDN information, refer to the *Multiaccess Enclosure Planning* guide.

Physical Planning

Gives information to help you plan the physical site used by the 3745/3746s frames, service processor, and network node processor: the physical dimensions, electrical characteristics, and so on. It also gives this information for the various components of the 3745/3646, such as the Multiaccess Enclosure, Controller Extension, LICs, LCBs, ARCs, and so on.

The cable descriptions include feature codes (FCs) and part numbers used when ordering them.

[1] No longer being manufactured

The guide includes and explains the controller installation sheets, which show what IBM has installed on your machines.

Plugging sheets for keeping track of your installed LICs, ARCs, and cables are provided along with examples and explanations of their use.

Note: This type of information for the Multiaccess Enclosure is in the *Multiaccess Enclosure Planning* guide.

Management Planning

Starts with a management overview covering:

- Tivoli® NetView®
- Performance Management
- Service processor
- Network Node Processor
- APPN Topology Integrator

Then there are chapters about:

- APPN/HPR Network Node management
- NetView Performance Monitor
- Remote console support
- IBM Remote Support Facility
- 3746 IP router management
- Multiaccess Enclosure APPN/HPR Network Node management
- X.25 network

There are MOSS-E worksheets for the network management parameters needed by the IBM service representative to install or upgrade your machine.

The guide explains the use of the MOSS-E Service Processor Customization.

There is an example of ESCON management information base (MIB) definitions.

Note: For Multiaccess Enclosure management information, refer to the *Multiaccess Enclosure Planning* guide.

Multiaccess Enclosure Planning

Provides information about the Multiaccess Enclosure and its adapters (ATM, ESCON, and so on) and how to configure them.

For information about:

- Multiaccess Enclosure APPN/HPR Network Node management, refer to the *3745/3746 Planning Series: Management Planning*
- Physical site planning and the cables, refer to the *3745/3746 Planning Series: Physical Planning*

Protocols Description

Is an in depth description of these protocols used by the 3746:

- APPN/HPR
- IP

The detailed discussions of how the 3746 and Multiaccess Enclosure support these protocols help you understand the purpose of the protocol parameter definitions and what types of information are needed for the most efficient operation of your 3745/3746-connected networks.

CCM Planning Worksheets, (Online)

These example worksheets for the 3746 and MAE can be used to plan the actual definitions of the many CCM parameters you need to configure your 3746.

This guides is available (in PDF format) on the Web at

`http://www.ibm.com/networking/did/3746bks.html#Customer`

Who Should Use the 3745/3746 Planning Series

The *3745/3746 Planning Series* is intended for network planners, network specialists, and system programmers responsible for collecting the information required for the installation and network integration of 3745 Communication Controller Models A and 3746 Expansion Unit Model 900 in an SNA environment, as well as the 3746-950 and 3746-900 as APPN/HPR network nodes and IP routers.

Where to Find More Information

While planning a migration, you must use the following documents in addition to the *3745/3746 Planning Series* guides:

- IBM *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180
- IBM *3745 Communication Controller All Models, 3746 Nways Multiprotocol Controller Model 900: Console Setup Guide*, SA33-0158 (This guide contains information about remote console access to 3745/3746-900s via an SNA/subarea, APPN, or TCP/IP path and using a modem.)

Also, you may need to use the following additional documents:

- IBM *3746 Nways Multiprotocol Controller Model 900 and 950: Controller Configuration and Management: User's Guide*, SH11-3081 (IBM recommends that you prepare controller definitions before installing a 3746. To obtain a stand-alone version of the Controller Configuration and Management that runs on an OS/2® workstation, contact your IBM marketing representative.)
- *3746 Nways Multiprotocol Controller Model 950: User's Guide*, SA33-0356. (This guide contains information about routine operations, installing and testing the communication line adapters, service processor, and remote consoles.)
- *Planning for Integrated Networks*, SC31-8062.

Be sure to use the latest editions of these documents. This will ensure that you have up-to-date and complete information about the 3746 controllers.

The following *IBM International Technical Support Organization* redbooks provide useful information about 3746 implementation:

- *APPN Architecture and Product Implementations Tutorial*, GG24-3669
- *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: APPN Implementation Guide*, GG24-2536
- *Subarea Network to APPN Network Migration Guide*, SG24-4656
- *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: IP Implementation Guide*, SG24-4845 (an IBM redbook).

Be sure to see the other relevant documents listed in the bibliography at the back of this guide.

Additional Information on the Web

You can access the latest news and information about IBM network products, customer service and support, and information about microcode upgrades at:

```
http://www.ibm.com/
```

The latest versions of the *Planning Series* and other 3745/3746 documentation are available in PDF format at:

```
http://www.ibm.com/networking/did/3746bks.html#Customer
```

CD-ROM

Starting with engineering change F12380, the Licensed Internal Code (LIC) is shipped on a CD-ROM. The complete 3745/3746 documentation set is also included on the CD-ROM.

Examples: 3745 Models A and 3746 *Planning Series*, 3746 NNP and Service Processor Installation and Maintenance Guides, CCM *User's Guide*, 3746-950 *User's Guide*, and others. See the bibliography for the complete name and form number of the books.

3745/3746 documentation is in PDF format. Acrobat Reader for OS/2® is included on the CD-ROM to allow you to read the .PDF files and print all or part of a book.

Accessing CD-ROM Information

To access the CD-ROM from a service processor equipped with a CD-ROM drive, do the following:

Step 1. Install the CD-ROM in the service processor CD-ROM drive.

Step 2. In the MOSS-E main panel, open the **View** menu and select **Information**.

Step 3. Double-click **CD-ROM documentation**. Your browser automatically opens and displays the documentation home page.

Step 4. Click any highlighted text (blue and underlined) to go to the material that interests you:

a. Click **Documentation** to access 3745/3746 books.

b. Click the icon marked PDF that corresponds to the item that interests you.

   The Acrobat Reader automatically opens and displays the file in the full panel mode. Use the **Page Up** and **Page Down** keys to move through the document.

   Press **Esc** to display the Reader menus that allow you to print all or part of the file.

   When you close the Acrobat Reader, you return to the browser.

   When you close the browser, you return to the MOSS-E Documentation menu.

Each document file has one or more of the following identifiers:

- Date
- Form number
- Engineering change level
- Revision code.

Check these identifiers on future releases of the CD-ROM to see if the documents that you use have been updated.

How to Use the 3745/3746 Planning Series

Your Responsibility as a Customer

You are responsible for performing the tasks listed in Table 1. These tasks are not performed by IBM personnel as part of the machine installation and basic operations. They can, however, be performed by IBM on a fee basis.

Table 1 (Page 1 of 3). Customer Tasks

Task	Where to Find Information
Network design:	Network design is not covered in this book. Refer to the following IBM books for SNA, APPN/HPR, and IP network planning guidance: • *Planning for Integrated Networks*, SC31-8062 • IBM redbooks: – *Subarea Network to APPN Network Migration Guide* – *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: APPN Implementation Guide* – *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: IP Implementation Guide* – *IBM Nways 2216 Multiaccess Connector Description* – *IBM 2216 Multiaccess Connector ESCON Solutions*
Physical planning: Before the IBM service representative arrives to install your controller, make sure that you have met the necessary requirements for the following: • Electric power • Floor space with service clearances • Space for the cables • The RSF switched line • The Controller Expansion (FC 5023) • Other components (such as the service processor).	"Physical Planning Details" chapter in the *3745/3746 Planning Series: Physical Planning*
Controller hardware configuration definitions: Decide what type of attachments (lines) and how many of each type you need.	This input is necessary for the IBM ordering system (CF3745). For more information, refer to the *3745/3746 Planning Series: Physical Planning*.

Table 1 (Page 2 of 3). Customer Tasks	
Task	**Where to Find Information**
Software definitions and tuning: • ESCON port, host link, and station definitions; ESCON resource, TCP/IP, and VTAM® tuning	Refer to: • “ESCON Adapters” chapter in the *3745/3746 Planning Series: ESCON Channels* • “ESCON Channel Adapter” chapter in the *3745/3746 Planning Series: Multiaccess Enclosure Planning* • “ESCON Configuration Examples” chapter in the *3745/3746 Planning Series: ESCON Channels*
• Token-ring port and station definitions; PU and LU maximum limits; port sharing with NCP-controlled traffic; duplicate addresses; token-ring APPN, IP, and/or NCP resource tuning and VTAM tuning	• “Token-Ring Adapters” chapter in the *3745/3746 Planning Series: Token Ring and Ethernet*
• Serial line (SDLC, PPP, frame-relay, and X.25) port and station definitions; location of CLPs, LICs, LCBs, and ARCs; maximum CLA line connectivity; CLP backups	• “Serial Line Adapters” chapter in the *3745/3746 Planning Series: Serial Line Adapters* • “3746 SDLC Support” chapter in the *3745/3746 Planning Series: Serial Line Adapters*
• Multiaccess Enclosure: hardware planning and configuration; software configuration and tuning	• *3745/3746 Planning Series: Multiaccess Enclosure Planning* • *3745/3746 Planning Series: Physical Planning*
• Use of the Controller Configuration and Management (CCM) application.	• *IBM Controller Configuration and Management User’s Guide*, SH11-3081. Also refer to: • *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: APPN Implementation Guide* (an IBM redbook) • *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: IP Implementation Guide* (an IBM redbook).
Filling out: • 3746 plugging sheets To keep a record of the processors and couplers (and their addresses) installed in the 3746 frame.	Refer to: • “Plugging Sheets for 3745 and 3746” chapter in the *3745/3746 Planning Series: Physical Planning*
• *CCM User's Guide*, SH11-3081 worksheets To plan the 3746 and MAE logical resource definitions. They can then be used when configuring the 3746 and MAE via the CCM.	• *3745/3746 Planning Series: CCM Planning Worksheets*

Table 1 (Page 3 of 3). Customer Tasks	
Task	**Where to Find Information**
NetView definitions in VTAM, the MOSS-E, NPM, CCM, NetView/360, and Tivoli NetView® (formerly NetView for AIX) for: • APPN traffic • IP traffic • NetView alert path.	Refer to: • “3746 Management Overview” chapter in the *3745/3746 Planning Series: Management Planning* • “3746 APPN/HPR Network Node Management” chapter in the *3745/3746 Planning Series: Management Planning* • “3746 IP Router Management” chapter in the *3745/3746 Planning Series: Management Planning*.
Controller, service processor, and network node processor definitions. For example: • Link IPL port information • Password management • NetView alert reporting path definitions • DCAF LU definitions • Ethernet port definitions for SNMP • Service processor token-ring and IP LAN addresses.	Refer to “Controller and Service Processor Integration” chapter in the *3745/3746 Planning Series: Overview, Installation, and Integration*. Fill out the worksheets in the various *Planning Series* guides. These worksheets are used by the IBM service representative during installation.
Remote console definitions (using DCAF): • Ensure that the necessary hardware and software is available for the type of console attachment chosen • Service processor definitions for DCAF • DCAF installation and configuration on the remote console.	Refer to: • “Remote Customer Consoles” chapter in the *3745/3746 Planning Series: Management Planning* • For the 3746-900, refer to the *3745 Console Setup Guide* • For the 3746-950, refer to the *IBM 3746 Nways Multiprotocol Controller Model 950 User’s Guide*
Connection to the IBM remote support facility (RSF): • Service processor connection (modem) definitions • Customer definitions for RSF records.	Refer to the “Connecting to the IBM Remote Support Facility” chapter in the *3745/3746 Planning Series: Management Planning*
Problem determination through the MOSS-E and NetView	For the 3746-900, refer to: • *Problem Analysis Guide* accessed online from the MOSS-E • *3745 Models A: Alert Reference Guide* • *3745 All Models: Advanced Operators Guide*

Finding Your Way Around in the New Planning Series

If you are familiar with the layout of the old *3745 Communication Controller Models A and 3746 Models 900 and 950: Planning Guide*, GA33-0457, Table 2 should help you find which of the eight new books of the planning series contains the information that you need.

Note: Some of the chapters in the *Planning Guide* have been split into two or more new chapters in one or more new guides.

Table 2 (Page 1 of 2). Location of Old Planning Guide Chapters in New Planning Guides

Old Planning Guide		New Planning Series Book	
Chapter	**Chapter Name**	**Chapter(s)**	**Guide Name**
1	3745 and 3746 General Information	--	Not included in the new guides
2	APPN/HPR Overview	1	*Protocols Description*
3	Internet Protocol (IP) Overview	2	*Protocols Description*
4	3746 ATM Support	4	*Multiaccess Enclosure Planning*
5	Token-Ring/802.5	B	*Token-Ring and Ethernet*
6	Ethernet Overview	C	*Token-Ring and Ethernet*
7	Frame Relay Overview	4, 5	*Serial Line Adapters*
8	Point-to-Point Protocol (PPP) Overview	4	*Serial Line Adapters*
9	X.25 Overview	2, 3, 5, 7	*Serial Line Adapters* *Management Planning*
10	ISDN Adapters	8	*Serial Line Adapters*
11	ESCON Overview	1	*ESCON Channels*
12	3745 and 3746 Installation and Upgrade Scenarios	2	*Overview, Installation, and Integration*
13	Configuration Scenarios	6	*Multiaccess Enclosure Planning*
14	3746 Planning Overview	1	*Overview, Installation, and Integration*
15	ESCON Adapters	1, 2, 3	*ESCON Channels*
16	Token-Ring Adapters	1, 2, 3	*Token-Ring and Ethernet*
17	Ethernet Adapters	4, 5	*Token-Ring and Ethernet*
18	Serial Line Adapters	1	*Serial Line Adapters*
19	3746 SDLC Support	3, 4	*Serial Line Adapters*
20	Multiaccess Enclosure	1	*Multiaccess Enclosure Planning*
21	Multiaccess Enclosure Adapters Overview	2	*Multiaccess Enclosure Planning*
22	ESCON Channel Adapter	8	*Multiaccess Enclosure Planning*
23	Multiaccess Enclosure ISDN Support	5	*Multiaccess Enclosure Planning*
24	3746 Configuration Overview	--	Not included in the new guides
25	Welcome to the CCM	--	Not included in the new guides
26	Multiaccess Enclosure Configuration	7	*Multiaccess Enclosure Planning*
27	3746 Base Frame ESCON Configuration Examples	1	*ESCON Channels*
28	Configuring the MAE ESCON Channel Adapter	8	*Multiaccess Enclosure Planning*

Table 2 (Page 2 of 2). Location of Old Planning Guide Chapters in New Planning Guides			
Old Planning Guide		**New Planning Series Book**	
Chapter	**Chapter Name**	**Chapter(s)**	**Guide Name**
29	3746 Management Overview	1	*Management Planning*
30	3746 APPN/HPR Network Node Management	2	*Management Planning*
31	3746 IP Router Management	6	*Management Planning*
32	MAE APPN/HPR Network Node Management	2	*Management Planning*
33	MAE IP Router Management	6	*Management Planning*
34	Controller and Service Processor	3	*Overview, Installation, and Integration*
35	Customer Consoles and DCAF	4 1 1	*Management Planning* *Overview, Installation, and Integration* *Token-Ring and Ethernet*
36	Connecting to the IBM Remote Support Facility	5	*Management Planning*
37	Performance Management with NetView Performance Monitor	3	*Management Planning*
37	3746 IP Router Management	6	*Management Planning*
38	MOSS-E Worksheets for Controller Installation (3745)	A A A	*Overview, Installation, and Integration* *Management Planning* *Token-Ring and Ethernet*
39	Parameter Cross-Reference Table	B	*Overview, Installation, and Integration*
40	CCM Worksheets for Controller Configuration Definitions	1	*CCM Planning Worksheets* (online)
41	Multiaccess Enclosure Worksheets	2	*CCM Planning Worksheets* (online)
42	Familiarizing Yourself with the Installation Sheets	2	*Physical Planning*
43	Plugging Sheets for the 3746 Nways Multiprotocol Controller	3	*Physical Planning*
44	Physical Planning Details	1	*Physical Planning*
A	3746-9x0 Microcode Levels (EC)	D	*Overview, Installation, and Integration*
B	ESCOM MIB	A	*Management Planning*
C	MOSS-E Service Processor Customization Function	C	*Overview, Installation, and Integration*

Chapter 1. Serial Line Adapters

On the 3746, serial line adapters are referred to as Communication Line Adapters (CLAs). A CLA consists of one Communication Line Processor (CLP) and up to four Line Interface Couplers (LICs). A CLA uses either LIC11s, LIC12s or LIC16s, or a combination of LIC types to connect to DCEs (modems) and DTEs (terminals) using SDLC, frame relay, X.25, ISDN, or PPP Data Link Control (DLC).

The CLA components are housed in the same enclosures as the ESCAs and TRAs in the base 3746-9x0.

CLP Types

CLP Types include CLP and CLP3. CLP has a 16-MB storage and CLP3 has a 32-MB storage and a more powerful processor. In this chapter, CLP stands for both types of processors, unless otherwise indicated. The improved connectivity of CLP3 is described more specifically in "Communication Line Adapter Connectivity" on page 18.

Communication Line Processors (CLP and CLP3)

The CLP provides DLC for LIC types 11, 12, and 16. Up to four LICs can be attached to the same CLP. All four LICs may be active at the same time as long as the line weights for the CLP maximum processor load and maximum storage are not exceeded (see "Line Weights and CLP Load" on page 9 and "Communication Line Adapter Connectivity" on page 18).

Up to four CLPs can be installed in a basic enclosure and up to six in each expansion enclosure. There are two LIC slots for each CLP slot. To connect a third and fourth LIC to a CLP, the CLP slot next to it must be empty, and the CLP slot and empty slot must occupy one of the slot pairs in the enclosure. The processor slots in the basic enclosure are labeled H, K, M, and P, and in the expansion enclosures, labeled D, F, H, K, M, and P (see Table 3).

For enclosure examples, refer to the "Familiarizing Yourself with the Installation Sheets" chapter in the *3745/3746 Planning Series: Physical Planning*, GA27-4238.

Table 3. 3746-900 Processor Slot Pairs

Enclosure	**Slot Pairs**		
Basic enclosure		H and K	M and P
First Expansion enclosure	D and F	H and K	M and P
Second Expansion enclosure	D and F	H and K	M and P

Note: For the addresses that correspond to the actual physical slot position, refer to the “Familiarizing Yourself with the Installation Sheets” chapter in the *3745/3746 Planning Series: Physical Planning*. The 3745/3746 hardware configurator (CF3745) automatically calculates the following:

- CLP and LIC locations.
- Maximum physical capacity (60 active lines per pair of LIC slots, 120 lines per CLP).
- Standard line weights, which represent an average between line speed, type of traffic, and traffic load. Large line weights might reduce the maximum capacity of the CLA. For details about CLP capacity, see “Line Weights and CLP Load” on page 9.

Communication Line Processor Connectivity

The maximum physical connectivity of a CLP is:

- 4 lines at speeds up to 2.048 Mbps[2].
- 32 lines at speeds up to 256 kbps[3].
- 120 lines at speeds up to 64 kbps. All 120 lines can be active at a time.

LICs

The 3746-9X0 can run three types of LICs: types 11, 12 and 16.

LIC Type 11

LIC11 is attached through active remote connectors (ARCs), which in turn are installed in line connection boxes (LCBs). Each ARC connects to a DCE or DTE. Up to 15 ARCs can be installed in a LCB. This allows a pair of LCBs to multiplex up to 30 lines into the LIC11.

The LIC11 attaches the following types of line to the controller:

- Low-speed (from 600 bps up to 64 kbps) lines

  Each line can use one of the following ITU-T interfaces:

  – V.24 (switched or nonswitched) at speeds up to 28.8 kbps.
  – V.35 (nonswitched) at speeds up to 64 kbps.
  – X.21 (nonswitched) at speeds from 600 bps up to 64 kbps.

  Thirty low-speed lines can be physically attached to a LIC11. All can be active at the same time.

- Medium-speed (above 64 kbps up to 256 kbps) lines.

  Each line is either ITU-T V.35 (nonswitched) or X.21 (nonswitched). Eight medium-speed lines can be attached to the LIC11.

Low- and medium-speed lines can be mixed on the same LIC11.

Direct attachment (without modem/DCE) to terminal/DTE is also possible. The following internal clocks are provided by the LIC11: 1200 bps, 2400 bps, 4800 bps, 9600 bps, 19.2 kbps, 38.4 kbps, 55.855 kbps, 64 kbps, and 256 kbps.

---

2 1 Mbps = 1 000 000 bits per second.

3 1 kbps = 1 000 bits per second.

LIC Type 12

LIC12 attaches one nonswitched line at speeds from 56 kbps up to 2.048 Mbps. The ITU-T interface for this high-speed line is either:

- V.35
- X.21

For direct attachment (without modems) to a DTE, for example, another 3745/3746, the LIC12 provides internal clocking for operations at 512 kbps, 1.024 Mbps, 1.536 Mbps, or 2.048 Mbps. Directly attached DTEs operating at different or at lower speeds, for example, a 3720 or 3725, must provide clocking. In this case, the LIC12 operates with an external clock provided by the attached DTE which is set between 56 kbps and 2.048 Mbps.

LIC Type 16

LIC16 is a single Primary Euro ISDN port (NCP controlled), operating at 2.048 Mbps with an external clock provided by the network. LIC16 supports E1 channels (30×64 Kbps) with HDB3 coding under NCP control.

The physical line interface of the LIC16 consists of a 120 ohms adapted link through an ODD26 connector fitted on the front of the case. The 30 m (98.5 ft) cable (part number 80G3984) of the LIC16 connects to the ISDN network connection. LIC16 supports CCITT G703, G704, G706, G732, and complies with European Community ISDN NET5/ETS 300011.

Characteristics of LIC Types 11, 12, and 16

Table 4. Characteristics of the LIC Types 11, 12, and 16

<table>
<tr><th rowspan="2"></th><th colspan="4">LIC Types</th></tr>
<tr><th colspan="2">LIC11</th><th>LIC12</th><th>LIC16</th></tr>
<tr><td>Protocol</td><td colspan="2">PPP, SDLC, frame relay, X.25</td><td>PPP, SDLC, frame relay, X.25</td><td>Euro-ISDN on D channel
frame relay on B channel</td></tr>
<tr><td>Line Speeds</td><td colspan="2">600 bps to 256 kbps</td><td>56 Kbps to 2.048 Mbps</td><td>1 D channel at 64 kbps
30 B channel at 64 kbps</td></tr>
<tr><td>ITU-T Interface</td><td colspan="2">V.24, (V.25 bis), V.35, X.21
(See Note 1)</td><td>V.35 or X.21
(See Note 2)</td><td>G703, G704, G706, G732</td></tr>
<tr><td>Number of Ports</td><td colspan="2">Up to 30
(See Note 3)</td><td>1</td><td>1</td></tr>
<tr><td>Cable Lengths (m)</td><td colspan="2">1.3, 7, 15, 35, 70, 105</td><td>(See Note 4)</td><td>30</td></tr>
<tr><td></td><td>Low-Speed Lines</td><td>Medium-Speed Lines</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>ARC Interface</td><td>V.24
(See Note 1)</td><td>V.35 and X.21</td></tr>
<tr><td>Line Speed</td><td>Up to 28.8 kbps</td><td>Up to 256 kbps</td></tr>
</table>

Notes:

1. Other interfaces (X.21 bis, for example) are supported using appropriate 3745 cable. Refer to the “Physical Planning Details” chapter in the *3745/3746 Planning Series: Physical Planning* for part numbers and cable lengths.
2. Depending on the cable used.
3. Multiplexed over the cable that connects the LIC11 to a pair of LCBs.
4. Refer to the “Familiarizing Yourself with the Installation Sheets” chapter in the *3745/3746 Planning Series: Physical Planning*.

LCBs

LCBs are used with the LIC11 to provide:

- Multiplexing of up to 30 lines to one LIC port.
- Reduced cable requirements between the controller and the modem room.

The LIC11 uses one cable to connect to one or two LCBs. Each LCB can connect up to 15 lines for a total of 30 lines per LIC11. The LCBs can be located in a standard 19-inch rack up to 103.5 m (341 ft) from the controller. This means, for example, that up to 30 DCEs (in a rack in the same room or in a separate modem room) need only one cable connection to the controller.

Note: The LIC11 cable is available as a plenum cable in the U.S.A. and Canada.

LCB Locations

LCBs can be installed in several locations:

3746-950 or 3746-900 frame
One or two LCBs (if no 2nd expansion enclosure installed).

Controller Expansion (FC 5023)
Up to 18 LCBs.

User installed racks
Any number of LCBs up to twice the number of LIC11s installed in the machine; the maximum is 32 LIC11s, that is 64 LCBs (containing a maximum of 600 ARCs).

Two Types of LCBs

There are two types of LCBs (functionally equivalent):

Line Connection Box Base (LCBB)
Connected directly to the LIC11.

Line Connection Box Expansion (LCBE)
Connected to the LCBB.

See Figure 1.

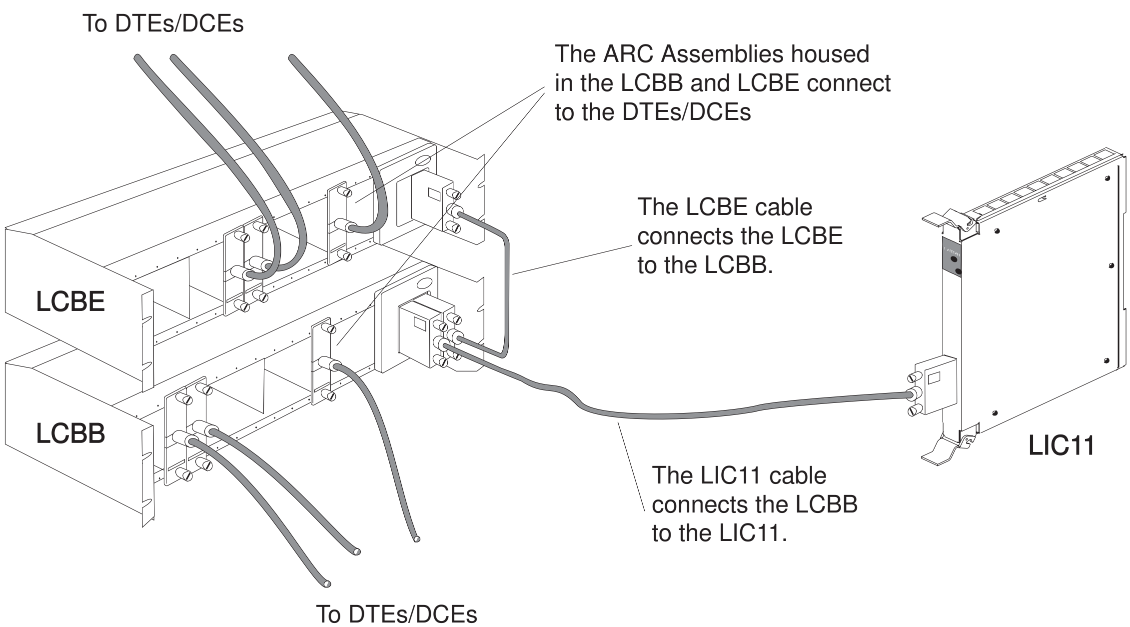


Figure 1. LCB Connections

For more information about the LCBs and for ordering information about the LIC11 cable, refer to the “Physical Planning Details” chapter in the *3745/3746 Planning Series: Physical Planning*.

ARCs

ARCs are housed in the LCBs and provide the electrical and physical interface between the DCE (modem) or DTE (terminal) and the adapter in the 3746-900 or 3746-950 (see Figure 1 on page 5). ARCs are available for different physical interfaces. For each type of ARC, there is a selection of cables with different lengths and types of end connectors.

An ARC is classified according to interface and attachment:

- Interface:

  ARC/V.24 Attached to a DTE or DCE through standard ITU-T V.24 interface connector.

  ARC/V.35 Attached to a DTE or DCE through standard ITU-T V.35 interface connector.

  ARC/X.21 Attached to a DTE or DCE through standard ITU-T X.21 interface connector.

  ARC/3745 Attached to a DTE or DCE through LIC1, LIC3, or LIC4A/LIC4B cable. This ARC cable has the same IBM connector as the connector on 3745/3746-L1x frames.

- Attachment:

  DCE
  DCE Transfix
  DTE (direct attachment).

- Cable length:
  Cable lengths range from 0.6 to 15 m. There are no plenum ARC cables.

For ordering information, refer to the “Physical Planning Details” chapter in the *3745/3746 Planning Series: Physical Planning*.

For more information on ARC assemblies, see Table 5 on page 7 and Table 6 on page 8.

ARC Assemblies A

The cable is permanently fixed to the ARC card.

Note: ARCs of this category are no longer available from IBM.

Table 5. ARC Assemblies A: ARC and Cable Permanently Attached

Interface	**V.24**				**V.35**				**X.21**			
Cable End Connector	**ARC V.24**		**ARC/3745**		**ARC V.35**		**ARC/3745**		**ARC X.21**		**ARC/3745**	
Attached to:	DCE	DTE	DCE	DTE	DCE	DTE	DCE	DTE	DCE	DTE	DCE	DTE
ARC Type (On label[1])	ARC V.24 DCE	ARC V.24 DTE	ARC V.24 DCE	ARC V.24 DTE	ARC V.35 DCE	ARC V.35 DTE	ARC V.35 DCE	ARC V.35 DTE	ARC X.21 DCE	ARC X.21 DTE	ARC X.21 DCE	ARC X.21 DTE
Cable Length m (ft)	**ARC Name** (On MOSS-E display)											
5 (17)	ARC 1A1		ARC 1C	ARC 1D	ARC 3A1		ARC 3C	ARC 3D	ARC 4A1 ARC 4A3[2]		ARC 4C	ARC 4D
12 (40)	ARC 1A2											
15 (50)		ARC 1B			ARC 3A2	ARC 3B			ARC 4A2 ARC 4A4[2]	ARC 4B		

Notes:

1. An ARC is labeled according to the type of device that it attaches to.
2. ARC4A3 and ARC4A4 (X.21 DCE - Transfix) provide internal wrapping of control (C) and indicate (I) leads. This is designed for Transfix DCEs (France), which do not support I and C signaling of X.21 interfaces.

ARC Assemblies B

This ARC assembly includes the ARC card and a cable. The cable can be disconnected from the card. Cable lengths are indicated by FCs (for available cable lengths, refer to the "Physical Planning Details" chapter in the *3745/3746 Planning Series: Physical Planning*.

Note: Also part of the assembly are two wire wrap plugs, one for the ARC card and another for the ITU-T interface at the end of the cable.

Table 6. ARC Assemblies B: Separate ARC and Cable

Interface	**V.24**				**V.35**				**X.21**			
Cable End Connector	**ARC V.24**		**ARC/3745**		**ARC V.35**		**ARC/3745**		**ARC X.21**		**ARC/3745**	
Attached to:	DCE	DTE	DCE	DTE	DCE	DTE	DCE	DTE	DCE	DTE	DCE	DTE
ARC Card Type (On label[1])	ARC V.24	ARC V.24	ARC V.24	ARC V.24	ARC V.35	ARC V.35	ARC V.35 3745 DCE	ARC V.35 3745 DTE	ARC X.21	ARC X.21	ARC X.21	ARC X.21
	ARC Name (On MOSS-E display)											
	ARC 1A0	ARC 1B0	ARC 1C0	ARC 1D0	ARC 3A0	ARC 3B0	ARC 3C0	ARC 3D0	ARC 4A0 ARC 4E0[2]	ARC 4B0	ARC 4C0	ARC 4D0

Notes:

1. An ARC is labeled according to the type of device that it attaches to.
2. ARC4E0 (X.21 DCE - Transfix) provides internal wrapping of control (C) and indicate (I) leads. This is designed for Transfix DCEs (France), which does not support I and C signaling of X.21 interfaces.

LCB Areas

LCBs are divided into four line areas. Each area of three or four lines can support one of the following:

- Up to four low-speed lines each with a speed of up to 64 kbps.
- One medium-speed line with a speed of up to 256 kbps.

A fully loaded LIC11 can serve 30 low-speed lines, 8 medium-speed lines, or any mixture of line types.

Areas for LCBs are shown in Table 7.

Table 7. LCB Slot Numbers in Each Area

LCB Type	**Area**	**Area**	**Area**	**Area**
LCBB	0 1 2 3	4 5 6 7	8 9 10 11	12 13 14
LCBE	16 17 18 19	20 21 22 23	24 25 26 27	28 29 30

Line Weights and CLP Load

Configuring Communication Lines on the 3746 (Line Weights)

CLPs perform DLC and data routing for traffic controlled by the 3746 (IP router, APPN/HPR network node). In addition, CLPs of the 3746-900 perform DLC for traffic routed by NCP running in the 3745. An individual line contribution to the CLP load (processor utilization) depends on the following:

- Traffic type: IP, HPR/ANR, HPR/RTP, APPN/DLUR, or NCP (3746-900).
- Line speed.
- Line protocol (frame relay, SDLC, X.25, PPP).
- Transmission type (duplex or half-duplex).
- Percentage of line utilization[4], resulting from messages sent by users and applications, and control information (for example, acknowledgements, ANR status frames, and so on).
- Parameters used by the 3746: *CCM User's Guide*, SH11-3081 definitions for the 3746-900 and 3746-950, and NCP definitions for the 3746-900.

CF3745 Hardware Configurator (Line Weights)

Standard Line Weight Assumptions: The 3746 hardware configurator (CF3745) assigns lines to CLPs by using standard line weights. The CF3745 assigns lines to CLPs without exceeding 90% of CLP load as calculated from standard line weights.

A standard line weight represents the CLP load resulting from a line operated under typical conditions, such as the percentage of line utilization (see Table 8 and Table 9 on page 10) and mix of traffic patterns (see Table 10 on page 10).

This line weight depends on the line speed, the line protocol (SDLC, frame relay, and so on) and routing protocol (APPN, ANR, IP, and so on).

Table 8. Assumed Line Utilization (Duplex) (Except NCP Traffic)

Line Speed Range	**Line Utilization[1]**
Up to 4.8 kbps	40%
Up to 28.8 kbps	45%
Up to 64 kbps	50%
Up to 256 kbps	45%
Up to 2.048 Mbps	40%

Note:

1. Line utilization includes user data, control traffic, header/trailer, and so on.

[4] Line utilization is determined by the size and rate of data messages exchange between users and applications.

Line Utilization Assumptions

Table 9. Assumed Line Utilization (NCP Traffic Only)

Line Speed Range[1]	Percentage of INN[3] Lines	INN Line Utilization[2]	Percentage of BNN[4] Lines	BNN Line Utilization[2]	Percentage of Duplex Lines	Percentage of Half-Duplex Lines
≥ 600 bps to 4800 bps	-	-	100%	40%	-	100%
> 4800 bps to 19.2 kbps	-	-	100%	40%	20%	80%
> 19.2 Kbps to 64 kbps	30%	60%	70%	40%	40%	60%
> 64 kbps to 2 Mbps	100%	40%	-	-	100%	-

Notes:

1. Line polling delay is assumed to be 0.2 s at speeds above 19.2 kbps and 0.5 s at speeds below or equal to 19.2 kbps.
2. Line utilization includes user data/control traffic, header/trailer, interframe gaps, and so on.
3. Intermediate Network Node.
4. Boundary Network Node.

Traffic Pattern Assumptions

Table 10. Assumed Traffic Mix

Traffic Type	Transaction Size: Bytes[1]	Percentage of Transactions[2]
Transaction Processing	128/128	20%
Interactive (3270-like)	40/1000	50%
Batch/File Transfer/Image	0/2000	15%
Batch/File Transfer/Image	0/4000	15%

Note:

1. For each direction, in or out of the 3746, size of the data message created by the sending workstation or application (0 means that the data traffic is in a single direction, in or out).
2. Expressed in % of the total traffic (100%).

Traffic Type Assumptions

Most of the standard default parameters of the CF3745 performance model are assumed for standard line weights[5]. Traffic types indicated in Table 12 on page 14 to Table 14 on page 17 are described in this section:

5 For X.25 lines, the standard parameters that mostly influence CLP utilization and resulting line weights are the following:

- Packet sizes (128 bytes) for X.25 packet formation and re-assembly.
- Packet acknowledgement frequency.

APPNDLUR

APPNDLUR applies to SDLC, frame relay, and X.25 3746 lines. The lines carry 3746-controlled APPN and/or dependent LU traffic.

Assumptions:

- Data messages (see Table 10 on page 10) are not segmented in the 3746 (particularly the CLP) or in any intermediate nodes between two end points (workstation and application).
- SDLC line polling delay is 0.2 seconds.

ANR

ANR applies to SDLC, frame relay, and X.25 3746 lines. The lines carry 3746-controlled HPR/ANR traffic.

Assumptions:

- Data messages (see Table 10 on page 10) are not segmented at HPR end points (RTP). The smallest segment size used on the RTP route is assumed to be at least equal to the largest data message (this smallest segment size is automatically recognized when an RTP connection is established).
- Small number of stand-alone control frames.
- SDLC/frame relay; assumed line mix of 50% SDLC and 50% frame relay.
- SDLC line polling delay at 0.2 seconds.
- frame relay lines, non-ERP mode.

Note: The first **ANR** column in Table 11 on page 13 to Table 14 on page 17 also applies to frame relay frame handler (FRFH) traffic (any protocol).

RTP

RTP applies to SDLC, frame relay, and X.25 3746 lines. The lines carry 3746-controlled HPR/RTP traffic.

CLP performs the boundary function (RTP) between *downstream* APPN/dependent LU traffic over these lines and *upstream* HPR traffic (HPR pipes terminate in the CLP).

Assumptions:

- Data messages (see Table 10 on page 10,) are not segmented in the 3746 (particularly the CLP) or in any intermediate nodes between two end points (workstation and application).
- SDLC line polling delay is 0.2 seconds.

IP

IP applies to PPP, frame relay, and X.25 3746 lines. The lines carry 3746-controlled IP traffic.

Assumptions:

- One stand-alone TCP acknowledgment of every two data packets.
- Data messages (see Table 10 on page 10) from IP hosts and applications are not fragmented at TCP/IP end points or in any intermediate router, including the 3746 (particularly the CLP).
- One data packet per data message.

NCP

The standard default parameters of the CF3745 performance model are assumed for line weights. See Table 9 on page 10 for assumed line utilization.

For a given transmission speed, Table 11 on page 13 shows standard line weights for CLP and Table 12 on page 14 shows standard line weights for CLP3. Corresponding standard CLP connectivity is shown in Table 13 on page 16 and CLP3 standard connectivity in Table 14 on page 17.

Weights and number of lines per CLP and CLP3 are indicated for line protocols (SDLC, frame-relay, PPP, and X.25), and traffic types (APPN/DLUR, HPR/ANR, HPR/RTP, IP, and NCP).

Standard Line Weights

Line weights corresponding to the "Standard Line Weight Assumptions" on page 9 are used by CF3745 to determine the required number of CLPs and lines. The CF3745 establishes the weight of a CLP at a maximum of 100, which is the theoretical CLP load of 90%. For the standard line weights of CLP3, see Table 12 on page 14.

The actual required number of CLPs and CLP3s, as determined by CF3745, will also depend on physical connectivity requirements.

Standard Line Weights for CLP

Table 11. Standard Line Weights[1] for CLP

Line Speeds (kbps)	Assumed Line Utilization	SDLC and frame relay[3]			PPP and frame relay[3]	X.25				SDLC frame relay X.25
		APPN DLUR	ANR	RTP	IP	APPN DLUR	ANR	RTP	IP	NCP[4]
2048.	40%	67	20	100[2]	16	100[2]	94	100[2]	100[2]	37.0
1544.	40%	50	15	100	12	100[2]	70	100[2]	80	33.0
1024.	40%	34	10	68	8	85	48	100[2]	54	29.0
512.	40%	17	5	34	4	42	24	56	27	19.0
256.	45%	9.6	2.9	19.2	2.2	24	13.5	32	15.4	12.5
128.	45%	4.9	1.5	9.6	1.1	12.2	6.9	16	7.8	7.5
96.	45%	3.9	1.2	7.8	0.9	9.7	5.5	13	6.2	5.5
64.	50%	3.5	1.1	7.0	0.8	8.7	4.9	11.5	5.6	3.1
56.	50%	3.3	1.0	6.6	0.6	8.2	4.6	10.9	5.3	2.9
48.	50%	3.2	0.9	6.4	0.4	8.0	4.5	10.5	5.1	2.7
28.8	45%	2.5	0.75	5.0	0.35	6.2	3.5	8.2	4.0	1.6
19.2	45%	2.0	0.6	4.0	0.3	5.0	2.8	6.6	3.2	1.0
14.4	45%	1.75	0.5	3.5	0.25	4.4	2.5	5.8	2.8	0.85
9.6	45%	1.5	0.45	3.0	0.2	3.7	2.1	5.0	2.4	0.7
4.8	40%	1.2	0.35	2.4	0.15	3.0	1.7	4.0	1.9	0.3
2.4	40%	1.05	0.3	2.1	0.15	2.6	1.5	3.5	1.7	0.15
1.2	40%	1.0	0.3	2.0	0.15	2.5	1.4	3.3	1.6	0.15

Notes:

1. The line weight for an intermediate speed is the weight corresponding to the nearest higher speed in the table.
2. Line utilization may not reach the percentages indicated in column **Assumed Line Utilization**.
3. For Frame Relay Frame Handler traffic (frame-relay switching), use "ANR" line weights.
4. Any data link control (SDLC, frame relay, X.25) and routing protocol (APPN, ANR, SNA/subarea).

Standard Line Weights for CLP3

Table 12. Standard Line Weights for CLP3[1]

Line Speeds (kbps)	Assumed Line Utilization	SDLC and frame relay[3]			PPP and frame relay[3]	X.25				SDLC frame relay X.25
		APPN DLUR	ANR	RTP	IP	APPN DLUR	ANR	RTP	IP	NCP[4]
2048. 1544. 1024. 512.	40%	45 33 34 11	10.5 7.4 5.2 2.6	89[2] 67 45 23	8.4 6.3 4.2 2.1	100[2] 83 57 28	50 37 25 12.5	100[2] 100[2] 75 37	56[2] 42 28 14	20 17 15 10
256. 128. 96.	45%	6.4 3.3 2.6	1.5 0.8 0.6	12.8 6.4 5.2	1.15 0.6 0.5	16 8.1 6.5	6.6 3.6 2.9	21 10.6 8.7	8.1 4.1 3.2	6.7 4.0 2.9
64. 56. 48.	50%	2.3 2.2 2.1	0.6 0.5 0.5	4.7 4.4 4.3	0.4 0.3 0.2	5.8 5.5 5.3	2.6 2.4 2.4	7.7 7.3 7.0	2.9 2.8 2.7	1.6 1.5 1.4
28.8 19.2 14.4 9.6	45%	1.7 1.3 1.2 1.0	0.4 0.3 0.25 0.25	3.3 2.7 2.4 2.0	0.15 0.15 0.15 0.1	4.1 3.3 2.9 2.5	1.8 1.5 1.3 1.1	5.5 4.4 3.9 3.3	2.1 1.7 1.5 1.3	0.8 0.5 0.4 0.35
4.8 2.4 1.2	40%	0.8 0.7 0.7	0.2 0.15 0.15	1.6 1.4 1.3	0.1 0.1 0.1	2.0 1.7 1.7	0.9 0.8 0.7	2.7 2.3 2.2	1.0 0.9 0.8	0.15 0.1 0.1

Notes:

1. The line weight for an intermediate speed is the weight corresponding to the nearest higher speed in the table.
2. Line utilization may not reach the percentages indicated in column **Assumed Line Utilization**.
3. For Frame Relay Frame Handler traffic (Frame Relay switching), use "ANR" line weights.
4. Any data link control (SDLC, frame relay, X.25) and routing protocol (APPN, ANR, SNA/subarea).

Customized Line Weights

The CF3745 hardware configurator allows 3746-9x0 lines, or groups of lines, to be assigned customized line weights. If the traffic over your lines is substantially different from the assumptions of the standard line weights for CLP in Table 11 on page 13 and CLP3 in Table 12 on page 14, you can use CF3745 to calculate customized line weights as follows:

Customized line weight = Percentage of Standard line weight.

The following examples apply to CLP standard line weights; the same formula also applies to CLP3 standard line weights.

One type of traffic

Line weight = xxx%[6] of a standard line weight where xxx is the percentage of line utilization.

For example, if you have a 512-kbps line speed and APPNDLUR type traffic, the standard line weight is 17 (see Table 11 on page 13). If your line has 60% utilization, the formula in CF3745 would read:

`150APPNDLUR`.

Your customized line weight is 25.5 (150% x 17).

Mixed traffic

Line weight = xxx% of the standard line weight for traffic type 1 + yyy% of the standard line weight for traffic type 2.

For example, if you have a 128-kbps frame relay line (or group of identical 128-kbps frame relay lines) with the following traffic mix:

- 50% IP traffic.
- 50% HPR/RTP traffic.

If both of the above meet standard line weight assumptions (total line use = 45%), then the formula in CF3745 would read:

`50IP50RTP`.

Your customized line weight in CF3745 is 5.35 (50% x 1.1 + 50% x 9.6).

6 xxx can be greater than 100%.

Standard Line Connectivity for CLP

Table 13. Standard Line Connectivity[1] for CLP

Line Speeds (kbps)	Assumed Line Utilization	SDLC and frame relay			PPP and frame relay	X.25				SDLC frame relay X.25
		APPN DLUR	ANR	RTP	IP	APPN DLUR	ANR	RTP	IP	NCP[3]
2048.	40%	1	4	1[2]	4	1[2]	1	1[2]	1[2]	2
1544.		2	4	1	4	1[2]	1	1[2]	1	3
1024.		3	4	1	4	1	2	1[2]	1	3
512.		4	4	2	4	2	4	1	3	4
256.	45%	10	32	4	32	4	7	3	6	8
128.		20	32	10	32	8	14	6	12	13
96.		25	32	12	32	10	18	7	16	18
64.	50%	28	90	14	120	11	20	8	17	32
56.		30	100	15	120	12	21	9	18	24
48.		31	111	15	120	12	22	9	19	37
28.8	45%	40	120	20	120	16	28	12	25	62
19.2		50	120	25	120	20	35	15	31	100
14.4		57	120	28	120	22	40	17	35	117
9.6		66	120	33	120	27	47	20	41	120
4.8	40%	83	120	41	120	33	58	25	52	120
2.4		95	120	47	120	38	66	28	58	120
1.2		100	120	50	120	40	71	30	62	120

Notes:

1. This is the maximum number of lines allowed by CF3745, according to the following assumptions:
   - Lines have the same speed.
   - Carry a single traffic type (APPNDLUR, ANR, IP, and so on).
   - Carry standard traffic (see "Standard Line Weight Assumptions" on page 9).
2. Line utilization may not reach the percentages indicated in column **Assumed Line Utilization**.
3. Any data link control (SDLC, frame relay, X.25) and routing protocol (APPN, ANR, SNA/subarea).

Standard Line Connectivity for CLP3

Table 14. Standard Line Connectivity[1] for CLP3

Line Speeds (kbps)	Assumed Line Utilization	SDLC and frame relay			PPP and frame relay	X.25				SDLC frame relay X.25
		APPN DLUR	ANR	RTP	IP	APPN DLUR	ANR	RTP	IP	NCP[3]
2048.	40%	2	4	1	4	1[2]	2	1[2]	1	4
1544.		3	4	1	4	1	2	1[2]	2	4
1024.		4	4	2	4	1	4	1	3	4
512.		9	4	4	4	4	4	2	4	4
256.	45%	15	32	7	32	6	15	4	12	14
128.		30	32	15	32	12	27	9	24	25
96.		38	32	19	32	15	34	11	31	32
64.	50%	43	120	21	120	17	38	12	34	62
56.		45	120	22	120	18	41	13	35	66
48.		47	120	23	120	18	34	14	37	71
28.8	45%	58	120	30	120	24	55	18	47	120
19.2		76	120	37	120	30	56	22	58	120
14.4		83	120	41	120	34	76	25	66	120
9.6		100	120	50	120	40	90	30	76	120
4.8	40%	120	120	62	120	50	111	37	100	120
2.4		120	120	71	120	58	120	43	120	120
1.2		120	120	76	120	58	120	45	120	120

Notes:

1. This is the maximum number of lines allowed by CF3745, according to the following assumptions:
   - Lines have the same speed.
   - Carry a single traffic type (APPNDLUR, ANR, IP, and so on).
   - Carry standard traffic (see "Standard Line Weight Assumptions" on page 9).
2. Line utilization may not reach the percentages indicated in column **Assumed Line Utilization**.
3. Any data link control (SDLC, frame relay, X.25) and routing protocol (APPN, ANR, SNA/subarea).

CF3745 Performance Model (CLP Load Estimates)

Excessive CLP loads may alter response times by causing queuing delays and activating congestion mechanisms for preventing CLP overload. CF3745 projects the CLP load, and the performance model output provides a CLP load estimate for every line group connected to a CLP.

After CF3745 has placed the lines according to the preceding standard line weights, the performance model uses the user traffic parameters to estimate the actual CLP load. If the result exceeds a projected CLP load of 90%, you can use CF3745 options, for example, customized line weights, to adjust the configuration.

NetView Performance Monitor (NPM) CLP Load

NetView Performance Monitor (NPM) Version 2 Release 3 (with APAR AW30643) monitors the processor (and storage) utilization of the CLPs (and other adapters of the 3746).

Note: If you are using NPM Version 2 Release 1 or Release 2, APAR numbers OW08565 and OW10584 are required as a minimum.

Measuring CLP loads is useful in planning for additional lines or traffic.

Performance Measurement Function - MOSS-E (CLP Load)

You can use MOSS-E (running in local and remote consoles) to produce a graphical representation of CLP loads, and storage utilization versus time. If this function indicates a load imbalance between CLPs, communication line equipment can be re-allocated from heavily loaded CLPs to lightly loaded CLPs. Re-allocating equipment can be carried out either by the user (for ARCs, LCBs, and LIC11 cables) or by a service representative (for LIC11s, LIC12s, and CLPs), and does not affect the operation of other communication line equipment.

The CF3745 performance model may be used to predict the effect of such configuration changes on the CLP load.

Also, you can use the CLP load display in MOSS-E to plan configuration upgrades for adding new lines or traffic.

NetView Alerts (CLP Load Thresholds)

CLP at High Load Threshold (97%)

CLP loads greater than or equal to 97% for three minutes generate an alarm and a NetView® Alert.

If the CLP load reaches 100%, congestion mechanisms are automatically activated to prevent CLP overload. This may increase response times, but no data is lost.

CLP Back to Normal Load Threshold (95%)

An alarm and a NetView alert are generated if the following occurs:

- The CLP load is greater than or equal to 97% after three minutes or more.
- The CLP load decreases to 95% for three minutes.

Communication Line Adapter Connectivity

For an overview of the 3746 Network Node and IP Router connectivity, refer to the “APPN / HPR Overview” chapter in the *3745/3746 Planning Series: Protocols Description*, GA27-4241.

If your planning indicates that you may use your CLP near their maximum limits, you should consider having your system verified by the IBM 3745/3746 hardware configurator (CF3745).

Maximum Number of Active Lines

The maximum number of active lines at the same time on a CLP can be up to 120.

A given line of the 3746-900 is assigned to either NCP-controlled traffic (defined and activated via NCP) or 3746-controlled traffic (defined and activated via the 3746 control point) or both (frame relay and X.25 lines). In the 3746-900, 3746-controlled lines (SDLC, frame relay, X.25, and PPP) and NCP-controlled lines (SDLC, frame relay, X.25 and ISDN) can be run through the same CLP.

Maximum Number of frame relay DLCIs

A 3746-900 configured with 3746 APPN/HPR or IP routing over WAN links, and the 3746-950 support 500 frame relay DLCIs per CLP, and 2000 frame relay DLCIs per CLP3.

A 3746-900 configured without APPN/HPR or IP routing over WAN links, (NCP controlled only), can support 3000 DLCIs per CLP and CLP3.

Maximum Number of Active Physical Units

CLP

In a 3746-900, with APPN/HPR or IP routing over WAN links, each CLP supports:

- Up to 1000 PUs over SDLC lines
- Up to 1000 PUs over frame relay, X.25 lines (Virtual Circuits) and ISDN B-channels (NCP).

Up to 1000 PUs can be activated by the NNP over SDLC, X.25 and frame relay lines, the rest being activated by NCP in the 3745.

In the 3746-950, up to 1000 physical units (PUs, for example, PS/2s and 3174s) can be active at the same time over the SDLC, frame relay, and X.25 lines on each CLP.

Any ratio of PU-sharing between LICs on the CLP can be configured. For example in SDLC, 100 PUs can be activated via one LIC11, 200 via a second LIC11, 300 via a third LIC11, and 400 via a fourth LIC11.

CLP3

In a 3746-900, with APPN/HPR or IP routing over WAN links, each CLP3 supports:

- Up to 1000 PUs over SDLC lines
- Up to 2000 PUs over frame relay, X.25 lines (Virtual Circuits) and ISDN B-channels (NCP).

Up to 3000 PUs can be activated by the NNP over SDLC, X.25 and frame relay lines.

In the 3746-950, up to 3000 physical units (PUs, for example, PS/2s and 3174s) can be active at the same time over the SDLC, frame relay, and X.25 lines on each CLP3. Any ratio of PU-sharing between LICs on the CLP3 can be configured. For example, 200 PUs can be activated via one LIC11, 400 via a second LIC11, 800 via a third LIC11, and 1600 via a LIC12.

Maximum Number of LU Sessions

CLP and CLP3 support respectively up to 3500 and 12500 sessions activated by the NNP. There is no limit to the number of APPN/ANR sessions.

In the 3746-900, the number of LU-LU sessions established by NCP depends on the amount of storage available in the 3745 CCU, rather than CLP storage, and is independent of the number of 3746-controlled sessions. The maximum number of possible sessions over a CLP or CLP3 is equal to the maximum number of NCP-controlled sessions (3745 storage dependent) plus the maximum number of sessions established by the 3746 Control Point.

Maximum Number of Active X.25, frame relay, and ISDN Stations

In addition to the SDLC connectivity, each CLP and CLP3 support respectively any mix of up to 1000[7] or 2000[7] frame relay stations (PUs), X.25 stations, and ISDN stations controlled by NCP. The maximum number of stations includes the following resources:

frame relay
All PUs access CLP via FRTE connections, for example, all PUs downstream from IBM 2210s, IBM 2216s operating in frame relay BAN mode, and IBM 3174 controllers. Each PU is controlled either by NCP or by the 3746 Controller.

Notes:

1. An IBM 2210 or IBM 2216 operating as an APPN/HPR network node for downstream PUs is seen by the 3746 NN as a single adjacent PU.
2. For frame relay lines, if a DLCI carries IP traffic, the 3746 IP router uses one station on this DLCI.
3. IP over PPP or frame relay switching does not use any stations.

X.25 logical stations
Virtual circuits (PVCs and SVCs) are run by NPSI V3R8, NCP (V7R4 or above), or the 3746 Controller. One VC is required per remote PU. Separate VCs are required for IP traffic.

X.25 physical stations (LAPB)
One per X.25 line, run by NPSI V3R8, or NCP (V7R4 or above), or 3746.

ISDN physical stations (LAP-D)
One per ISDN line on a LIC16, run by NCP.

ISDN Signalling Stations (Q.931)
One per ISDN line on a LIC16, run by NCP.

ISDN Logical Stations
frame relay PUs activated over B channels (equivalent to 64-kbps frame relay lines).

[7] 3000 for a 3746-900 with all the CLPs and CLP3s operating under NCP control only.

Maximum Number of X.25 Modulo 128 Lines (NPSI)

An X.25 line is controlled either by NCP (X.25 ODLC line) or NPSI (X.25 line), and operates either at modulo 8 or at modulo 128. X.25 NPSI lines, which operate at modulo 128, affect the maximum line connectivity of the CLP as follows:

- CLP supports four X.25 modulo 128 lines controlled by NPSI per pair of LIC slots.
- Each X.25 NPSI modulo 128 lines reduces the total connectivity of the CLP by 15 for the other types of supported lines. Table 15 shows the allowed modulo 128 and other lines on one CLP with two LICs.

Table 15. Lines Per CLP with Two LICs Attached

Type of Line	Number of Lines				
X.25 NPSI Modulo 128	0	1	2	3	4
X.25 NPSI Modulo 8, X.25 ODLC, SDLC, frame relay, or PPP	60	45	30	15	0
ISDN LIC16 lines	2	2	2	1	0

Note: The numbers in Table 15 should not be exceeded by the following:

- CLP line definitions
- Backing up one active CLP with another active CLP

Total Number of Active Resources

The storage available in the CLP does not allow the maximum possible number of lines, NCP-controlled PUs, and 3746-controlled PUs to be simultaneously activated with any number of 3746-controlled sessions.

Table 16 on page 22 gives examples of maximum CLP configurations (IP routing not installed). It is assumed that within each configuration, PUs are configured with the same number of sessions, including control sessions (this does not include ANR sessions). For SDLC lines, all PUs are assumed to use modulo 8.

Examples of Maximum Configurations for CLP

Table 16. Examples of Maximum CLP Configurations

Lines	PUs (3746 NN)	LU Sessions (3746 NN)	ANR Sessions (3746 NN)	PUs (3746-900/ NCP)
frame relay				
FR: 120	1 (APPN/HPR)	3500	Any	—
FR: 120	500 (APPN/HPR)	2180	Any	—
FR: 120	500 (APPN/HPR)	1580	Any	500
FR: 120	1000 (APPN/HPR)	860	Any	—
FR: 120	1000 (Dependent)	1260	Any	—
FR: 120	—	—	—	1000[1]
X.25				
X.25: 120	500 (APPN/HPR)	1960	Any	—
X.25: 120	500 (APPN/HPR)	1360	Any	500
X.25: 120	1000 (APPN/HPR)	640	Any	—
X.25: 120	1000 (Dependent)	1040	Any	—
X.25: 120	—	—	—	1000[1]
SDLC				
SDLC: 5	500 (APPN/HPR)	1500	Any	—
SDLC: 15	30 (APPN/HPR)	3000	Any	—
SDLC: 30	180 (APPN/HPR)	2270	Any	—
SDLC: 40	250 (APPN/HPR)	1300	Any	500
SDLC: 50	400 (Dependent)	1300	Any	—
SDLC: 60	300 (Dependent)	1500	Any	—
SDLC:120	—	—	—	1000

Note:

1. 3000 for a 3746-900 with all the CLPs operating under NCP control only.

The following simplified storage formula can help you estimate CLP (not CLP3) connectivity (microcode EC level D26120 and above):

```
  (20 x lines_SDLC) + (1.5 PU_NCP) + (1.2 PU_m128) + (1.25 x LU)
+ (4.8 x PU8s) + (5.2 x PU16s) + (6.0 x PU32s)
+ (7.6 x PU64s) + (10.8 x PU128s) + (17.2 x PU256s)
+ (4.3 x PUD8s) + (4.7 x PUD16s) + (5.5 x PUD32s)
+ (7.1 x PUD64s) + (10.3 x PUD128s) + (16.7 x PUD256s)
+ (3.3 x PU8) + (3.7 x PU16) + (4.5 x PU32)
+ (6.1 x PU64) + (9.3 x PU128) + (15.7 x PU256)
+ (2.8 x PUD8) + (3.2 x PUD16) + (4.0 x PUD32)
+ (5.7 x PUD64) + (8.9 x PUD128) + (15.2 x PUD256)
< or = 4375 - x
```

x is different from zero if any licensed internal code is loaded in the CLPs, in addition to the APPN/HPR option. x is identical for all CLPs in a given 3746 configuration, and is the sum of selected CLP options. These options include:

- IP = 1103
- X25 = 270
- ISDN = 306 (3746-900 only).

Various SDLC, X.25, and frame relay resources that factor in CLP storage must be weighted, as indicated in the formula, and the total must not exceed the maximum specified value of 4735 – x. Use the formula and the number of related resources for each CLP:

Line_SDLC
: Number of SDLC lines (3746 NN + NCP).

PU_NCP
: Number of PUs controlled by NCP (3746-900 only) and connected via SDLC lines.

PU_m128
: Total PUs (3746 NN + NCP) using modulo 128 over SDLC lines.

LU
: Total number of user (half) sessions controlled by the 3746 NN (over SDLC, X.25, and frame relay lines). This does not include ANR sessions, which can be in any quantity.

PUns
: Total APPN/HPR PUs (modulo 8 + modulo 128), each with up to n sessions[8], connected to the 3746 NN via SDLC lines.

PUDns
: Total dependent PUs (modulo 8 + modulo 128), each with up to n sessions[8], connected to the 3746 NN via SDLC lines.

PUn
: Total APPN/HPR PUs, each with up to n sessions[8], connected to the 3746 NN via frame relay or X.25 lines.

PUDn
: Total dependent PUs, each with up to n sessions[8], connected to the 3746 NN via frame relay or X.25 lines.

Note: Sessions entirely routed within the same processor must be counted twice in the LU number (full sessions). Sessions routed to another processor, for example ESCON®, are counted once in the LU number (one half session in the CLP).

CF3745 provides an estimate of CLP storage utilization based on user connectivity requirements, including IP and HPR/RTP.

Actual storage use may vary, depending on the network environment. Storage congestion, if any, is reported to the network operator via NetView alerts.

[8] Includes APPN/dependent (data) sessions and control sessions (CP-CP, SSCP-PU, SSCP-LU), and does not include ANR.

Checking Activation Limits and Capacity Planning

3745/3746 Configurator (CF3745)
Verifies that the planned CLP configuration does not exceed CLP storage and PU limits.

NetView Performance Monitor (CLP storage utilization)
See "NetView Performance Monitor (NPM) CLP Load" on page 18.

MOSS-E (CLP storage utilization)
See "Performance Measurement Function - MOSS-E (CLP Load)" on page 18.

PU limit
When a CLP reaches the limit of active SDLC PUs or active X.25, frame relay, and ISDN stations, and the 3746 control point or NCP (3746-900) attempts to activate another PU or station beyond this limit, the following occurs:

- CLP rejects the PU activation request.
- A generic alert is sent to NetView indicating line congestion.

Storage limit (CLP storage thresholds)
There is no automatic control in the number of LU sessions established by the 3746 control point for a given CLP. If the storage limit of the CLP is reached, any new activation requests for SDLC lines, PUs, and 3746-controlled LU-LU sessions are rejected and a generic alert is sent to NetView indicating line congestion.

CLP at High Storage Threshold (97%)
CLP storage greater than or equal to 97% in a three minute time period generates an alarm and a NetView alert (every three minutes, three times).

CLP back to normal storage threshold (95%)
If CLP storage is greater than or equal to 97% for three minutes or more and decreases to 95% or less for a three minute time period, an alarm and a NetView alert is generated.

Note: The storage threshold alerts above are also applicable to other processor types (TRP2, TRP3, ESCP2, and ESCP3).

Processor Backups

In a CLP backup configuration, two LIC slots of a CLP are connected to an adjacent CLP. If a CLP fails, the LICs are automatically switched to the backup CLP. However, APPN, Dependent LU, and HPR sessions previously flowing over switched LICs must be re-established (IP and HPR/ANR traffic is connectionless and traffic is not disrupted). The backup CLP handles the additional traffic from the LICs of the failed CLP. When problems with the failed CLP are fixed, a switchback returns the system to the original configuration.

Use the MOSS-E **Define Backup CLP** option for backup links. Any combination of LIC types can be backed up.

Before you back up CLPs, see the following information:

Maximum Number of Active Lines, PUs, and 3746 LU-LU Sessions

See “Total Number of Active Resources” on page 21.

Processor Slot Pairing

CLPs in a backup configuration must be located in one of the eight pairs of processor slots in the 3746 enclosure. See Table 3 on page 1.

One-Way or Two-Way Backups

Figure 2 shows an example of a two-CLP backup configuration with the backup defined in both directions (two-way backup). Each CLP backs up the LICs to the other CLP, and each has two LICs for normal operations. CLP X backs up the two LICs of CLP Y and CLP Y backs up the two LICs of CLP X.

You can also use one-way backups where CLP X backs up the LICs on CLP Y but CLP Y does not back up CLP X.

One- or two-way backups can be used with any number of LICs (up to four).

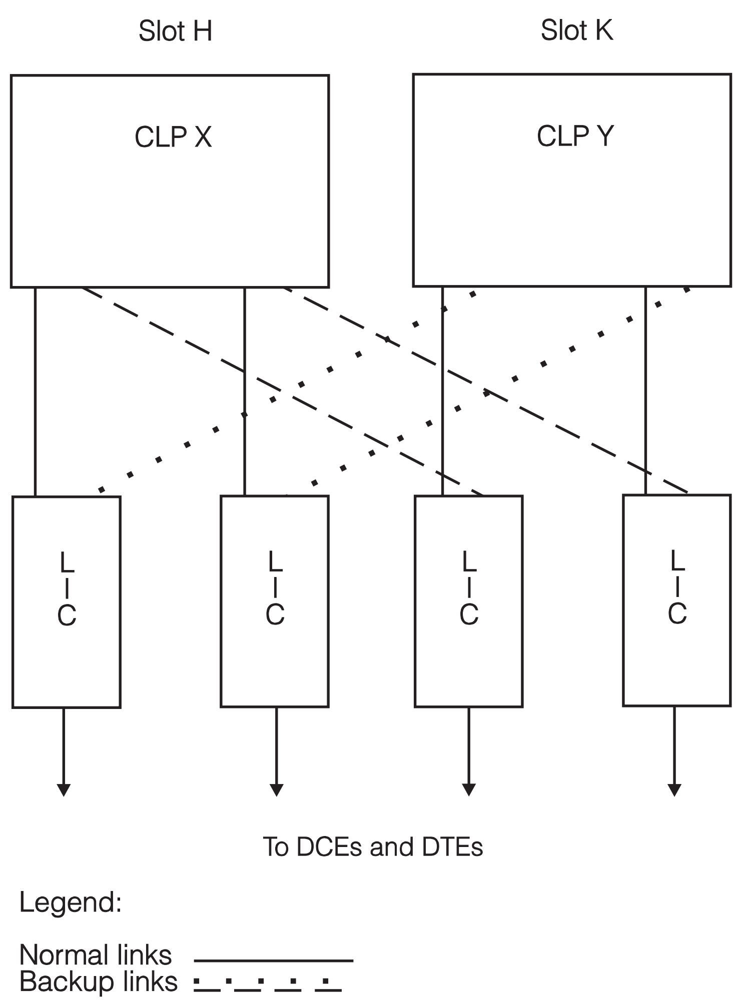


Figure 2. Example of a Configuration with CLP Backup Capability

Chapter 2. Frame Relay Overview

This chapter examines the frame-relay functions offered by the 3745 and 3746. It supplies the reader with an overview of the frame-relay functions supported by NCP and the 3746 NNP, explains how IBM 3745 and 3746 controllers can be used to build frame-relay networks, and how to connect to frame-relay networks built using 3745s and 3746 Model 900s. It also discusses the implementation of frame relay in the 3746-950 and 3746-900 under NNP control.

Frame relay is supported on all leased line attachments on the low-speed scanners, high-speed scanners, and CLP (3746 Models 900 and 950) serial ports with line speeds up to 2 Mbps.

Frame-relay functions implemented in NCP and IBM 3745/3746 Models 900 and 950 comply with the ITU-T and ANSI frame-relay standards, and to RFC1490 *Multiprotocol interconnect over Frame Relay* and the SNA extensions. Fragmenting as described within RFC 1490 is not supported; SNA segmenting however is, however, supported.

The ability to manage a network is an important consideration. 3745/3746 frame-relay is supported by the IBM network management products NetView, and NPM (NetView Performance Monitor), and provides a variety of well-known tools (Generic Alerts, PDSTATs, RECMS, NTune, etc.).

Note: For more information refer to:

- *IBM 3746-900 and NCP Version 7 Release 2*, GG24-4464
- *IBM 3746 Nways Controller Models 900 and 950: APPN Implementation Guide*, SG24-2536
- *IBM Frame Relay Guide*, SG24-4463
- *3746 Nways Controller 950 and 900 IP Implementation*, SG24-4845
- Appendix A, “ACF/NCP 3745 and 3746 Frame-Relay Support” on page 165.

Frame-Relay Introduction

Frame relay is a high-speed packet switching technology based on permanent virtual circuits (PVC) for interconnecting data terminal equipment (DTE). The frame-relay standard defines only the physical DTE-DCE interface, layer 1, and the data link connection (DLC) link level interface, layer 2, for accurate exchange of data. Multiplexing on the physical layer is accomplished at the DLC layer by data link connection identifiers (DLCI).

A frame-relay DTE is called Frame-Relay Terminating Equipment (FRTE).

The FRTEs communicate with each other via the frame-relay network using the I.233 frame format.

The frame-relay network nodes provide a frame switching function called Frame-Relay Frame Handler (FRFH). Figure 3 on page 28 shows three PVCs: FRTE1 to FRTE2, FRTE1 to FRTE3, and FRTE2 to FRTE3, all going through the FRFH switch.

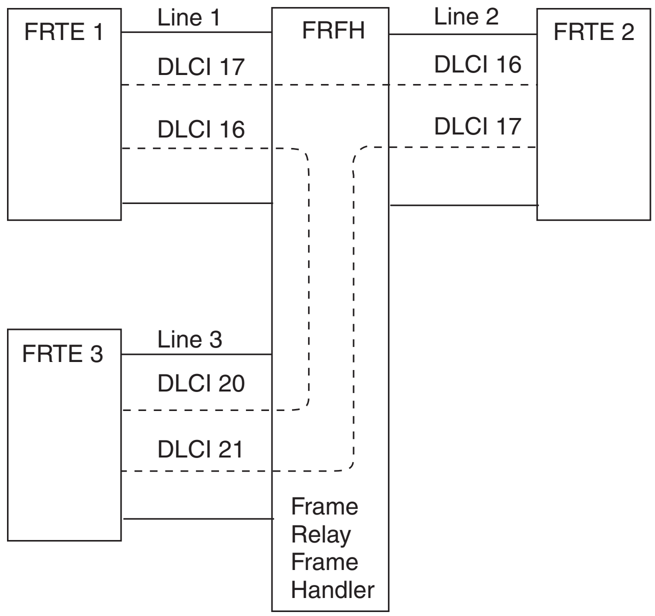


Figure 3. Frame-Relay Terminology

The frame-relay network does not provide guaranteed delivery of sent packets but does guarantee:

- The integrity of transported data by a frame check sequence that exists in every frame.
- That packets will not be duplicated across the network.
- That packets will be received in the order that they are sent.

Frame relay allows packets to be discarded during transport because of network congestion. It is the responsibility of the FRTE to ensure end to end delivery of packets.

Higher layer protocols (for example, IEEE 802.2 Logical Link Control (LLC), SNA/Subarea, APPN, HPR, or TCP/IP) are transparent to the frame-relay network. It simply transports the higher protocols as user data. It is recommended that frame relay be used on ***good-quality lines*** because recovery from transmission errors is done end-to-end instead of hop-by-hop.

Frame-Relay Network: Example

The diagram below illustrates a simple frame-relay network. Note that in some case a device functions solely as a FRTE, while at other times it is implemented with the FRFH function in addition.

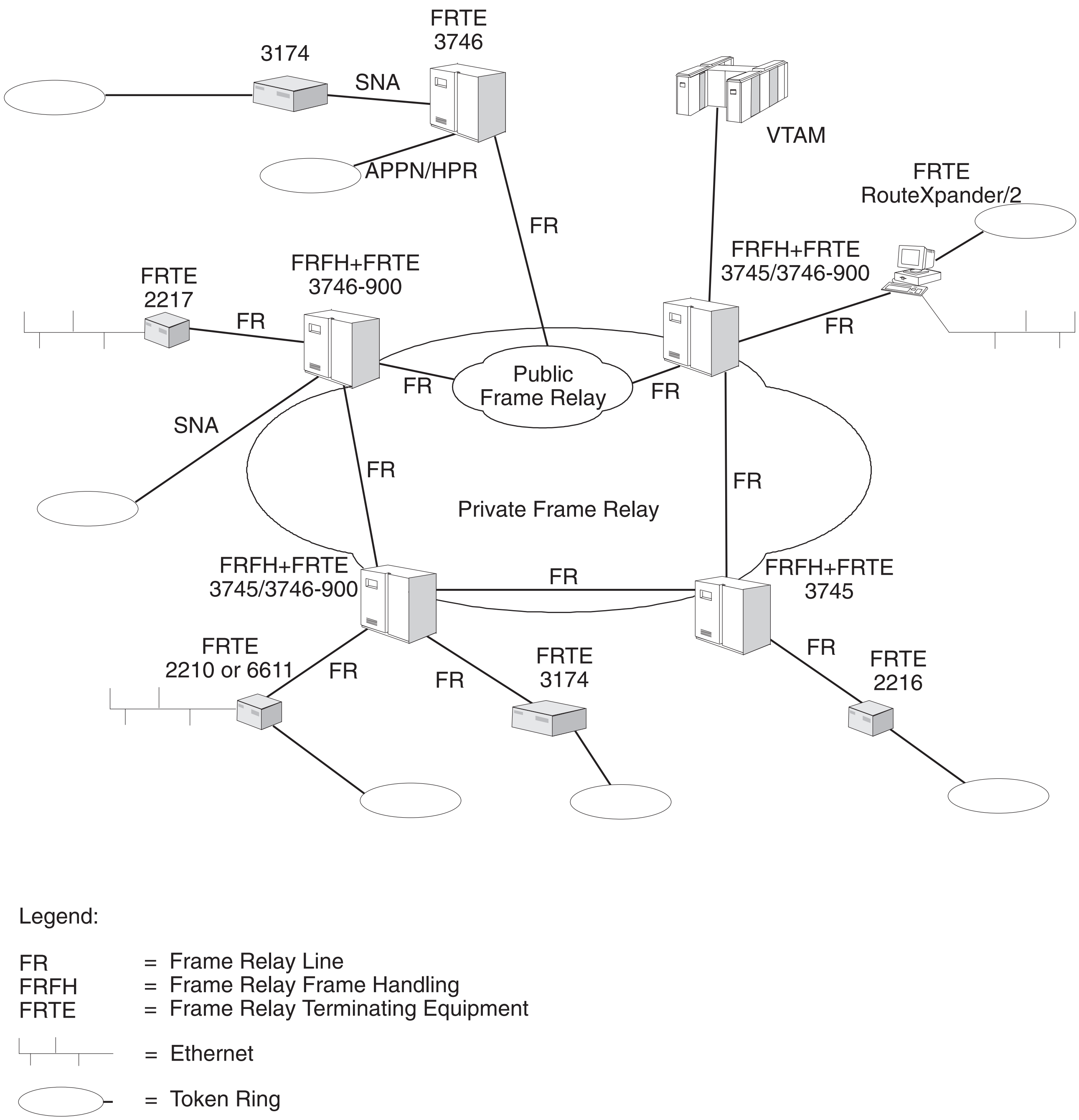


Figure 4. Example of a Frame-Relay Network with 3745s and 3746s

Frame-Relay Formats

The FRTE connections are supported by the 3746 in the same way as token-ring connections. The FRTE connections are defined as switched logical link stations. The RFC 1490 is used to identify the type of connection. Two formats are supported:

- **The RFC 1490 routed format** is used with equipment such as the IBM 3174 Establishment Controller. Multiple SNA stations connected to the 3174 can access the 3746 NN over a single DLCI and are identified by a different ***Service Access Point*** (SAP). The RFC 1490 routed format is used to provide the frame-relay ***boundary network node*** (BNN) function. This format is also used between adjacent SNA or APPN node. IP traffic is routed with NLPID='CC'. See Figure 5 for the frame header for SNA traffic using the RFC 1490 routed format.

SNA or APPN or HPR with ERP format:

DLCI	03	08	4C 80	70 XX	DS AP	SS AP	Nr	Ns	PIU	FCS

HPR non ERP format:

DLCI	03	08	50 81	70 85	NLP	FCS

Legend:

DLCI	=	The Q.922 address on two bytes: B'ddddddxx ddddxxxx', where dddddd dddd is the data link control identifier (DLCI) number.
X'03'	=	Unnumbered Information (UI) frame (one byte)
X'08'	=	Network Layer Protocol Identifier (NLPID), which indicates that the IUT-T Recommendation Q.933 is used.
X'4C80'	=	Layer 2 is an IEEE 802.2 type 2 protocol (indicates error recovery)
X'70XX'	=	Layer 3, where XX can be: • X'81' for SNA subarea, PU4-PU4 (FID4) • X'82' for SNA subarea peripheral PU4-PU2 (FID2) • X'83' for APPN (FID2) • X'85' for HPR (NLP).
DSAP	=	Destination service access point
SSAP	=	Session service access point
Nr	=	Receive sequence number
Ns	=	Send sequence number
PIU	=	Path Information Unit (the transported SNA or APPN data)
FCS	=	Frame check sequence

Figure 5. RFC 1490 Routed Format for SNA Traffic

For additional information, refer to the ANSI T1.617 Annex F or the ITU-T Q.933 Annex E.

- **The RFC 1490 bridged 802.5 format** is used with equipment such as the IBM 2210 Nways Multiprotocol Router or IBM 3746 Nways Multiaccess Controller. This provides the frame-relay *boundary access node* (BAN) function. IP over bridged traffic is ***not*** supported. See Figure 6 for the frame header for SNA BAN traffic using the RFC 1490 bridged format.

Frames sent and received without LAN FCS:

DLCI	03	00	80	00	80	C2	00	09	00	40	Token Ring Frames	FCS
					OUI		PID					

Frames received with LAN FCS:

DLCI	03	00	80	00	80	C2	00	03	00	40	Token Ring Frames	LAN FCS	FCS
					OUI		PID						

Legend:

DLCI	=	The Q.922 address on two bytes: B'dddddxx ddddxxxx', where dddddd dddd is the data link control identifier (DLCI) number.
X'03'	=	Unnumbered Information (UI) frame (one byte)
X'00'	=	Unused byte (pad)
X'80'	=	Network Layer Protocol Identifier (NLPID), which indicates that the Subnetwork Access Protocol (SNAP) header is used
X'0080C2'	=	Organizationally unique identifier (OUI) for the IEEE 802.1 protocol (three bytes)
X'00XX'	=	Product identifier (PID), where XX can be: • X'03' for the IEEE 802.5 protocol with the LAN FCS preserved (sent and received frames) • X'09' for the IEEE 802.5 protocol without a LAN FCS (received frames only).
X'00'	=	Unused byte (pad)
X'40'	=	Flow control (FC) field
Token-ring frames	=	IEEE 802.5 frame that contains the SNA, APPN, or HPR transported data
LAN FCS	=	Frame check sequence used on the LAN
FCS	=	Frame check sequence

Figure 6. RFC 1490 Bridged Format for SNA Traffic

For additional information, refer to the RFC 1490.

The multiple stations attached to the 2210 or 2216 are identified by their MAC addresses, which allows an unlimited number of stations to use the same DLCI number. The number of stations using the same DLCI is only limited by the bandwidth of the frame-relay link between the 2210 or 2216 and the 3746 NN.

For both RFC 1490 formats, the integrity of the data is ensured by the 802.2 Logical Link Control (LLC) protocol that is connection oriented and provides reliable data link services. The 802.2 is the same LLC as the LLC used for SNA transport over a LAN.

3746 Frame-Relay Implementation

Frame-Relay DLCI Numbers

For FRTE connections, the DLCI number is assigned by:

- DLUS or CCM for connections initiated by the 3746 NN (call-out).
- The attached SNA, APPN/HPR, or IP device for connection initiated by the remote equipment (call-in).
- The frame-relay network for IP connections initiated via the "orphanage" function discussed below.

Port Sharing

Frame relay is the only type of serial interface that is supported by all 3745 and 3746 protocol stacks. A single frame-relay interface (port) can be activated simultaneously by each protocol stack, 3746 NN/DLUR and IP, and 3745 NCP. Frame-relay, together with the 3745 and 3746, is ideally suited for building a multiprotocol network backbone.

Notes:

1. When using a dual-CCU 3746-900, a frame-relay line can only be activated from either CCU-A (NCPA) or CCU-B (NCPB), not both at the same time.
2. NCP 3746-900 frame-relay support is limited to SNA only. NCP does not support IP over frame-relay on 3746-900 attachments.

CLP Sharing

A CLP line is dedicated, at any given time, to one of the following types of data link control (DLC):

- SDLC (NNP or NCP driven)
- X.25 (NNP, NPSI, or NCP driven)
- Frame relay (NNP or NCP driven)
- ISDN (NCP driven: LIC16, for Europe only)
- PPP (NNP driven).

SDLC, X.25, frame-relay, PPP, and ISDN lines can be mixed on the same CLP.

A frame-relay line is a leased point-to-point circuit that can be attached to a LIC11 or LIC12.

On any one of the frame-relay ports, any mix of protocols is supported (for example: BAN and BNN, for SNA and APPN/HPR, and IP can be supported on a port). Any of the above protocols can be used on any DLCI of the same port.

PVC Sharing

To accomplish the IP, APPN, and NCP/subarea connectivity one can use either separate PVCs for each of the individual protocol stacks or use the 3746-9x0 PVC sharing facilities.

The 3746-9x0 PVC sharing facilities enable the 3746-9x0 to distinguish between and share a PVC for 3746 IP, 3746 NN/DLUR (routed and bridged frame format), and NCP/Boundary (routed and bridged frame format) traffic. The sharing of a 3746 controlled frame-relay line with NCP requires NCP V7 R5 or higher.

Additionally, devices such as the 2210 router support mixing IP (routed frame format) and BAN traffic (bridged frame format) on the same PVC. The 3746 supports this mixing of frame formats on a single PVC, see “Frame-Relay Formats” on page 30 for details on traffic encapsulation.

The following diagrams show how the 3745 and 3746 differentiate between the different traffic types arriving at either 3745 or 3746 adapters.

Internal routing of incoming frames is done as follows:

1. Check DLCI number (this may be a FRFH DLCI).
2. Routed frame format frames
   - NLPID=X‘CC’ this is IP traffic
   - NLPID=X‘08’ Q.933 Encapsulation
   - Layer 2 field indicates ERP or non-ERP
   - Layer 3 field indicates INN, BNN or APPN, or HPR.
3. Bridged frame format frames

   NLPID=X‘80’, SNAP encoding

IP traffic is routed by the IP router of the 3746. INN traffic always goes to the NCP, BNN/APPN traffic is routed by the DSAP. HPR traffic is routed by ANR label. Therefore, in the case of HPR traffic controlled by NCP running as a CNN, HPR packets can be switched at the adapter level in the 3746 without being routed to software components.

Frame-Relay Frame Handler Functions

The frame-relay frame handler functions take the traffic arriving on a VC (3745 or 3746 port), and switch all the traffic on that VC to an outbound VC. All forms of encapsulation are supported as the frame contents (apart from the frame header) are not examined by the FRFH function.

The FRFH function can switch VCs between ports on the 3745 and ports on the 3746 (both machines must be connected by an internal or external link).

The definitions for frame switching are loaded from NCP into the 3745 and 3746, or from CCM for the 3746 adapters controlled by the NNP.

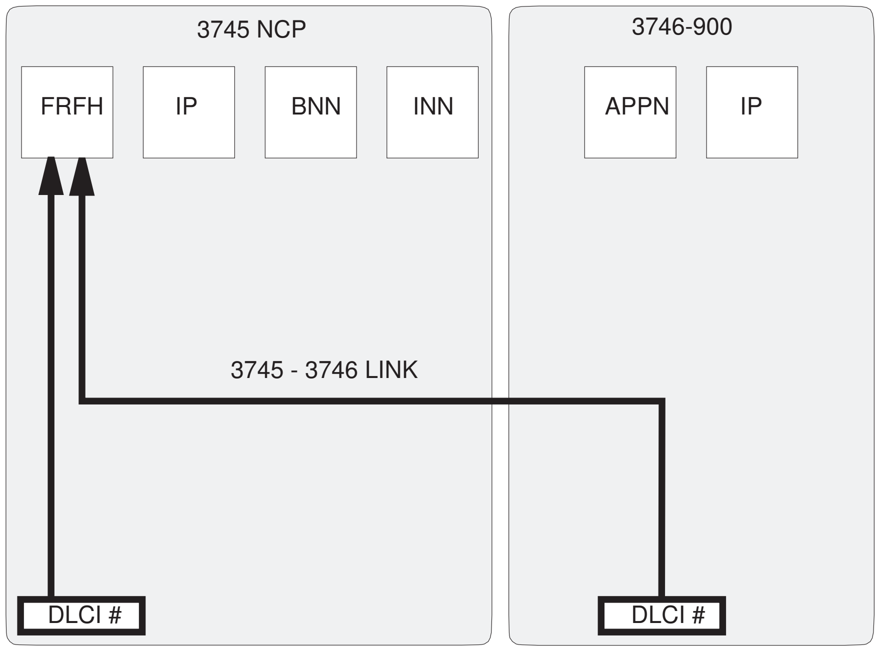


Figure 7. 3745 Frame Handler Function

IP over Frame-Relay

3745 and 3746 IP traffic is sent using NLPID encapsulation with NLPID=X‘CC’, and uses the RFC1490 routed frame format. For IP the bridged frame format is not supported. The IP SAP X‘AA’ is used for LAN traffic but is not used for IP over frame-relay. IP traffic from 3746 adapters is passed to the 3746 IP component, while traffic from the 3745 adapters is passed to the 3745 IP component.

IP traffic on 3746 adapters can be multiplexed with APPN and BNN traffic on the same DLCI. SNA traffic is encapsulated with NLPID=X‘08’ (routed frame format) or NLPID=X‘80’ (bridged frame format). Traffic for the 3746 APPN CP and NCP BNN function is distinguished by the SAP values in incoming SNA frames.

Figure 8 on page 35 shows the IP support.

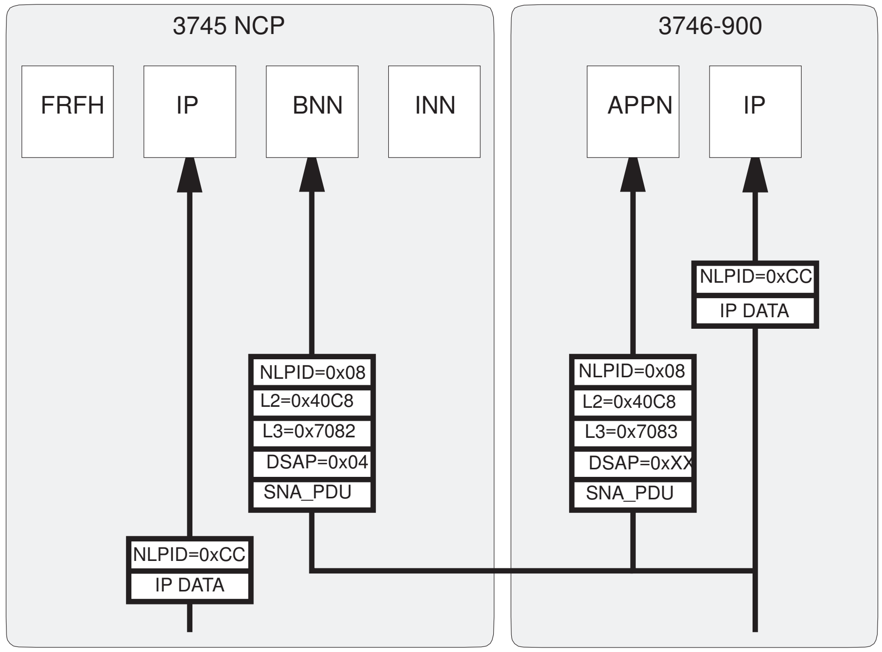


Figure 8. 3745 and 3746 IP over Frame-Relay

INN over Frame-Relay

Frame-relay INN traffic can be either in the RFC1490 routed or bridged frame format. INN traffic on 3745 ports can share a DLCI with IP traffic for the NCP. This traffic can be distinguished by the NLPIDs used (see Figure 9). INN traffic over frame-relay (routed or bridged frame format) always uses DSAP=X‘04’ and SSAP=X‘04’. Traffic from 3746 ports can also be passed to the NCP INN function.

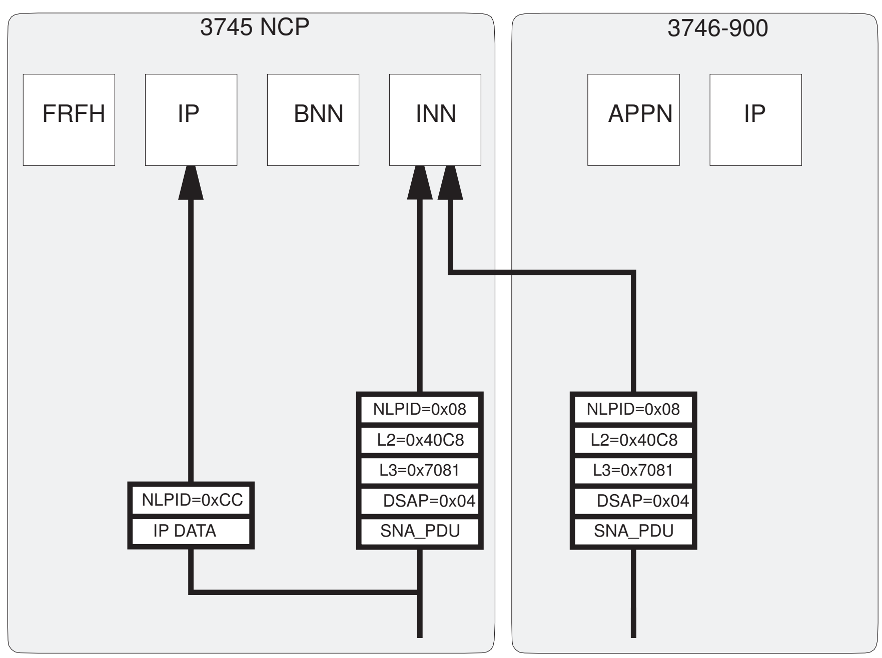


Figure 9. 3745 INN Traffic - Routed Frame Format

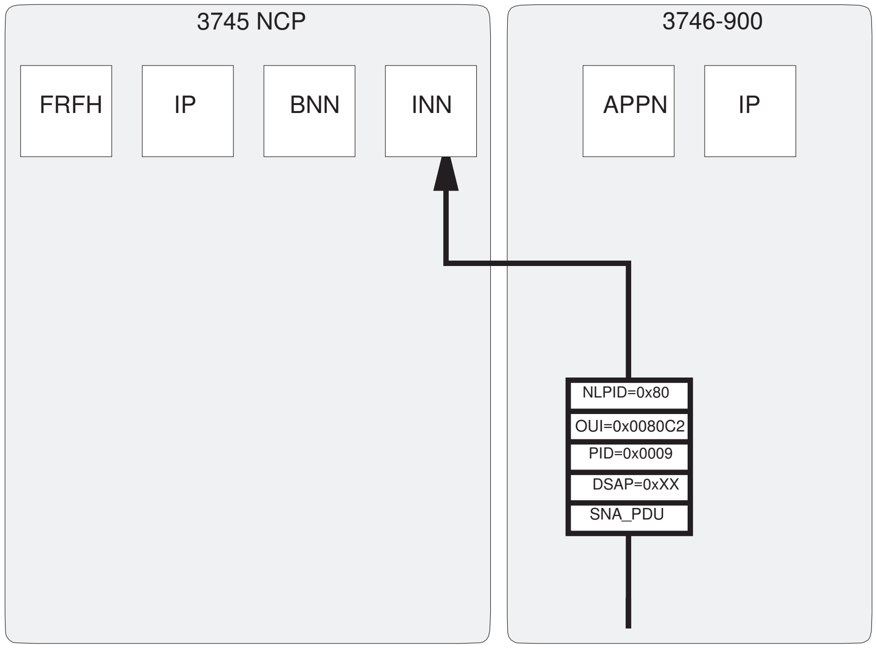


Figure 10. 3745 INN Traffic - Bridged Frame Format

BNN and APPN over Frame-Relay

BNN and APPN traffic from 3745 adapters uses a separate DLCI and cannot be multiplexed with other traffic. BNN and APPN traffic from 3746 adapters can be multiplexed with IP traffic on the same DLCI (see Figure 11 and Figure 12 on page 37).

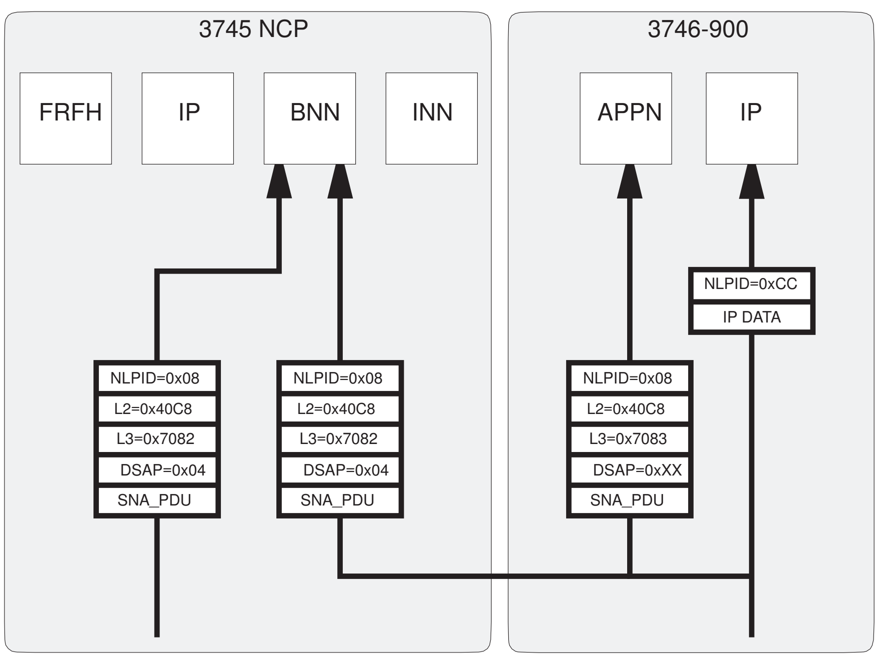


Figure 11. BNN/APPN Traffic - Routed Frame Format

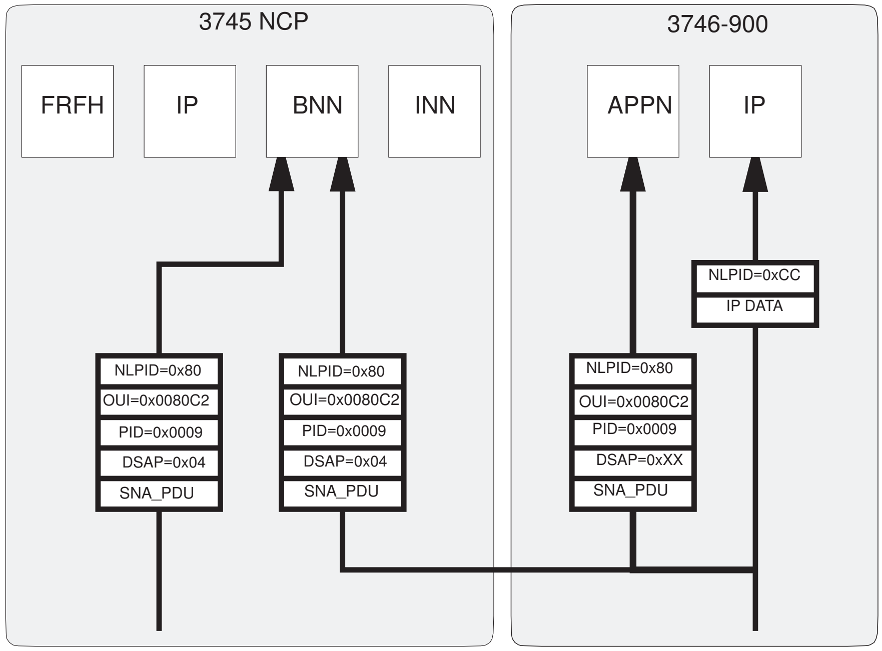


Figure 12. BNN/APPN Traffic - Bridged Frame Format

FRTE Subarea Connections (FRTE SA)

A subarea node is either a PU type 4 (NCP) or a PU type 5 (VTAM). FRTE SA connections apply to connections between PU4s (NCPs).

FRTE subarea connections are supported by NCP and the 3746-900 in the same way as the token-ring subarea connections. A physical line running frame relay is used to multiplex subarea logical connections. The subarea logical lines are defined as leased lines, each with a single T4 node. The 3746-900 provides an IEEE 802.2 connection-oriented attachment to the adjacent subarea node. NCP provides the transmission group, XID, path control, physical unit management and services, and the DLCI to be used for the connection.

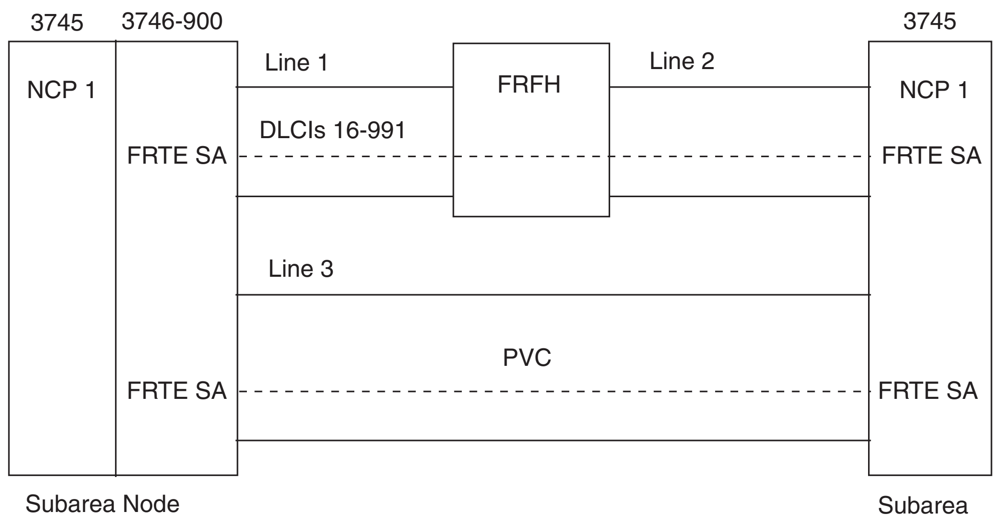


Figure 13. Frame-Relay Terminating Equipment: Subarea Connections

Figure 13 shows an FRTE SA between two NCPs that is supported on a direct connection between two NCPs as on line 3 or through an intermediate network as on line 1 and line 2.

Mixed media multilink transmission groups (MLTGs) are supported over an FRTE SA subport of the 3746-900. In Figure 13, the two connections between NCP 1 and NCP 2 may belong to the same TG.

Frame-relay congestion management is provided by the 3746-900 when:

- A frame with the backward explicit congestion notification (BECN) bit set is received, and the sending rate is decreased.
- A frame with the forward explicit congestion notification (FECN) bit set is received, and the BECN bit is set in the next frame sent.

NCP provides frame discard eligibility (DE) support if selected at NCP configuration time. When DE is supported by the transport network, the 3746-900 uses the DE bit in the frame-relay packet header. DE is set for packets containing data frames, but it is never turned on (set) for packets containing SNA control frames.

FRTE Peripheral Node Connections (FRTE PN)

As with FRTE subarea connections, FRTE peripheral connections (BAN, BNN, APPN) are supported by NCP/3746-900 in the same way as token-ring peripheral connections. The peripheral connections are defined as switched logical lines.

The frame-relay BAN function enables the 3745 and 3746-900 to communicate with IBM 2210 and 6611 routers and their SNA downstream physical units (PUs) using:

Dynamic route selection
: The 3745/3746-900, in conjunction with ACF/NCP Version 7 Release 3, dynamically routes the SNA flow from the downstream PUs to the appropriate destination, thus eliminating the need for an additional router adjacent to the 3745/3746-900.

Multiple stations over the same DLCI
: The frame-relay BAN function uses the RFC 1490 bridged-frame format. This BAN support of the 3745, 3746-900, 2210, and 6610 uses MAC address multiplexing, which allows a practically unlimited number of stations to use the same DLCI number.

  The number of stations using the same data link connection identifier (DLCI) is only limited by the bandwidth of the frame-relay link between the router and the 3745 or 3746-900.

Multiple DLCIs over the same frame-relay link
: Though only one DLCI is usually required between the 3745 or 3746-900 and the router, the frame-relay BAN supports multiple DLCIs over the same frame-relay link.

The frame-relay BNN function allows the 3745 and the 3746-900 to route SNA traffic for frame-relay attached equipment, such as the IBM 2217 Nways Multiprotocol Concentrator, the IBM 3174 Establishment Controller, or the IBM PS/2 with Route Expander. Multiple SNA physical units, connected to an IBM 3174 Establishment Controller, can access the 3745 or the 3746-900 over a single DLCI. This function is called service access point (SAP) multiplexing. The frame-relay BNN function uses RFC 1490 routed format.

The frame-relay APPN function allows the 3745/3746-900, in conjunction with VTAM and NCP, to be a composite network node (APPN CNN).

As with the frame-relay subarea connections, the 3746-900 provides the IEEE 802.2 connection-oriented services and NCP provides the remainder of the necessary functions. The DLCI may or may not be given to the 3746-900 by NCP depending on where the connection request originates. For a host-initiated connection (call-out), the DLCI is provided by NCP. For an end-user device initiated connection (call-in), the DLCI is provided by the end-user device.

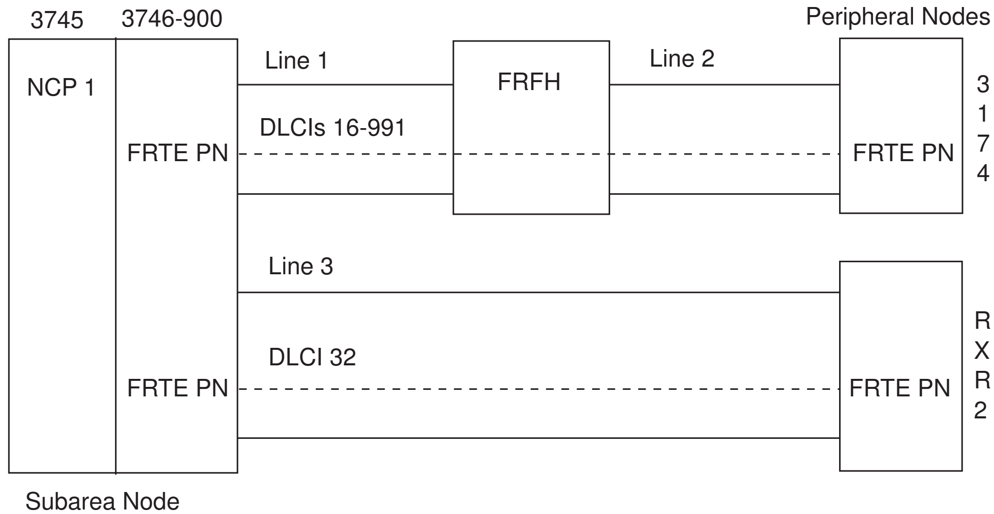


Figure 14. Frame-Relay Terminating Equipment: Peripheral Node

FRTE PN is supported on a direct connection as on Line 3 as shown in Figure 14, or through an intermediate network.

Frame-relay congestion management is provided by the 3746-900 when:

- A frame with BECN bit set is received. The sending rate is decreased.
- A frame with FECN bit set is received. The BECN bit is set in the next frame sent.

NCP provides frame-discard eligibility (DE) support if selected at NCP configuration time. When DE is supported by the transport network, the 3746-900 uses the DE bit in the frame-relay packet header. The DE bit is set for packets containing data frames, but it is never turned on (set) for packets containing SNA control frames.

Both PU 2 and PU 2.1 devices are supported. The NCP/3746-900 provides support for both subarea and peripheral connections over the same 3746-900 frame-relay physical line.

Frame-Relay Switching Equipment (FRSE) Functions

Frame-relay switching equipment support includes frame-relay frame handler (FRFH) support, dynamic reconfiguration of FRFH subports and routes, alternate physical links (substitute subports), frame-relay congestion, and performance management.

Previously, NCP was responsible for the definition, activation, deactivation, and dynamic reconfiguration of FRFH subports. These subports could be on 3745 or 3746 serial adapters. This support is now also in NN.

NCP V7.5 permits FRSE between NCP base frame lines and the NCP lines in the 900 frame. Note that an NN node can only use lines in the 950 frame.

Note: FRFH functions could also be run over connections between token-ring adapters on the 3745. This is not possible on the ODLC TIC3 adapters of the 3746.

Support has now been added allowing the NNP of the 3746 to configure and control FRFH functions. This allows the 3746-950 to support FRFH functions.

For FRFH functions, the 3746-900 provides the actual routing functions (see Figure 22 on page 55). Routing frame-relay data between 3746-900 ports is supported. The 3746-900 ports may be attached to the same or to different CLPs.

The same line can support both FRFH and FRTE subports.

The FRFH function can be used to switch any type of traffic. Incoming frames are switched to their outbound port without any regard for the data encapsulated in the frames.

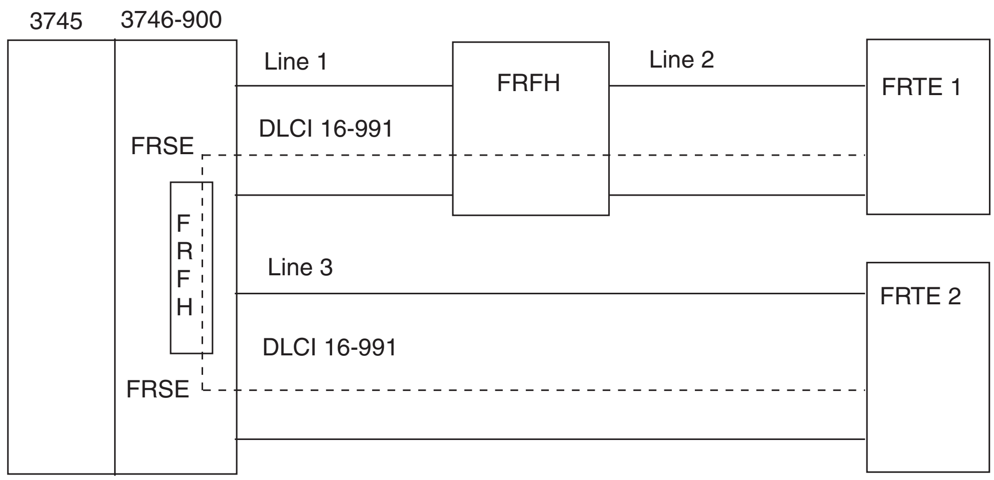


Figure 15. Frame-Relay Switching Equipment (FRSE or FRFH)

An FRTE can be directly attached as in Line 3 or through an intermediate network as on Line 1 in Figure 15. Frame-relay congestion management is provided by the 3746-900:

- When the first level of congestion occurs, FECN is set. The BECN bit is never set.

  Note: This is different from the 3745. If there are frames available flowing in the reverse direction, the 3745 sets the BECN bit.

- In case of severe congestion, frames are discarded. The frames with the DE bit set are discarded first.

Frame-Relay Substitute Subport

An ***FRSE SET*** is a set of two to four subports (A,B,C,D) where A and B are defined as the *primary partners*. We may substitute C for A or D for B. The path from C to D is ***not*** allowed. A diagram is provided below in Figure 16.

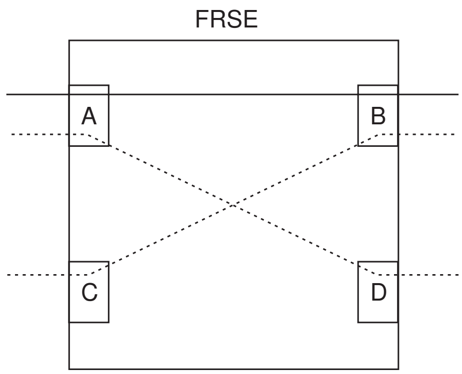


Figure 16. Frame-Relay FRSE Set

A substitute subport provides non-disruptive route switching (NDRS) to the end user.

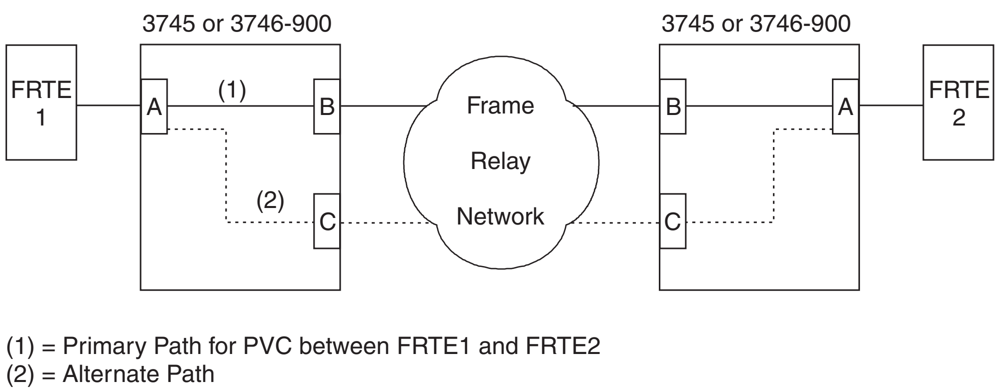


Figure 17. Frame-Relay Substitute Subport

A substitute subport can be defined for an FRFH subport. When a substitute subport is defined at both ends of a PVC, this provides an alternate PVC between paired 3745 or 3746-900 switching nodes as shown in the Figure 17. In both boxes, the primary path is defined from subport A to subport B. When the path from subport B of the left box to the subport B of the right box fails, an alternate path is used between subport C of both boxes. Local management interface (LMI) is required at subports B and C. This is also supported by the 3746-950.

The substitute subport provides a nondisruptive route switching for the PVC established between FRTE1 and FRTE2 in the previous figure. When the primary path is reestablished, the traffic automatically switches back to it.

Frame-Relay Local Management Interface (LMI) Support

The 3746-900 LMI support conforms to ANSI T1.617 Annex D and ITU-T Q.933 Annex A.

Frame-relay LMI support is provided entirely by the 3746-900, except for the definition of the LMI timers and thresholds. The timer and threshold values are defined in the NCP and passed to the 3746-900 at activation time. Events that are detected via LMI (for example, LMI status change or reaching an LMI error threshold) may result in failure of the associated SNA resources that are handled by the NCP. The link integrity verification (LIV) tests and full status polling are handled entirely by the 3746-900.

NCP determines the mode of LMI support at activation of the LMI subport only when LMI support is defined for that physical line. NCP will determine the mode based on the LMI frames received dynamically at the time of connection establishment.

The different LMI modes are supported in the same way as for 3745 attached resources. The behavior is dynamically discovered at connection establishment time.

The modes that are possible are listed below:

- Network to Network Interface (NNI): The LIV inquiries and the PVC status inquiries and responses are sent by both partners on the frame-relay interface. This is also called LMI bidirectional protocol. Both partners must support this mode.
- Network to User Interface: The partner is a DTE that does not support NNI. The partner polls the 3746-900 and does not answer the LIV enquiries sent by the 3746-900.
- User to Network Interface (UNI): The partner is a DCE that does not support NNI. The partner answers the status inquiries sent by the 3746-900.
- No LMI: The partner does not answer the status request and does not send status inquiries to the 3746-900.

Since NCP negotiates dynamically with the remote end, it is possible to find a configuration mismatch: ITU vs. ANSI, one at one end of the line and the other at the other end. The result will be "no LMI".

NN lines can either negotiate as above or be forced into the NUI mode. If they are mismatched, we will wait in an LMI PENDED STATE and the line will not be available for use. Redefinition will be necessary.

System Definitions

The configuration of the NCP 3746-900 frame-relay resources is similar to that of the 3745. It is created via the network definition facility (NDF) during NCP generation.

- Physical lines represent frame-relay ports. The maximum frame size supported is 8250 bytes (as it was for the 3745).
- The LMI is represented as a physical station PU type 1.

- Additional physical stations are used to represent frame-relay subports used for FRSE. These PUs can be dynamically added or deleted from VTAM® without requiring NCP regents or loads.
- A logical line and the associated logical station (PU type 4) represent a FRTE SA.
- A pool of logical lines and associated logical stations are available for dynamic use at connection setup time for FRTE PN (BAN, BBN or APPN).
- FRSESET is used to define a switching path inside the 376-900 between two of its subports. The FRSESET paths can be modified from VTAM without NCP regents or reloads.
- Substitute subports are defined via the FRSESET definition statement. NDF is used to define the communication rate for each DLCI.

Configuration of NNP frame-relay resources by CCM is straightforward. Panels are presented for port, LMI, DLCI and APPN definitions.

Congestion Control

Frame-Relay Standards

Congestion control can be defined as a set of mechanisms incorporated to attain certain network performance objectives, particularly in the peak periods, while optimizing or improving the network resource requirements. It aims to minimize the number of occurrences of user-perceived congestion. Frame-relay networks should not allow users to monopolize network resource usage at the expense of other users. Congestion control includes both congestion avoidance and congestion recovery mechanisms.

The service offered by a frame-relay service is the transparent and unacknowledged transfer of frames. The user data received will be like the data sent except the address and FCS field, which can be modified by the network. The network does not guarantee message delivery. Therefore, frames may be dropped. A frame-relay network experiencing congestion will either inform its users about the congestion, assuming the users will take appropriate action (not detailed in the frame-relay standards!) to relieve the congestion, or it simply discards frames.

Frame-relay networks using *out-of-band* congestion signaling report congestion by sending explicit congestion control messages on a dedicated DLCI. In addition to frames originating from remote end stations and LMI message sent by the network, end stations may also receive Consolidated Link Layer Management (CLLM) messages generated by the network reporting congestion. The use of CLLM is not widespread.

Frame-relay networks using *in-band* congestion signaling report congestion by using bits in the frame address field. End station will receive no other frames (the exception being LMI messages) than those frames sent by another end station.

The network is able to inform end stations about congestion by using two fields in the frame address field. For this purpose the *forward explicit congestion notification (FECN)* bit and the *backward explicit congestion notification (BECN)* bit have been reserved. The FECN bit will be set in frames flowing in the direction in which the network is experiencing congestion. The BECN field will be set in frames flowing in the opposite direction in which the network is experiencing congestion.

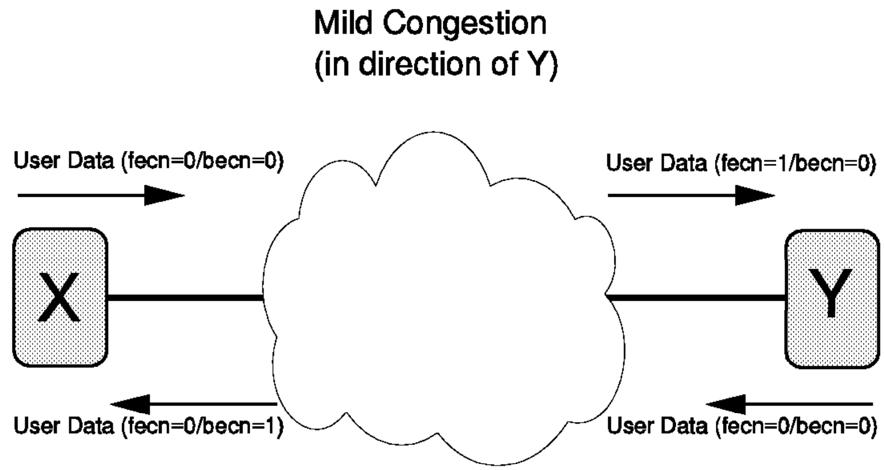


Figure 18. In-Band Congestion Signaling

The consequence is that if traffic on a specific virtual circuit is uni-directional, only the receiving station will be informed about the congestion and not the transmitting station, which may be the cause of the congestion.

FECN and BECN congestion indicators are usually set by the network only. However, in particular cases they may be set by end stations as well. As an example, ACF/NCP Version 7 Release 2 sets BECN in the first frame to be transported after a frame with FECN has been received. This informs the other end of the PVC about the congestion, allowing it to decrease its transfer rate helping the network to relieve the congestion.

FECN/BECN will be set during mild congestion, while the network is still able to transfer frames. A frame-relay network will usually start discarding frames during severe congestion. End stations are able to "prioritize" their traffic by using the *discard eligibility (DE)* in the address field of the frame header. The network will start to discard frames with the DE field set first; however, frame delivery is not guaranteed and there is nothing in the frame-relay standards that restrains networks from discarding frames without the DE bit set.

The frame-relay standards do not specify the conditions under which the FECN/BECN bits will be set and when frames with or without DE will be discarded. It is assumed, but not enforced, that end stations reduce their information transfer rate upon detection of network congestion. Congestion control based on the discarding of frames or the use of FECN/BECN bits, and relying on the "good behavior" of end stations, has therefore been considered inadequate to networks providing a frame-relay service and additional provisions have been defined.

Committed Information Rate (CIR) and Burst Sizes

The 3746-950 provides CIR support which is ***not*** available under NCP. The maximum number of bits per seconds that an end station can transmit into the network is bounded by the *access rate* of the user network interface. The access rate is limited by the line speed of the user network connection and established by subscription.

The maximum committed amount of data that a user may offer to the network is defined as *committed burst size (B_c)*. B_c is a measure for the volume of data for which the network will guarantee message delivery under normal conditions. It is measured during the *committed rate measurement interval (T_c)*.

End stations are allowed to transmit data in excess of the committed burst rate. The *excess burst size (B_e)* has been defined as the allowed amount of data by which a user can exceed B_c during the committed measurement rate interval T_c. If spare capacity exists, the network will forward the data to its destination. The network, however, is free to mark the data as discard eligible (DE).

The *committed information rate (CIR)* has been defined as the allowed amount of data that the network is committed to transfer under normal conditions. The rate is averaged over an increment of time T_c. The CIR is also referred to as *minimum acceptable throughput*. Remember that CIR is implemented only for NN and IP 950 lines.

B_c and B_e are expressed in bits, T_c in seconds. The access rate and CIR in bits per second. CCM allows to define B_c, B_e, T_c, DLCI while the CIR is computed. The access rate is valid for each user network interface. For B_c, B_e and CIR incoming and outgoing values can be distinguished. If the connection is symmetrical the values in both directions are the same. For permanent virtual circuits B_c (incoming and outgoing), B_e(incoming and outgoing) and CIR (incoming and outgoing) are defined at subscription time. They are negotiated for SVCs at call establishment time. T_c is calculated as depicted in Table 17.

Table 17. Measurement Interval Calculation

CIR	**B_c**	**B_e**	**Measurement Interval (T_c)**
> 0	> 0	> 0	$T_c = B_c/CIR$
> 0	> 0	0	$T_c = B_c/CIR$
0	0	> 0	$T_c = (B_e/\text{Access Rate})^2$

Note:

Table depicts the valid parameter configurations. Other configurations are for further study.

When the two communicating end stations have different access rates the network may define a smaller T_c value.

Individual CIRs on a physical connection are always lower than the access rate; however, the sum of CIRs defined can be larger than the access rate. An example could be a network connection with an access rate of 256 Kbps on which three virtual circuits have been defined: two having a CIR of 128 Kbps each, one having a CIR of 64 Kbps.

Optimal values for the above parameters depend on network implementation, availability of spare network capacity, charging methods, type of user device and performance required. These are only a few considerations and careful study of the total network is required (as well as the more immediate future changes that can be anticipated).

Networks may mark frames above B_c with discard eligible (DE) but have plenty of spare capacity to transport the frame, or may instead have limited capacity and discard excessive frames immediately. Networks may mark frames above B_c+B_e with discard eligible (DE), and possibly transport it, or just drop the frames as suggested by ITU-T I.370.

The Network manager always tries to balance costs and performance, and examines the frame-relay service provider charging schemes. Networks may implement fixed charging depending on access rate, a scheme dependent on CIR, B_c and B_e or more sophisticated schemes, for example charging on number of bits transported and charging progressively for data above B_c or B_c+B_e. Depending on the charging scheme employed, subscribing to high values of CIR, B_c and B_e, may lead to high networking costs. It should be examined if the performance gain, if any, counterbalances the additional networking expenses.

Many devices have limited control over the volumes of data they send into the network. Assuming that flow control mechanisms implemented on top of the layer 2 core function are not inhibiting data transfer, data will be transmitted with a speed up to the network access rate. If the device has only one DLCI active, or has (temporarily) data to send for one DLCI only, the data rate on a single DLCI may be equal to the network access rate. If the sum of committed and excess burst size (B_c+B_e) is lower than the access rate times T_c, the network may decide to discard frames. In this situation it may be advisable to give all DLCIs the following values:

B_c+B_e = Access rate*T_c

Depending on functions implemented on top of the layer 2 core functions, lost frames may be quickly detected and recovered from. This may be a time-consuming activity that severely impacts performance. In the latter case, subscribing to high values of CIR, B_c and B_e is important.

Communication Rate (CR) and Committed Information Rate (CIR)

The 3746 provides communication rate (CR) support. A part of the access rate (physical line speed) is assigned by the user to each station. IP traffic ***per DLCI*** is represented by ***one*** station. The total bandwidth available is split between the stations. This capability differs from the committed information rate (CIR), which is defined as the information rate which the network is committed to transfer under normal conditions over a DLCI.

If all the stations, at any point in time, require more bandwidth than is available, then each station is limited to their user-predefined bandwidth. In case of overflow, the data for those stations that create the overflow are kept in a software queue. They will be transmitted at the next opportunity. If the overflow on the DLCI lasts too long, the data in excess is discarded. The stations that create the overflow are paced and slowed down to their communication rate, while the other ones continue to get their communication rate.

When CR is implemented, if the total physical bandwidth is not fully used the unused bandwidth is available for stations that may then exceed their CR in making use of the unused bandwidth.

For private networks where one wishes to fully utilize all the bandwidth, implementing CR is preferable. For public networks, where CIR is a cost factor and constraint, it is preferable to implement CIR.

The assignment of the communication rate to the stations is via the CCM at 3746 configuration time. Note that CR and CIR can ***not*** be shared on the same physical line. Also SNA line sharing is ***not*** possible when the CP defines the link as having a given CIR. This information is passed by the NNP to the 3746 CLPs at activation time.

When CR is enabled for a given line:

- SNA and APPN FRTEs echo incoming FECNs as BECNs; incoming BECNs reduce XMIT windows as per DYNWIND definitions.
- IP FRTEs ignore incoming FECNs and BECNs.
- FRFHs transport FECNs and BECNs transparently. They do not set BECNs.
- FRTEs and FRFHs set FECNs whenever there is congestion on the transmit physical line.

When CIR is enabled for a given line:

- FRTEs echo incoming FECNs as BECNs.
- FRTEs and FRFHs set FECNs whenever there is congestion on the transmit physical line. They use Bc as a CR to manage the contention.
- FRFHs transport FECNs and BECNs transparently.
- FRFHs will also set FECNs as soon as the traffic received from a partner subport exceeds that DLCIs CIR during a Tc period. This will also happen when the delay introduced by the FRFH gets too large.

Throughput is optimized when CIR is enabled by tuning to just under the level at which the network sets FECNs and BECNs. All FRTEs will adjust their output rate between *minimum information rate* (MIR) and *excess information rate* (EIR). This is called *adaptive-CIR* (A-CIR) and is based on a unique tuning algorithm. This is opposed to CR, which handles the first physical hop and does ***not*** look for the logical bottleneck within the network. This minimizes queues and delays throughout the network and saves bandwidth on the first hop for other DLCIs that still have end-to-end bandwidth available.

The following provides further detail:

EIR = 0 means the same as $B_c = 0$.

MIR is set at either:

$$25 * B_c/T_c$$

or

9.6 Kbps if $B_c = 0$.

The EIR can be calculated using the following formula:

$$EIR = (B_c + B_e)/T_c$$

Also, when $B_c = 0$, the EIR becomes B_e/T_c. This is different from the IBM 2216 or 2210, which do not define T_c and would then commit the whole physical bandwidth as EIR.

FRFHs do not implement A-CIR. They set:

$$CIR = (_c + B_e)/T_c$$

or, if the first hop is congested they set8colon

$CIR = B_c/T_c$

Having FRFHs implement CR and FRTEs implement CIR will move delays and congestion to the endpoints and optimize the utilization of the network backbone. But it is best that both end points implement CIR simultaneously because of the setting of FECNs and BECNs. Note that CIR values need not be the same for these end points if there is unbalanced traffic.

Figure 19 illustrates how A-CIR is used to maximize the use of available bandwidth between two network end points. Every 3.2. seconds a new CIR is computed based on current network congestion (BECNs). (The time interval, 3.2 seconds, was determined pragmatically and took into consideration the anticipated system turnaround time (the value was chosen to exceed it). This permits learning about current network conditions that resulted from the previous network settings. You will note that this permits the A-CIR curve to stabilize around the available network bandwidth.

You can also see in the graph how the A-CIR curve quickly approaches the network's available bandwidth even after that bandwidth changes. The broken variable CIR curve oscillates and makes measurably less efficient use of the bandwidth.

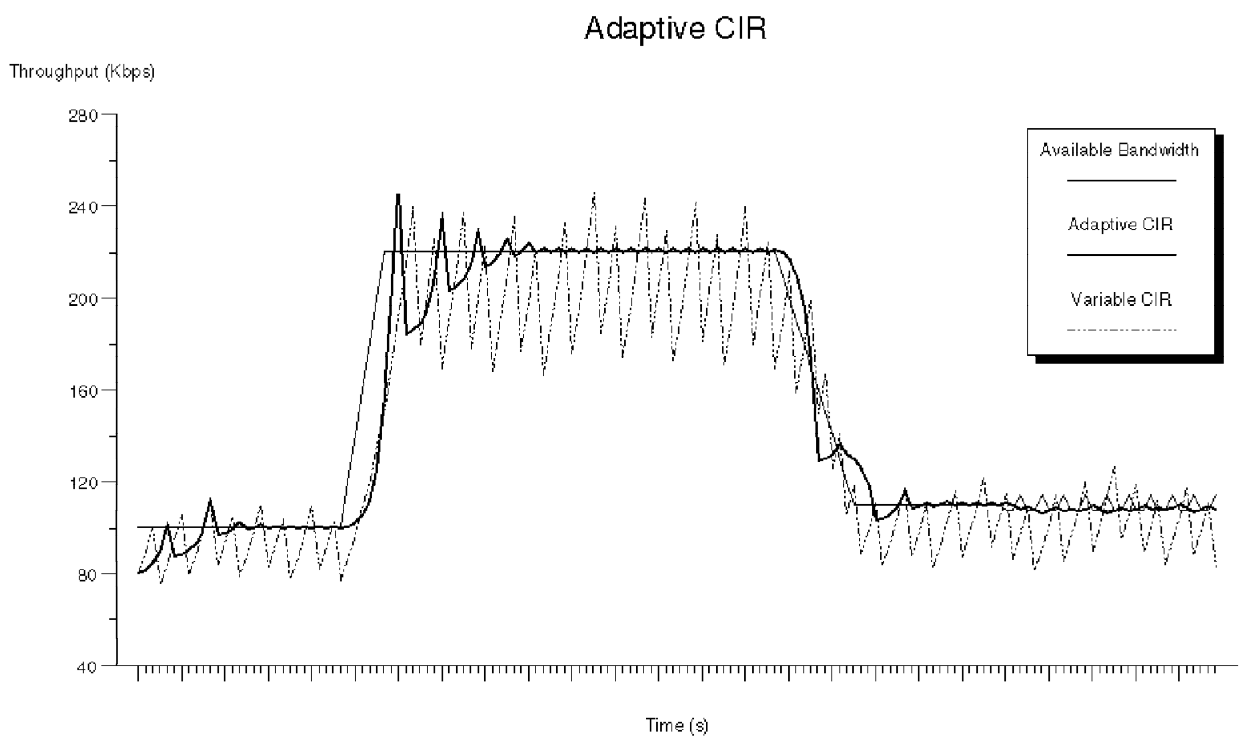


Figure 19. Adaptive-CIR verses Available Bandwidth

Data points were calculated for the above graph using the respective algorithms for A-CIR and CIR. Available bandwidth was varied to simulate possible network conditions. The interval is 3.2 seconds as mentioned above.

The formula is:

New CIR/Old CIR = 1 +/- 2^{N-P}

where P is *precision* which is configured and preset to 8. Its possible range is 6 - 10 and N is a runtime variable that is dynamically incremented with a range of 0 - 5. The sign +/- is determined by BECNs. If BECNs are received during the last 1.6 second interval, the sign is - and the CIR is effectively decreased, allowing network congestion to dissipate. If no BECNs are received the sign is set to +.

When CIR is updated with the same sign as the previous update, *N* is incremented by 1 until it reaches its maximum value of 5. When the sign changes, *N* is reset to 0. This is done after computing the new CIR when the CIR is less than the previous CIR and before new CIR computation in the other case.

For the 3746 adapters, either COMRATE or CIR can be specified at the port level. The default value is CIR disabled. This means COMRATE is enabled.

3746 Bandwidth Reservation System

The Bandwidth Reservation System (BRS) allows the customer to define how bandwidth should be assigned between protocols within a DLCI.

As per Figure 20 on page 51 and other descriptions, BRS works on top of CIR. It does not have priority capability. The BRS implementation in the 3746 by the NNP supports a mechanism whereby each of three traffic types, SNA (APPN, DLUR, HPR-ERP), HPR¬ERP (non-ERP), and five different IP sockets can be assigned a portion of a DLCI's CIR (bandwidth). The balance, from 100%, should be assigned to the remaining IP traffic. These five sockets do not have to be well known and are assigned at configuration time.

Figure 20 on page 51 shows how 3746 BRS works. When CIR is enabled, T_c, B_c, and B_e can be defined for each DLCI. B_c and B_e may be equal to zero, but B_c plus B_e must be greater than zero. B_c and B_e are expressed in multiples of DATABLK. For FRFH and FRTE DLCI's:

T_c The measurement interval (T_c) is defined at the DLCI level. The default value is 0.1s. The value is specified in tenths of a second (1-255).

B_c Committed burst size in units of DATABLK (0-64).

B_e Excess burst size in units of DATABLK (0-64).

Then for FRTE DLCIs, each protocol can be assigned a percentage of those CIR values:

```
CIR parameters per DLCI: Bc, Be, Tc

BRS DLUR/APPN/HPR (ERP): T%
    HPR (non-ERP):       U%
    IP:                  V%
    Socket1:             W%
    .
    .
    .
    .
    Socketn:             X%
```

The percentages can be defined between 0% and 100%. A zero value means no bandwidth is reserved for that protocol, which means all that protocol traffic will be discarded when congestion occurs. If a protocol has no BRS defined, then that protocol's traffic does not participate in BRS and all that traffic is transferred whatever the level of congestion.

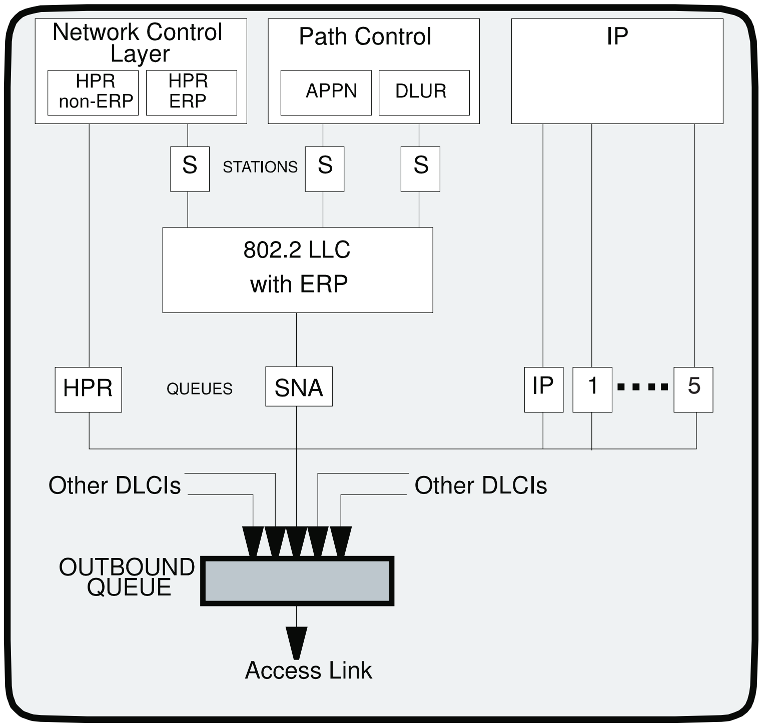


Figure 20. 3746 BRS

BRS is only used when there is more traffic to send than the available bandwidth. 3746 BRS is not used for FRFH DLCIs.

MAE Bandwidth Reservation System

On serial connections, frame relay (FR) and PPP, the MAE implements a BRS mechanism. BRS enables the network administrator to reserve portions of the bandwidth of a circuit for specific types of data, differentiate between urgent, high, normal, and low-priority traffic within that bandwidth, and therefore favor the transmission of the highest-priority data.

BRS allows you to decide which packets to drop when demand (traffic) exceeds supply (throughput) on a network connection. Bandwidth reservation is not used until more than 100% of the available bandwidth is requested.

Bandwidth reservation *reserves* transmission bandwidth for a network connection. This reservation feature allocates minimum percentages of total connection bandwidth for specified classes of traffic.

BRS Components: BRS uses the following mechanisms to differentiate between traffic types and then to queue that traffic.

Circuit Classes

Frame-relay interfaces can be grouped into circuit classes and each circuit class is assigned a percentage of the frame-relay interface's bandwidth. The sum of bandwidths reserved per link must be less than 100%. A *default* class is defined per frame-relay interface and cannot be deleted. The bandwidth assigned to the DEFAULT class can be changed.

Traffic Classes

Bandwidth reservation guarantees bandwidth for specific types of encapsulated traffic (classes) identified by either the protocol type or a filter. Traffic classes are defined for each PPP interface and each frame-relay circuit.

BRS supports the following protocols:

- IP
- ARP
- IPX
- Bridging
- SNA/APPN-ISR (BAN and BNN)
- APPN-HPR (BAN and BNN)
- Appletalk
- DECnet IV
- Banyan Vines
- OSI/DECnet V.

Note: By default, all protocols/applications are assigned to the default class with priority normal.

BRS also supports the following filters:

- IP tunneling
- SDLC tunneling over IP (SDLC Relay)
- Rlogin
- Telnet
- SNA/APPN-ISR
- APPN-HPR
- SNMP
- IP Multicast
- DLSw
- MAC Address (through MAC filtering tags)
- MAC Filters
- NetBIOS
- Network-HPR
- High-HPR
- Medium-HPR
- Low-HPR
- X.25 Transport Protocol (XTP).

Using either the type of protocol or a filter to differentiate between traffic types, traffic can be assigned to one of the *traffic classes*.

The reserved percentages for each class are a minimum slice of bandwidth for the network connection. When the network is operating to capacity, messages in any one class can be transmitted only until they use the configured bandwidth allocated for the class. In this case, additional transmissions are held until other bandwidth transmissions have been satisfied.

Priority Levels

Within each traffic class, the traffic can also be assigned a *priority level*. When BRS transmits packets for a traffic class, all packets with urgent priority are sent first, then all high priority, then all normal priority, and then all low priority. The following priority levels are defined:

- Urgent (U)
- High (H)
- Normal (N)
- Low (L).

Figure 21 shows three traffic classes. Each traffic class has its own set of data, which has been given a priority (shown by the four queues: urgent(U), high (H), normal (N), and low (L).

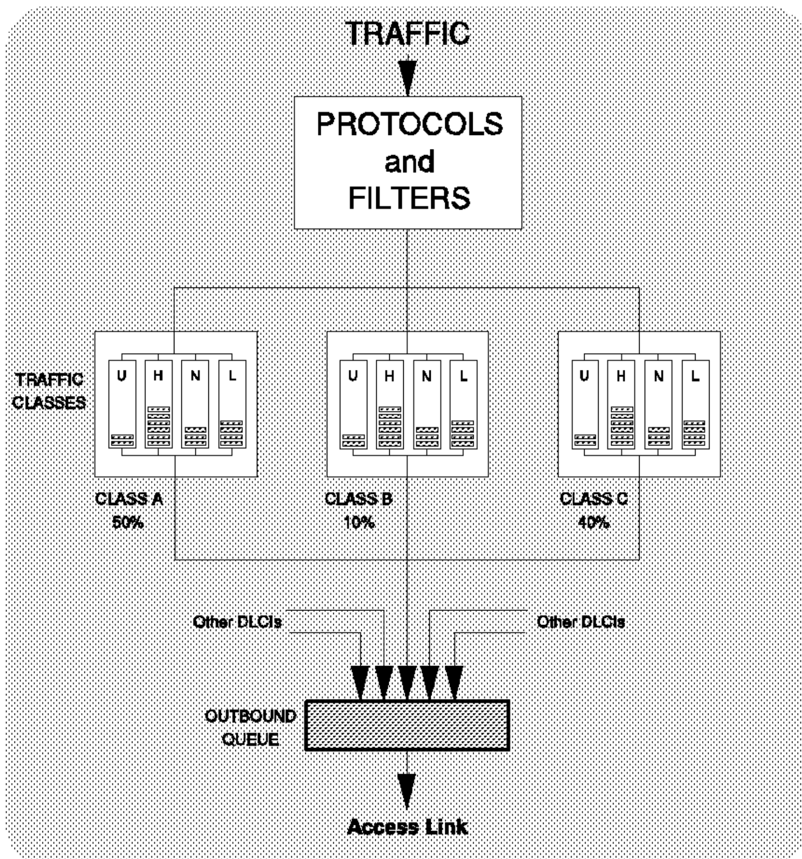


Figure 21. 3746 Multiaccess Enclosure BRS

Both *orphan circuits* (circuits that are not configured but are learned via LMI) and configured circuits with BRS explicitly disabled, use a default queueing mechanism where all frames are assigned to a default traffic class at the circuit level, and the circuits are assigned to the default circuit class.

Figure 21 shows three traffic classes. Class A is assigned 50% of the bandwidth available to that DLCI, class B is assigned 10%, and class C is assigned 40%. Traffic bound for the DLCI shown is differentiated by the previously discussed protocol types or filters, and is assigned one of the four priorities. In the 2210 and 2216, each traffic class has a queue for each priority level.

BRS Support of APPN Traffic: When SNA/APPN-ISR is assigned to a traffic class, either APPN-ISR traffic that is being routed by the router's APPN code or SNA or APPN-ISR traffic that is being bridged will be assigned to this class. This is why SNA/APPN-ISR shows up as a protocol (the *routed* case) and as a filter (the *bridged* case). To identify SNA/APPN-ISR traffic that is being bridged, the BRS code looks for any bridging frames that use a DSAP or SSAP of 0x04, 0x08, 0x0C and a LLC (802.2) control field value that is ***not*** the unnumbered information (UI) type (that is ***not*** 0x03).

If SAPs other than 0x04, 0x08, or 0x0C are used for SNA/APPN-ISR bridge traffic, a sliding window MAC filter can be created to identify and tag SNA/APPN traffic. Using the BRS MAC filtering support, MAC filter tags can be assigned to a traffic class and priority.

When APPN-HPR is assigned to a traffic class, the BRS code looks for any bridging frames that use a DSAP or SSAP of 0x04, 0x08, 0x0C, and 0xC8 and a LLC (802.2) control field value that is equal to the unnumbered information (UI) type (that is 0x03).

If the user wants to differentiate between HPR-HPR traffic depending on its transmission priority then the user can use the following HPR filters:

Network-HPR
Used for HPR traffic that is using the network transmission priority.

High-HPR
Used for high transmission priority.

Medium-HPR
Used for medium transmission priority.

Low-HPR
Used for low transmission priority.

This means that one of the above HPR transmission filters can be assigned to a different traffic class and/or priority than the other APPN HPR traffic.

Summary of 3745/3746-900 SNA NCP Routing and Frame-Relay Switching

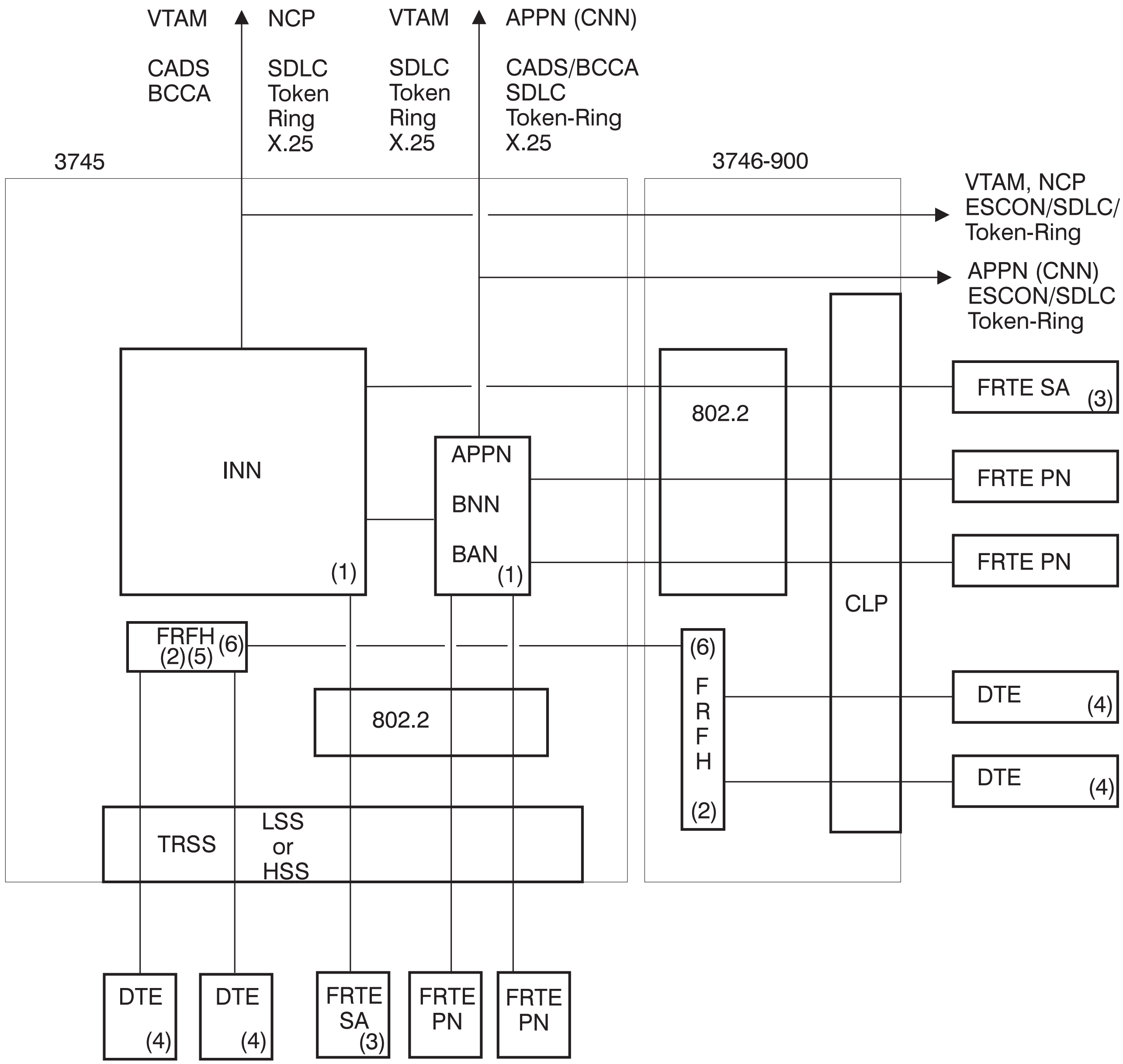


Figure 22. Summary of 3745/3746-900 SNA Routing and Frame-Relay Switching

Notes:

1. SNA Routing layer.
2. Switching layer.
3. 3745 or 3745/3746-900.
4. These DTEs can be FRTE SA, FRTE PN, or any FRTE or FRFH.
5. FRFH is also supported over the 3745 TRSS (token-ring adapter) in addition to the LSS and HSS.
6. FRFH between a 3745 subport and a 3746-900 subport (NCP V7 R4).

3745 and 3746-900 FRFH Details

A DLCI used for FRFH has to be either predefined in NCP or dynamically added from VTAM.

For NCP V7 R4

In a NCP V7 R4 frame-relay node, the frames can be switched between any pair of the following:

- 3745 LSS or HSS port
- 3745 TIC2 port
- 3746-900 CLP port.

See Figure 22 on page 55.

When using substitute subports, the primary and secondary subports can be any type of the above ports.

For NCP V7 R2 and NCP V7 R3

When using substitute subports, both the primary and the substitute subport must be part of the 3746-900 or of the 3745 (for 3745/NCP frame relay). There is no frame switching between a 3745 line or a TIC2 port and a 3746-900 line. However, for SNA frame-relay traffic, the routing functions of ACF/NCP are used to route the SNA traffic (subarea, peripheral) between a 3745 line and a 3746-900 line.

Table 18 shows the possible frame switching from either of the following:

- 3745 LSS/HSS/TIC2 subport to a 3745 LSS/HSS/TIC2 subport
- 3746-900 CLP subport to a 3746-900 CLP subport.

Also see FRFH in Figure 22 on page 55.

Table 18. Subport FRFH for Frame-Relay Switched Traffic with NCP V7 R2 and V7 R3

From Subport	**To Subport**			
	3745 Primary (LSS/HSS) (TIC2)	**3746-900 Primary (CLP)**	**3745 Substitute (LSS/HSS) (TIC2)**	**3746-900 Substitute (CLP)**
3745 Primary (LSS/HSS/TIC2)	Yes	No	Yes	No
3746-900 Primary (CLP)	No	Yes	No	Yes
3745 Substitute (LSS/HSS/TIC2)	Yes	No	N/A	N/A
3746-900 Substitute (CLP)	No	Yes	N/A	N/A

Note: N/A = Substitute subport to substitute subport is not applicable

There are no such limitations with NCP V7 R4 or V7 R5.

Functions Not Supported by NCP

There is no NCP support for frame relay over TIC3s in the 3746-900 and no NCP support for IP over 3746-900 frame-relay lines.

Additional Functions Supported by the 3746 Network Nodes

The 3746 NNP supports *orphanage*. An *orphan circuit* is a PVC that is not defined. When an undefined DLCI is discovered thru LMI, the 3746 can learn the IP address of this DLCI by sending an Inverse ARP to acquire the partner IP addresses over active DLCIs. LMI is required to support orphan circuits. If a partner frame-relay DTE does not support Inverse ARP, the DLCI used for IP must be statically defined in CCM. The 3746 answers all Inverse ARP messages received.

When the 3746 is directly connected with no intermediate network to equipment that only supports the LMI user side, LMI should be set to NUI the 3746 and the attached equipment, such as a 2210 or 2216, must be configured with *orphanage OFF*. This is illustrated in Figure 23 and Figure 24.

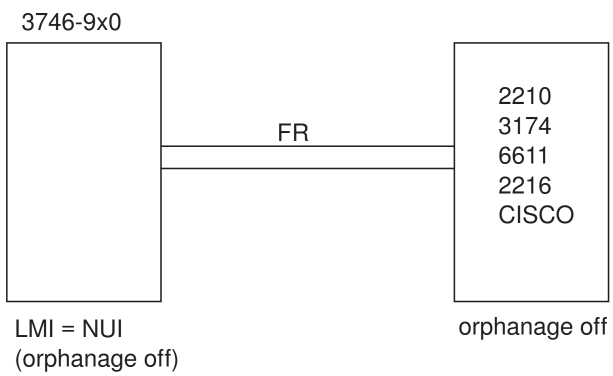


Figure 23. Direct Connection with a Router

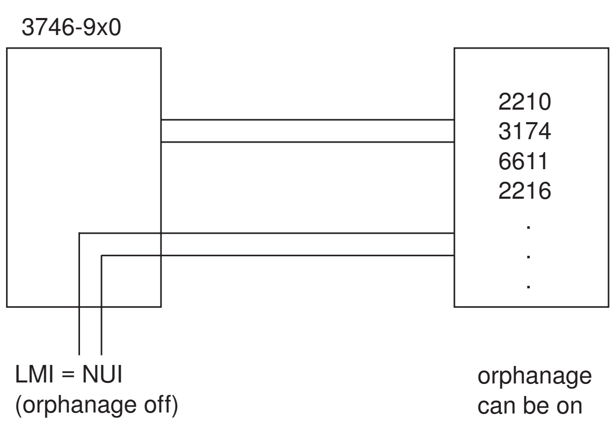


Figure 24. FRSE and Direct Connection

Note: *Orphanage OFF* will require explicit definition of the DLCIs but will save cycles at session setup time. Using *orphanage ON* will save on definitions but will generate more network traffic.

The 3746 NNP never sends ARP messages. The 3746 answers ARP messages received;the ARP answer is sent by the 3746 on the same DLCI as the ARP was received. This could be different from the DLCI number found inside the ARP message itself. The format of the ARP message is defined in RCF 1490. When the 950 is connected to a frame-relay cloud LMI should be set to adaptive and orphanage can be set on as shown in Figure 25

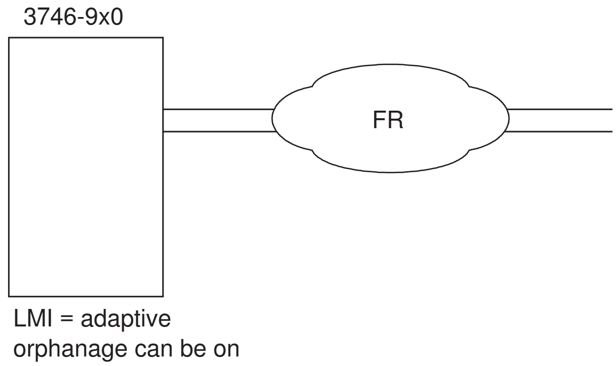


Figure 25. Not Point to Point

FRTE Peripheral Node Connections (FRTE PN)

FRTE PN is supported on a direct connection as shown on Line 3, or through an intermediate network as shown between Lines 1 and 3 in Figure 26.

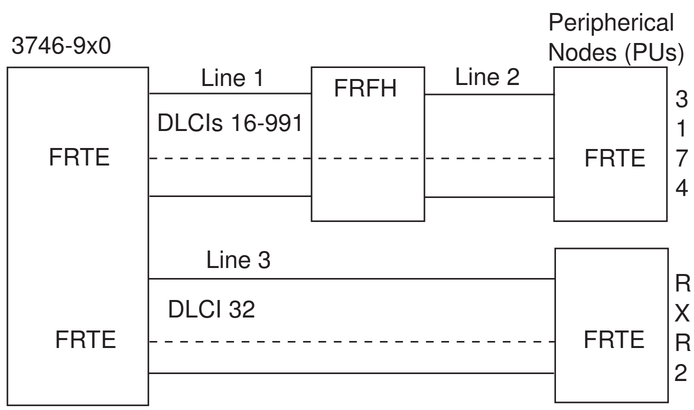


Figure 26. Frame-Relay Terminating Equipment Peripheral Node

Frame-relay congestion management is provided by the 3746 when:

- A frame with BECN bit set is received; the sending rate is decreased.
- A frame with FECN bit set is received; the BECN bit is set in the next sent frame.

The 3746 provides frame-discard eligibility (DE) support if selected at CCM configuration time. When DE is supported by the transport network, the 3746 uses the DE bit in the frame-relay packet header. The DE can be set for packets containing data frames, but it is never turned on (set) for packets containing SNA or APPN/HPR control frames.

Both PU 2 and PU 2.1 devices are supported with either the RFC 1490 routed or bridged format.

Frame-Relay Local Management Interface (LMI) Support

The 3746 LMI support conforms to ANSI T1.617 Annex D and ITU-T Q.933 Annex A.

Frame-relay LMI support is provided entirely by the 3746 for the 950 NNP or in the NCP generation for the 3746-900. The LMI timer and threshold values are defined using CCM. They are passed to the 3746-9x0 CLPs at activation time. Events that are detected via the LMI (for example, LMI status change or reaching an LMI error threshold) may result in failure of the associated resources that are handled by the NNP.

The different LMI modes are dynamically discovered at connection establishment time as follows:

- **Network to Network Interface (NNI)**: The link integrity verification (LIV) inquiries and the PVC status inquiries and responses are sent by both partners on the frame-relay interface. This is also called LMI bidirectional protocol.
- **Network to User Interface (NUI)**: The partner is a DTE that does not support NNI. The partner polls the 3746-9x0 and does not answer the LIV enquiries sent by the 3746-9x0.
- **User to Network Interface (UNI)**: The partner is a DCE that does not support NNI. The partner answers the status inquiries sent by the 3746.
- **No LMI**: The partner does not answer the status request and does not send status inquiries to the 3746-9x0.

System Definitions

The configuration of 3746-9x0 frame-relay resources is done using CCM or in the NCP generation:

- The frame-relay port of the 3746-9x0 contains the LMI parameters (ANSI versus CCITT, timers, thresholds).
- Frame-relay DLCI parameters.
- Stations (SNA, APPN/HPR) used for FRTE. Logical SNA stations attached via DLUR may be defined in the VTAM/DLUS Switched Major Node.
- IP over frame relay.

NetDA/2 Frame-Relay Support

IBM's "Network Design and Analysis/2 (NetDA/2)" is an OS/2-based tool for SNA subarea and APPN topology design and evaluation. It also generates PATH and COS tables and provides assistance to those implementing networks with frame-relay, High-Performance Routing (HPR), or asynchronous transfer mode (ATM) connections.

The *NetDA/2 V1R4 Design Tool Guide and Tutorial* redbook SG24-4225 describes how to use NetDA/2. A chapter of this redbook describes using NetDA/2 to create NCP statements for frame-relay networks.

NetDA/2 offers the following frame-relay capabilities:

- Allows definition of existing PVCs in standard NetDA/2 tables.

- Generates PVCs according to user-defined parameters.
- Assigns DLCIs automatically but also allows. you to control how DLCIs are assigned.
- Displays frame-relay nodes on the Network view.
- Lists PVCs and highlights them on the Network view.
- Produces reports on network PVCs, which can be arranged by node or PVC.
- Adds PVCs to the TRUNKS table (registers PVCs as TGs) so that they can be used in route control.
- Combines PVCs into MLTGs.
- Integrates PVCs into existing subarea routes, thereby “shortening” the routes. When NetDA/2 integrates PVCs into routes, it registers the PVCs as TGs. When you select **Integrate**, NetDA/2 attempts to integrate only unregistered PVCs into routes.

NetDA/2 will not only help in the design of a future frame-relay network, but also in the evaluation of an already installed one. Using utilities available in SSP V4R3, the user can process the NCP definitions and create files that are readable by NetDA/2. After NetDA/2 has processed these files, the model will contain the labels of all the resources involved in the frame-relay definitions, physical and logical, including the DLCIs and MLTGPRIs. Once the model includes all this data, NetDA/2 can produce reports detailing the path followed by each PVC. The user can quickly verify the accuracy of the model by requesting NetDA/2 to produce a skeleton of the NCPs; the definitions created should match the NCP sources.

The frame-relay definitions are quite complex and the user can easily make mistakes. A common one is to create PVCs that will loop; the data may go more than once through the same NCP. NetDA/2 will detect these loops and produce a report that will highlight those PVCs.

NetDA/2 can also show in a map or diagram the path followed by the different PVCs.

SNA Over Frame Relay

This section contains information for configuring NCP frame-relay links. Most of the information is relevant to direct links (PVCs) between subarea nodes (NCP) and between subarea and peripheral nodes.

Migrating from SDLC to Frame Relay

SDLC normally runs on a pair of copper wires, or the equivalent, between two SNA nodes. There is generally no store and forward of the frame in an intermediate node and the SDLC frame is not processed by software. Therefore:

- The transit delay between end nodes is short and is mainly dependent on the line speed and the propagation delay over a single hop.
- Congestion in the receiving SNA node can be quickly indicated to the sending node by sending an RNR or by delaying an answer to polling.
- If a frame is lost after a line error, the next frame is usually received safely. The receiving node quickly sends a reject frame notifying the sending node that

a frame has been lost. The recovery is performed by resending only the last two or three transmitted frames.

Due to the primary-secondary relationship between nodes, there are mechanisms to prevent buffer overrun in the receiving node. (In NCP, you can use the PASSLIM, PAUSE, and REPLYTO parameters to prevent overrun.)

Unlike SDLC, frame relay:

- Is a store and forward protocol
- Network paths usually have several hops.

In frame relay, each intermediate node must completely receive a frame before sending it on to the next hop. Therefore, the end-to-end transit delay is mainly dependent on the line speed on each hop of the multiple hop PVC.

Any congestion on the path is normally indicated by sending FECN and BECN messages before discarding frames. The time taken for congestion notification to reach the transmitting node is not negligible. During this time, the transmitting node may have sent several additional frames.

At a given instant, there are certain number of frames in transit over the network that have not reached the receiving end node.

This requires the transmitting end node, when a frame is lost, to resend the lost frame and all frames already sent after the lost frame.

Such a recovery may require resending several frames, which (in the worst case) may be equal to or greater than the MAXOUT value.

The protocol used for SNA over frame relay is IEEE 802.2, see Chapter 2, “Frame Relay Overview.” It is a balanced, duplex protocol (one data flow in each direction).

Multilink Transmission Group (MLTG)

Multilink transmission groups can be set up between NCP nodes. In a MLTG, multiple PVCs are set up between adjacent NCPs and traffic can be balanced over these PVCs.

As long as one PVC is active in the group, the failure of all the other PVCs is non-disruptive for the user sessions, but their response may be degraded.

A PVC carrying SNA traffic between NCP nodes is dedicated to this traffic. For this PVC, there is a single SNA connection between the two PU4 NCPs. This connection is called a *link station* in SNA or a *logical link* in NCP.

BUILD Definition Statement

MLTGORDR=FIFO
: FIFO is the default value. The MLTG lines are selected in the order that they are activated.

MLTGORDR=MLTGPRI
: The stations are added to the list of active stations based on the MLTGPRI value coded in each station. The station with the highest priority are selected first. The stations with the same priority are selected using a round robin mechanism.

Code this keyword value when the traffic is distributed over multiple links that have the same speed.

LINE Definition Statement

MLTGPRI=(0 to 255)

MLTGPRI defines a priority for a line in a MLTG. The lowest and default value is 0.

The priority value assigns the order in which NCP selects the lines: this value is not a weight. The lines with the same priority are used according to a round robin mechanism. It is recommend that:

- Links with the same capacity should be defined with the same priority.
- Links with higher capacity should be defined with a higher MLTGPRI value.

Re-Transmissions

A frame can be lost because either an error is detected during the CRC check or there is network congestion. In both cases, the frame has to be retransmitted. For a MLTG, the frames are re-sequenced on the receiving end, therefore, such re-transmissions may delay all the traffic for all the links in the MLTG. In order to avoid too much delay, define:

- T1TIMER with a value that is not too high
- RETRIES to a small value in order to declare a link failure or an station inactive, INOP (inoperative), as soon as possible. This allows the traffic to be shifted to other links of the MLTG while the failed link is fixed or the station is automatically restarted (re-driven) by VTAM.

  After two retries on a MLTG link (that is, after a frame has been sent three times without being acknowledged) NCP will copy the corresponding PIU to the re-transmission queue. The frame will be rescheduled for transmission on another link of the MLTG. Therefore, frames queued for transmission on a poor quality or congested link are transmitted on another link of the MLTG. This is one reason why it is important to have both:

  – An infrastructure with a very low physical error rate, less than 10 to the minus 7 power (10^{-7}).

  – A very low discard rate in the frame-relay network, that is, the PVCs are defined with a CIR in accordance with the actual traffic as shaped with MAXOUT and MAXFRAME.

MLTG Resilience

A MLTG is not taken down as long as there is still one link operational. There are ways to prevent the failure of a MLTG and loss of all its session:

- Define a reliable direct SDLC link with a small bandwidth and with a lower priority than the regular frame links used for the bulk of the traffic.

  The added delay on frame relay due to the store and forward in each intermediate node will not be increased by this low priority SDLC link.

- If you have NCP V7 R3 or later, add a standby link. This link remains in standby mode until all the other non-standby links have failed.

  This standby link must be active, but NCP never uses it while any of the other regular MLTG links are operational.

Note: The standby link can also be used for congestion relief, that is, when the queue on the MLTG exceeds a predefined threshold.

Refer to *Network Control Program V7 R3, ACF/SSP V4 R3, EP R12: Resource Definition Reference*, SC31-6224-02, for the description of the TGCONF parameter.

Additional NCP Parameters

ADDIFG=(NO, YES, or 1 to 255)

The default value is NO.

For more information, see Interfrane gap on page 120.

BLOCK=(bytes,pius)

For an explanation of blocking, see Blocking factor on page 120.

The recommended values over frame relay are:

```
BLOCK=(2000,8)
```

The first subparameter value (2000) must be less than or equal to MAXDATA.

For an NCP to NCP link the MAXDATA value must be less than or equal to MAXFRAME - 16.

CIR=(Bc,Be,Tc)

Beginning with NCP V7 R7, a CIR can be configured for each DLCI in a 3746 frame-relay line and it can be different for each DLCI. In the default CIR parameters, Bc (committed burst rate) and Be (excess burst rate) are multiplied by the value of the DATABLK keyword of the LINE definition statement.

For more details on 3746 CIR support, refer to the NCP Version 7 books listed in the bibliography.

COMRATE=(FULL or NONE,n)

It is recommended not to set the discard eligible (DE) bit in the 3745 or 3746 when this bit is used by the frame-relay switch to mark the frames that exceed the CIR. In this case, the COMRATE parameter must be coded as follows:

```
COMRATE=(FULL,n)
```

where the n value assigns a weight to the station being defined. This numeric value represents the number of transmission units (defined by DATABLK in the physical link) sent for this station in case of congestion at each transmit opportunity. This mechanism only applies when the output queue builds up, that is, when there is more data to send than the line speed permits; when this occurs, the 3745 or 3746 sends (n * DATABLK) bytes for each station being serviced using a round robin mechanism.

To treat all the link stations fairly using this mechanism, it is recommended that:

$$R = (\mathrm{Sum}(n_i * \mathrm{DATABLK}) * 8) / \mathrm{Access\_Rate} < 3s$$

where n_i is the weight of each station.

Appropriate recommended values for R over different access rate links are:

- 0.4 s for 2 Mbps
- 0.5 s for 1.5 Mbps

- 1.0 s for 256 Kbps
- 2.0 s for 64 Kbps.

For efficient traffic distribution for the station, it is recommended that:

```
(n * DATABLK) >   MAXFRAME
(n * DATABLK) >= (MAXOUT * Average_frame_size)
```

When there is a single link station on a physical link, the traffic does not need to be distributed per station. Therefore, the COMRATE weight is of less importance. But, as COMRATE is also used for the 3746 internal congestion algorithm, it is good practice to define a

```
DATABLK = Average_frame_size
```

and

```
n=MAXOUT
```

Note: On an INN link, the average frame size is close to half the value of MAXDATA or BLOCK when both these values are in the same range.

For additional information, see 121 and DATABLK on page 121.

DYNWIND=(nw,dw,dwc)

In NCP V7 R6, more granularity is supported for *dw* over 3745 lines and for *dwc* over 3745 and 3746 lines. Before NCP V7 R6, the support for reducing the working window was by 50%, 75%, 87% or 93% by coding the dividing factor *dw* (frame lost) or *dwc* (congestion) equal to 2, 4, 8 or 16 respectively.

With NCP V7 R6 and above, it is possible to reduce the working window by a ratio of 7%, 12%, 25%, 50%, 75%, 87% or 93%.

In addition, with NCP V7 R6, the frame-relay congestion parameters of the 3746 internal congestion mechanism can be tuned during NCP configuration. Before NCP R7 R6, the 3746 used hard-coded medium values for the internal congestion mechanism; they are OK in 90% of the cases.

FRSPRI

Station priority is a 3746 function in NCP V7 R6. Each SNA station is either:

- An INN station, which is the only station on a DLCI
- A peripheral station, which can share a DLCI with other stations.

Each station is assigned a local priority on the frame-relay port. The 3746 puts the traffic for stations with a higher priority in front of lower priority station traffic in the link outbound queue.

Currently all the frames processed by the IEEE 802.2 DLC layer are put in the link outbound queue after they are processed by the 802.2 layer of each station.

Without station priority, if you are using multiple PVCs with large frame size and large MAXOUT, new frames are queued behind all the traffic queued for all the PVCs. This may delay important traffic on a busy line.

To benefit from this priority function, the different types of traffic must be separated onto different DLCIs. When batch and interactive traffic is segregated on different link stations, define for:

- Batch traffic, a small window (see MAXOUT on page 65 for the minimum value) and a small COMRATE weight.
- Interactive traffic, a higher window and higher COMRATE weight.

MAXDATA=(BFRS+26 or 65535)

MAXDATA specifies the PIU segment size, its default and maximum value is MAXFRAME-16. Smaller values may be necessary for a high speed line that has multiple PVCs connecting remote NCPs attached at different speeds. Smaller PIU segments may prevent overrunning the low speed lines attaching the remote NCP.

The segmenting is done by NCP in the 3745 CCU and requires 3745 CCU cycles for both 3745 and 3746 lines. For instance, when a hub NCP is attached at 2 Mbps and a spoke NCP is attached with at 64 Kbps, it is highly recommended to use a MAXDATA of 512 bytes. With a value of 512, and BFRS=240 and a small MAXOUT (see MAXOUT on page 65), NCP will send all the intermediate and the last PIU segments with a maximum length of 480+26 bytes.

MAXFRAME=(282 to 8250)

The maximum frame size must not be too high on a low speed line because each intermediate frame switch node has to store the full frame before forwarding it to the next node. Typically on a 2 Mbps line, the frame size should not exceed 2000 bytes[9] .

With frame relay, the CIR assigned to each PVC is important. The frame size must not be too high in an effort to preserve the CIR for all PVCs. A larger frame size, such as 8K, could monopolize a 64 Kbps line for 1 second.

Furthermore, the 2 byte CRC does not offer very much protection above 4K.

For all of these reasons, it is advised to use a frame size around 2000 bytes.

But, for example, a value of MAXFRAME=2090 limits the number of DLCIs that can be used on the link to 414 because

```
(2090-18)/5 = 414.4
```

This limit exists because in the LMI PVC full status message sent by the DCE to the user:

- The header is 17 or 18 bytes long
- Each PVC status is given in a 5 byte Information Element (IE).

MAXOUT = (1 to 127)

NCP and the 3746 start transmitting with the maximum transmit working window, that is, a working window equal to MAXOUT, the maximum number of frames sent without waiting for an acknowledgment. The actual working window can vary between 1 and MAXOUT.

MAXOUT should not be **too high:**

- A high MAXOUT could quickly create congestion when a low CIR is used. When congestion occurs, the switches inform the DTEs that they are exceeding their CIR by sending a congestion indication. If the DTE creates a high congestion or exceeds too quickly its CIR, the congestion indication may not reach or be processed by the DTE before the network discards frames. When frames are lost, they have to be

9 Historically, for the same reason, X.25 started on low speed lines with a default packet size of 128. It was only when the X.25 line speed grew to 2 Mbps that the packet size grew to 2000 bytes.

retransmitted. The higher MAXOUT is, greater is the chance that a high number of frames must be re-transmitted. When more than one percent of the frames have to be retransmitted, throughput is badly degraded.

- When interactive and batch traffic share the same TG (as is usually the case in SNA). High MAXOUT values on multiple links within a TG mean that a lot of data could be flowing through the network at the same time. This data is queued in the 3746 outbound queue or in other possible network bottlenecks. Therefore, new interactive traffic cannot be transmitted in front of data (which may be batch traffic) already queued along the path.
- In summary, MAXOUT must not be too high:
  - To minimize retries when frames are discarded either after transmit errors or during congestion.
  - To avoid congestion in the network that may lead to discards before congestion indications are taken into account by the entry points. This is true even if a reasonable MAXFRAME is used.
  - To ensure the efficiency of the priorities in the subarea nodes.

MAXOUT should not be **too low:**

MAXOUT should be set so that the total number of bytes sent do not exceed the number that can be sent and acknowledged during a round trip delay: MAXOUT should be high enough to feed the network before an acknowledgment is received. But, as MAXOUT refers to a number of frames, it is difficult to determine exactly the appropriate value because the actual frame size varies from a few bytes to MAXFRAME.

For a transmitted frame and the acknowledgment in the reverse direction, the actual round trip delay is the sum of:

- The serialization of the bytes onto each link: the delay time depends on the line speed.
- The processing time in each intermediate node, normally small and negligible.
- The input and output queuing in each node, where applicable
- The propagation delay, which increases with distance. Use as an average value 10 ms per 1000 km to take into account the hardware infrastructure of the network.
- The T2 timer in the receiving node.

MODULO=128

Frame-relay stations always operate in modulo 128. MODULO=128 must be specified to be able to specify a value for MAXOUT greater than 7.

RETRIES=(6,0,0)

A frame-relay network is supposed to use good quality lines and an appropriately sized PVC. For a MLTG, a failing link should be quickly removed from service, the other links of the MLTG will handle the traffic of the failing link while it is fixed.

The default value of 6 is recommended and may even be decreased to 4.

T1TIMER

T1TIMER must be higher than the average delay for an acknowledgment to come back from the receiving partner. See MAXOUT on page 65 for the round trip delay factors.

The T1TIMER and T2TIMER apply at opposite ends of a IEEE 802.2 connection.

802.2 lines are in the HDLC balanced mode: there is a full protocol running in each direction. There is no primary or secondary consideration in this mode. The traditional primary and secondary sides in a SDLC NCP-to-NCP connection are used in frame relay for echo cancellation. The Command/Response bit of the frame-relay A-field is used between NCPs for echo detection and automatic suppression. This mechanism is unique to NCP.

For example, a T1TIMER value of 2 seconds is appropriate for port speeds higher than 256 Kbps and network trunks with speed higher than 2 Mbps.

There are other important considerations to take into account that are described in the NCP books.

T2TIMER=(0.1,,5)

This is the delay during which a receiver may have to wait before sending an acknowledgment. It starts when a frame without the poll bit set is received.

T2TIMER must be much lower than the T1 timer in the partner node to avoid T1 elapses. The poll bit is set in the last frame in a working window: the receiver immediately sends the acknowledgment of a data frame received with the poll bit set.

The working window may vary between one and MAXOUT when congestion or frame loss occurs.

T2TIMER is not used when the transmit working window is equal to one. In this case, each frame is sent with the poll bit set and, thus, forces the receiving partner to acknowledge without waiting for T2 to elapse or waiting for n3 frames to be received.

Note: The n3 parameter, the third subparameter of the T2TIMER parameter, is the number of frames that can be received before sending an acknowledgment. When the data traffic is balanced, the acknowledgment can be sent in an I-frame flowing in the opposite direction instead of in a separate RR frame; this is called “piggy-backing”. Therefore, on a busy frame-relay logical link you may not see any isolated RR frame as long as the T2 timer is not zero and N3 is higher than two.

CIR NCP Support

Traffic shaping mechanisms have been added in the following NCP releases:

NCP V7 R5 spacing over 3745 lines

NCP V7 R5 can insert a delay between transmitted frames when a BECN is received. This is configured in the fourth, *dwdmax*, and fifth, *twcuse* subparameters of the DYNWIND parameter:

dwdmax

Specifies the upper limit for the time delay that NCP waits before transmitting the next I-frame to a station experiencing congestion. NCP initiates this delay when the working window is equal to 1 and a BECN is received. The first BECN received creates a delay of 100 ms, each additional BECN received increases this delay by 100 ms, up to *dwdmax*.

twcuse

Specifies whether a station ignores other BECNs for a period of 100 ms after receiving the initial BECN.

Specify YES to have a station ignore subsequent BECNs for 100 ms.

Specify NO to have the station react to all BECNs.

NCP V7 R6 CIR shaping on 3745 and 3746 lines

See DYNWIND on page 64 for the 3746 decrement granularity for the transmit working window in case of congestion.

NCP V7 R7 adaptive CIR over 3746 lines

When CIR is enabled (as opposed to COMRATE), the 3746 supports CIR enforcement. Furthermore, the 3746 adaptive CIR can adjust its transmission rate to the actual network bottleneck, no matter where it is located.

Note: Adaptive CIR also applies to APPN or IP resources driven by the 3746 NNP.

Frame-Relay Boundary Access Node Load Balancing

BNN support for duplicate MAC addressing was introduced to provide backup capability for frame-relay BAN lines in the event of a frame-relay component failure. In addition, it allows down-stream PUs (DSPUs) to connect to any frame-relay line with the same MAC address. (There must be a connection from NCP to the VTAM in which the BNN station is defined.) Ideally, this results in statistical load balancing by spreading network traffic across the multiple duplicate MAC addresses.

However, unequal distribution occurs for incoming calls when the majority of the connections are established through one particular frame-relay DLCI in a group of frame-relay DLCIs that use the same MAC address. This disparity is the result of both the nature of the frame-relay environment and the DSPU. When a BNN station wants to connect through specific DLCI, it broadcasts a route discovery frame (‘Test Resolve’ or ‘XID802.2’ command frame) to determine a path through the network to any frame-relay DTE having that MAC address. Duplicate BAN DLCI MAC addresses supporting BNN connections are attached by routers to a backbone ring.

These routers always forward a discovery frame to the group of DTEs (that have DLCIs with the same MAC address) in the same sequence: this can result in one DTE receiving and responding to all the discovery frames sooner than the other DTEs. Because DSPUs generally use the path indicated in the first response received, most (if not all) of the connections are establish through this first DLCI, resulting in potential load problems once session data begins to flow.

A balancing mechanism that results in better IEEE 802.2 LLC peripheral connection distribution for DSPUs, resulting in the traffic load being more evenly supported across the duplicate MAC addresses, has been implemented.

This enhanced load balancing counts the number of frame-relay logical, peripheral connections that are established through a DLCI on a frame-relay line. Based on the number of supported connections, the frame-relay DLC (data link control) increases the time needed for additional peripheral connections by delaying its response to the route discovery frames. This delay allows the incoming call requests to be established through an alternate duplicate MAC address, thus resulting in a better call distribution.

Time Delay and Working Count

The amount of time (in seconds) that a response is delayed is determined using the following expression:

```
Time_Delay = ((Number_Of_Sessions/(Connection_Balance_Factor * 16)) * 0.1
```

The expression calculates the number of 100 ms time-periods that must pass before a response can be sent. Because the T1 timer default is 1.0 seconds, the time delay value is restricted to a 0.9 second maximum. This prevents a broadcast storm of retransmitted route discovery frames. To further ensure that a broadcast storm does not occur, all responses for peripheral route discovery frames are given the highest transmission priority: any time a response is transmitted, it is sent ahead of any queued frames awaiting transmission.

Each peripheral connection generated for either an incoming or outgoing call request are counted. This working count is decreased when a peripheral connection is brought down.

Connection Balancing Factor

The connection balancing factor is a user-defined value that controls the granularity of the connection balancing. The balancing factor value has a range from 0 to 32.

A zero value means that the frame-relay line will not perform the connection balancing function, the DLC will respond immediately to all route discovery frames.

A balancing factor of:

1 gives a 32 connection granularity.

According to the Time_Delay expression, while there are less than 32 peripheral connections have been established over the DLCI, the frame-relay line does not introduce a response-time delay.

Once 32 peripheral connections have been established, there is a 100 millisecond delay before sending a response to route discovery frames. This allows the other duplicate frame-relay lines with fewer connections to accept the incoming call requests. This delay increases to 200 milliseconds once 64 connections have been established and so on.

32 gives a 512 connection granularity.

While there are less than 512 peripheral connections have been established over the DLCI, the frame-relay line does not introduce a response-time delay. After 512 connections are established, there is a 100 millisecond delay. After 1024 connections, there is a 200 millisecond delay and so on.

For a duplicate frame-relay environment supporting a small number of DSPUs (200), a finer balancing granularity (smaller balancing factor) would be appropriate. Conversely, a larger balancing factor would be suitable for an environment supporting a larger number of DSPUs (2500). The following expression can be used to suggest an adequate balancing factor based on the total number of DSPUs to be supported by the duplicate frame-relay environment:

```
Balancing_Factor = Max(1,Min(32,Int(Total_Number_of_DSPUs/160)))
```

Because the connection balancing function is performed independently by each of the duplicate frame-relay lines, there is no limit to the number of DTEs that may participate in this balancing scheme. To achieve an approximately symmetrical connection distribution, it is recommended that the same connection balancing factor be defined for all of the duplicate DTEs. However, defining differing values can result in a weighted connection distribution, which may be more suitable for your network configuration.

NCP NDF Keyword

The keyword BALANCE is coded in the physical GROUP and DLCI definition statements in one of the following ways:

BALANCE=(factor,H)
BALANCE=(factor,D)
BALANCE=(AUTO).

Where *factor* is an integer or the character string 'AUTO'.

H means that BALANCE is coded in hexadecimal, D means that BALANCE is coded in decimal. The decimal format is the default format if H or D is not specified. This keyword has the following possible values:

- 0 for no load balancing, the default value
- 1 to 32 for manually defining the balance factor
- 'AUTO' to call the auto-adaptive load balancing explained in "Automatic Load Balancing Configuration" on page 71.

APPN CCM Configuration

The 'Connection balance factor' can be defined in the **Frame-Relay Port - DLC Parameters** window. This value of this parameter has a range of:

- 'No Load Balancing', the default value
- 1 to 32 for manually defining the balance factor
- 'Automatic' to call the auto-adaptive load balancing explained in "Automatic Load Balancing Configuration" on page 71.

Notes:

1. Load balancing is not applicable to IP traffic because IP is connectionless and does not exchange Test or XID frames.
2. Unlike NCP, this parameter applies to all the DLCIs of the frame-relay port.

Load Balancing and Port Sharing

On frame-relay ports that are shared between NCP and APPN, if load balancing is defined in either NCP or APPN, it is applied to the frame-relay port.

If load balancing is defined for both NCP and APPN, the connection balance factor with the highest value is used. Auto-adaptive load balancing is the highest possible value.

Manual Load Balancing Configuration

The manually configured ‘Connection Balance Factor’ defines the slope of the straight line in Figure 27 followed by the Test response Delay versus the number of active Stations. This factor is set follow the maximum number of stations but is not dynamically adjusted to follow the changing number of simultaneous active stations.

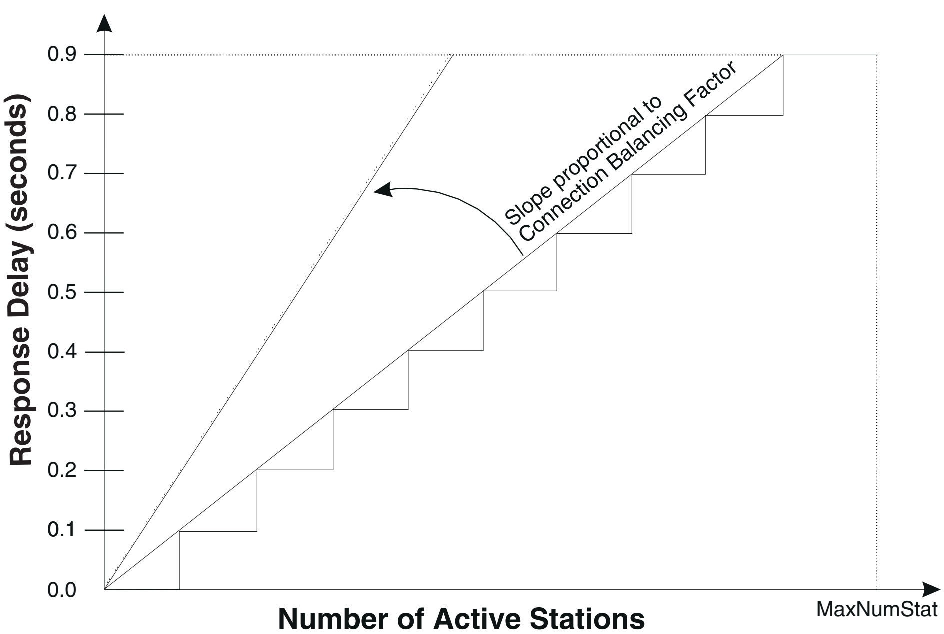


Figure 27. Manually Configured Load Balancing has a Straight Line Slope

Automatic Load Balancing Configuration

The auto-adaptive balance function is an improvement over manually configured load balancing. Auto-adaptive load balancing tries to keep a constant ratio between the weight of a new station and the number of already active stations. The slope in Figure 28 on page 72 is a logarithmic curve defined by:

```
f(x) = Ln(x + 1) / Ln(MaxNumStat + 1)
```

where:

- x = number of active station
- f(x) = delay (seconds) before responding to test frame.

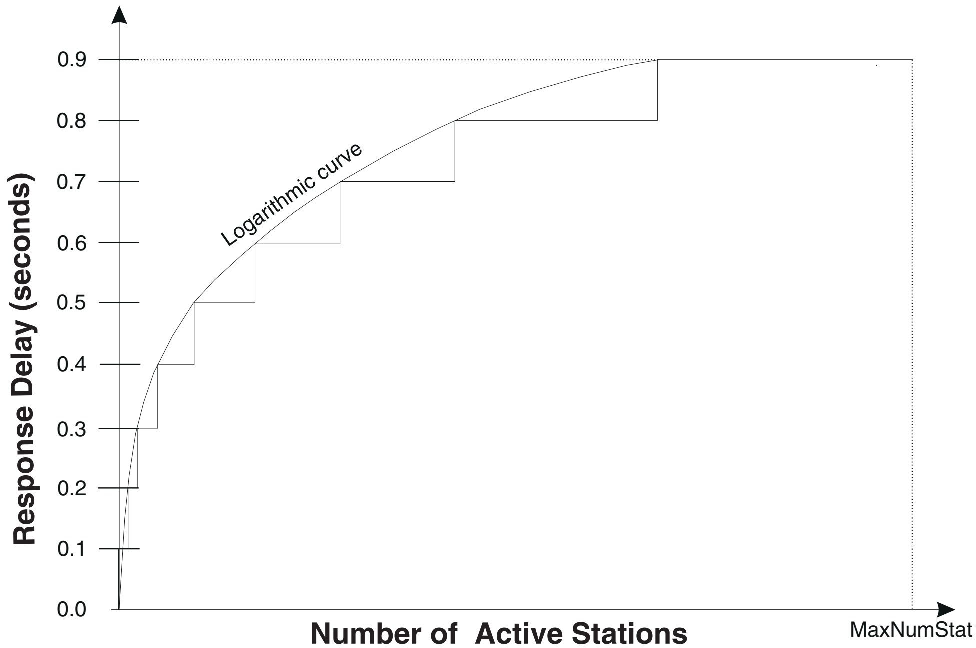


Figure 28. Auto-Adaptive Balancing has a Logarithmic Slope

As MaxNumStat increases, the weight of each new station decreases.

The load balancing is constantly adjusted with the number of currently active stations.

Automatic Load Balancing Configuration Example

Table 19 shows the length (in seconds) of delay in response to a test frame as a function of the number of active stations using:

```
x = Int(e(y * Ln(MaxNumStat + 1)) -1)
```

where

```
y = Int(Ln(x + 1) / Ln(MaxNumStat + 1))
```

Table 19. Response Delays when MaxNumStat equals 3000

Number of Active Stations	**Response Delay (seconds)**
0 ≤ x < 1	0.0
1 ≤ x < 4	0.1
4 ≤ x < 10	0.2
10 ≤ x < 24	0.3
24 ≤ x < 54	0.4
54 ≤ x < 121	0.5
121 ≤ x < 271	0.6
271 ≤ x < 604	0.7
604 ≤ x < 1346	0.8
1346 ≤ x < 3000	0.9

Hardware Requirements

Manual load balancing can use either:

- The 3745
- CLP3s in a 3746-9X0
- Or both: frame-relay lines on the 3745 and 3746-900 can be manually configured to use delayed response-time load balancing at the same time.

Automatic load balancing, using a delayed-response time, uses only CLP3s in a 3746-9X0.

Chapter 3. X.25 Overview

X.25 is a packet switching technology allowing data transmission at low, medium or high speed (up to 2 Mbps). X.25 guarantees data transmission without error or loss, and packets arrive at their destination in the order that they were sent.

The X.25 ITU-T recommendation specifies the three following OSI layers:

- Layer 1: Physical layer
- Layer 2: Data link layer, called Link Access Procedure Balanced (LAP-B)
- Layer 3: Network layer, called Packet Layer Protocol (PLP).

For X.25, the physical layer is the same as for any other WAN protocol implemented in the CLP (frame relay, SDLC or PPP). The X.25 support implements the X.25 layer 2 (LAP-B) and 3 (PLP). It also implements another layer above PLP for adapting SNA, APPN/HPR, and IP protocols to the X.25 layers.

Figure 29 shows how the X.25 functions are implemented in the 3746-9x0. The CLP can be under NCP or NNP control.

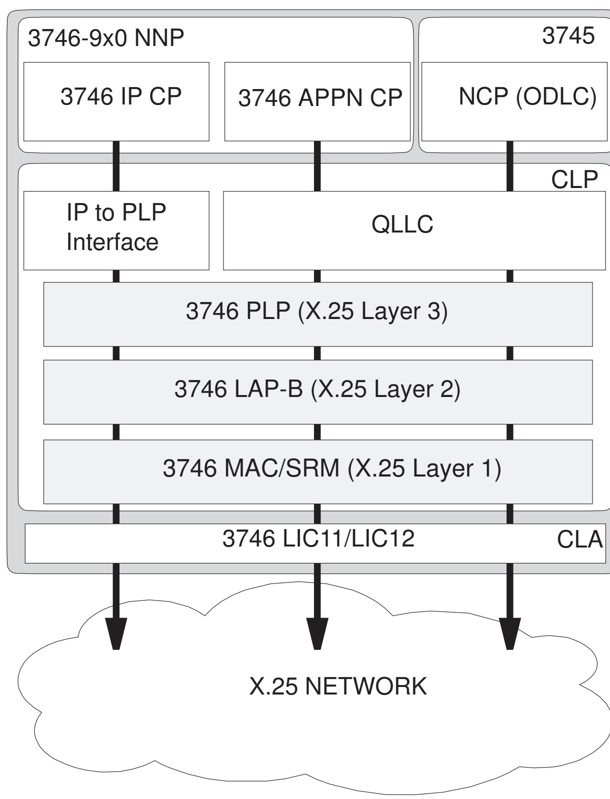


Figure 29. 3746-9x0 Native X.25 Implementation

X.25 Supports

NPSI Support (NPSI ODLC)

The Communication Line Processors (CLP) support ITU-T X.25 protocol in conjunction with the X.25 NCP Packet Switching Interface (NPSI) program running with ACF/NCP in the 3745. This allows the 3746-900 to carry all traffic flows supported by NPSI, SNA, and non-SNA, over connections to an X.25 private or public network. The CLP performs only the physical layer (layer 1), the other layers (X.25 and above) are performed by NPSI.

The rest of this chapter, except when otherwise indicated, does not apply to the NPSI support in the 3746-900 (NPSI ODLC). For further information refer to the NPSI documentation, especially *X.25 Planning and Installation*.

Native X.25 Support (FC 5030)

The X.25 support feature (FC 5030) allows the CLP to perform the X.25 layers, the QLLC layer and the IP-to-PLP interface in addition to the physical layer (see Figure 29 on page 75). The following traffic is supported:

- **NCP traffic (X.25 ODLC)**

  Starting from Version 7 Release 4, NCP is able to flow SNA traffic over X.25 without requiring NPSI:

  – Subarea node traffic
  – Peripheral node traffic
  – Low-entry networking (LEN) traffic
  – APPN traffic, when NCP acts together with VTAM as a composite network node (CNN)

  In summary, any SNA traffic that NCP is capable of handling can flow over an X.25 line attached to the 3746-9x0 Communication Controller.

  The interface layer between X.25 and NCP implements the QLLC protocol

  Note: The short hold mode is not supported over a subarea SVC.

- **APPN/HPR traffic**

  The APPN/HPR control point, residing in the network node processor (NNP), is able to flow APPN/HPR traffic over an X.25 line without requiring NCP:

  – SNA subarea node traffic (DLUR traffic)
  – HPR traffic
  – APPN traffic

  In summary, any traffic that the APPN/HPR control point is capable of handling can flow over an X.25 line attached to the 3746-9x0 Communication Controller.

  The interface layer between X.25 and the APPN/HPR control point implements the QLLC protocol.

- **TCP/IP traffic**

  The IP control point, residing in the network node processor (NNP), is able to flow any TCP/IP traffic over an X.25 line.

  The following TCP/IP routing protocols are supported over X.25:

  – RIP

- OSPF

  The neighbors around the X.25 network have to be configured manually through CCM.

- BGP

The SNMP MIBs for X.25 are also implemented. Refer to “X.25 Network Management” chapter in the *3745/3746 Planning Series: Management Planning, GA27-4239*.

The interface layer between X.25 and the IP control point conforms to the RFC 1356.

Functions Supported

The 3746-900 and 950 can be either a DTE:

- Attached to a packet switched data network (PSDN) that conforms to the ITU-T Recommendation X.25 (1993).
- A DTE directly attached to another DTE, that conforms to the ISO 7776 (Layer 2) and ISO 8208 (Layer 3) standards.

The functions supported are:

Layer 1

The physical layer can be either leased X.21, V.24 or V.35.

The maximum speed for an X.25 line is 2 Mbps.

Layer 2 (LAP-B)

The (data) link layer conforms to X.25 LAP-B single link procedure (SLP).

- The modulo can be either 8 or 128.
- Piggy-backing technique is used at the frame level (that is, use of an information frame to acknowledge another information frame flowing in the reverse direction) with use of the timer T2. This technique decreases the number of RR frames flowing over the line and, therefore, improves the performance.

Layer 3 (PLP)

The packet layer features the following characteristics:

- Switched Virtual Circuit (SVC) and Permanent Virtual Circuit (PVC) are supported.
- The X.25 support of the 3746-9x0 complies with the X.25 versions 1980, 1984, 1988 and 1993.
- X.25 addresses with the TOA/NPI format are supported.
- The DTE/DCE role is negotiated at restart time in case of a direct DTE to DTE attachment, in conformance with the ISO 8208 standard.
- The modulo at packet level is either 8 or 128.
- Piggy-backing technique is used at the packet level (that is, use of a data packet to acknowledge another data packet flowing in the reverse direction) whenever possible. This technique decreases the number of RR packets flowing over the line and, therefore, improves the performance.

- Data packet segmentation and re-assembly is performed when the PIU size (SNA) or MTU size (IP) is greater than the packet size.
- Optional user facilities can be included in a call request packet (specified by X.25 or not).
- Up to 16 bytes long user data can be included in the Call User Data (CUD) field of a call request packet.
- A data packet with the delivery confirmation bit (D-bit) is never sent. When such a packet is received, the D-bit is ignored.
- Interrupt packet is not supported.

Above Layer 3 (PLP)

- For SNA, the QLLC layer implements the loading and activation of a remote NCP over an X.25 subarea PVC or SVC controlled by NCP.
- Performance monitoring (for LAPB and PLP) and accounting through the Network Performance Monitor (NPM).

Performance Enhancements

- For X.25 SNA, the data throughput of the 3746-900 is multiplied by a factor of up to 10 compared to NPSI [10], allowing a 3746 to support up to 1000 packets per second (128 bytes/packet) on each CLP.
- For X.25 SNA traffic, the processor (CCU) load of the 3745 attached to the 3746-900 is reduced by up to 90% compared to NPSI.
- For IP traffic a 3746 is able to support up to 1000 packets per second on each CLP.
- X.25 lines can be used very efficiently, close to 100% utilization, at every speed, up to 2.048 Mbps.

To get precise X.25 performance figures, use the 3745/6 configurator (CF3745).

CLP Lines

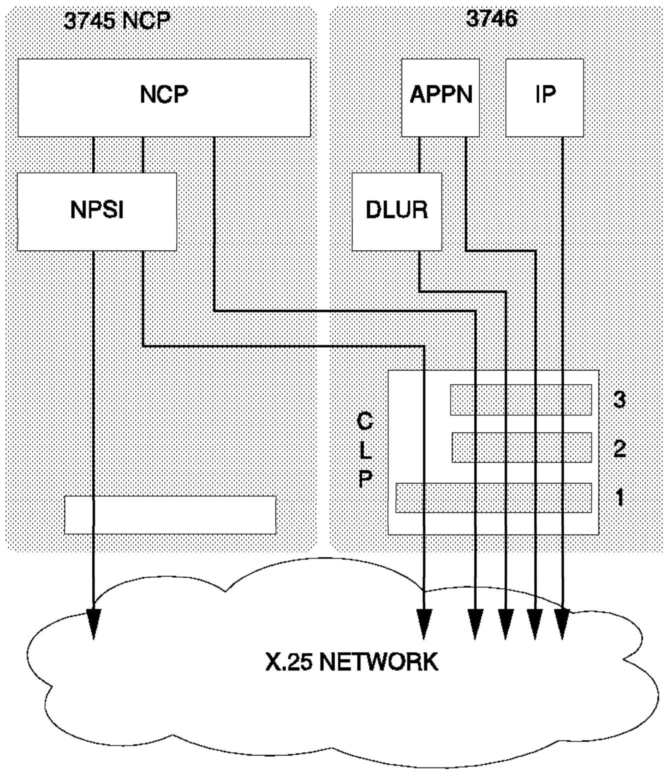
Any port of a LIC11 or LIC12 can be defined as an X.25 line. An X.25 line can coexist with any line supporting other protocols on the same CLP (frame relay, SDLC, PPP, ISDN). It can also coexist with NPSI ODLC lines (3746-900 only).

For information about the total of amount of resources supported per CLP, refer to the *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180.

[10] The improvement factor varies, depending on the network environment and traffic characteristics (message size, packet size, etc)

X.25 Line Sharing

Figure 30 shows an example of how X.25 is implemented in the 3746-900, and it also shows how lines can be shared.




```
Legend:
1. Physical Layer
2. DLC Layer (LAP-B + PLP)
3. QLLC (LLC3), or "IP to PLP" Interface.

Note:
NPSI traffic cannot share the same physical
line with NCP (X.25 ODLC), APPN and IP traffic.
```

Figure 30. 3746-900 X.25 Line Sharing

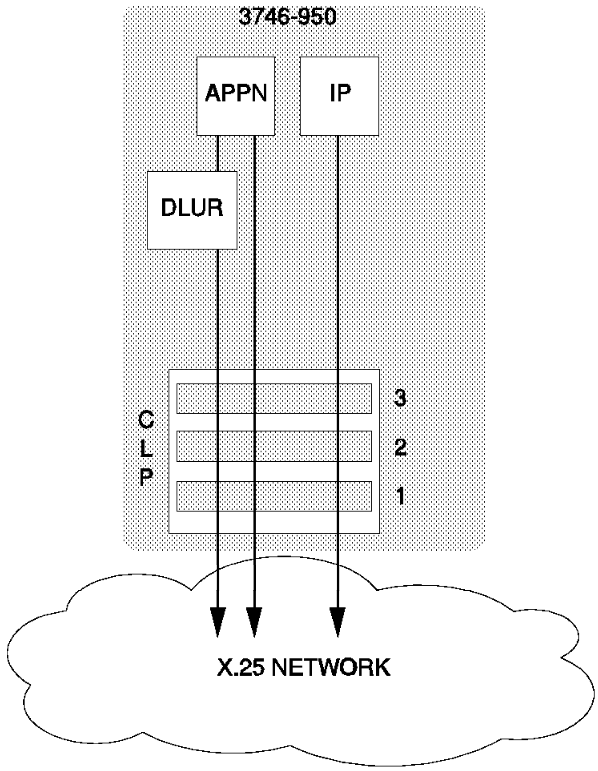


Figure 31. 3746-950 X.25 Line Sharing

The following traffic types can flow simultaneously over an X.25 line:

- Subarea SNA
- APPN/HPR
  - SNA (DLUR)
  - HPR
  - APPN.
- TCP/IP.

This means that either or both 3746 control points (APPN/HPR and IP), and ***one*** NCP (3746-900), can activate or de-activate an X.25 line.

Notes:

1. In the case of 3745-41A or -61A (dual-CCU), only one NCP can control an X.25 line at a time.
2. In a 3746-900, the X.25 line can additionally carry NCP-controlled traffic (X.25 ODLC), but not NPSI traffic (NPSI ODLC).
3. When the line is shared by NCP in addition to APPN/HPR and/or IP, the line must be configured in CCM, for both APPN/HPR and IP, and in NDF for NCP. The configuration parameters in CCM and NDF must be identical (see also “Resource Activation” on page 81).

How to Deliver Incoming Calls

Since an X.25 line can be shared by several control points (network node, IP and NCP), an incoming call should be delivered to the right control point. This is performed by means of two pieces of information received in the incoming call packet. These are:

- The first byte of the Call User Data (CUD) field, called the *protocol identifier*
- The last two digits of the called DTE address, called the *subaddress*.

  Note: If the called DTE address contains only one digit, the subaddress is considered as 0 followed by the received digit.

The following rules apply to deliver an incoming call:

- If the protocol identifier is X'CC', the call is delivered to the IP control point, in accordance with the RFC 1356.
- If there is no protocol identifier (no CUD field was received in the incoming call) the call is delivered to the IP control point, to support the old IP routers (before RFC 1356).
- If the protocol identifier is X'E3' or X'EB' (subarea node traffic), the call is delivered to the active NCP, whatever the subaddress value is.
- If the subaddress received in the incoming call exactly matches with one coded at port level in a control point (APPN/HPR or NCP), the call is delivered to that control point.
- The call is delivered to the active NCP, when there is no called DTE address in the incoming call or if the received subaddress does not match with the APPN one, on condition that no subaddress is defined in NCP (NPADTEAD not coded). This allows backward compatibility.

When the call cannot be routed to a control point, it is rejected and an alert is sent.

Resource Activation

This section applies only to a 3746-900.

When the line is shared by NCP in addition to APPN and/or IP, two sets of configuration parameters are needed. At activation time, each is checked. All the parameters must be the same in the two sets. If not, the values provided in the older activation are used. Those provided in the later activation are ignored, but the activation itself is not rejected. There are two exceptions:

NPA eligible
: Can be the same or different. Each control point can ask for NPM independently.

Local DTE address
: Must be different. The last two digits are used as a subaddress to route the incoming calls and therefore must be different. If the subaddresses are equal, the later activation is rejected.

Subaddress Allocation

Since subaddress can be used to deliver an incoming call, a subaddress must be allocated to each control point when the line is being shared by NCP and APPN/HPR (this does not apply to IP).

For NCP, the subaddress is coded as the last two digits of the NPADTEAD operand of the X25.MCH statement. If this operand is coded with only one digit, it is considered as equal to 0 followed by that digit.

For APPN/HPR, the subaddress is coded as the last two digits of the DTE address at the port level. It is recommended to allocate the APPN/HPR subaddress as follows:

- The subaddresses, allocated to NCP and to APPN/HPR, must be different. If not, the second activation of the X.25 line is rejected.

  For a 3746-900, allocate a value different from the last two digits of the NPADTEAD operand. This ensures backward compatibility with NCP, when the NPADTEAD operand is coded. This assumes that NPADTEAD contains the actual DTE address as known by the network.
- The local DTE address must be at least two digits long.

The IP control point cannot be allocated a subaddress. Subaddress is never used to route a call to the IP control point (the protocol identifier is used).

The subaddresses, allocated to NCP and to APPN, must be different. If not, the later activation of the X.25 line is rejected.

Note: The X.25 networks generally provide subaddress in two different ways:

- The subaddress is included within the address, for example the last two digits.
- The subaddress consists of all the digits in addition to the address. It is then referred to as the complementary address.

Ask your network provider about the subaddress.

Implementation Details

Protocol Identifier

The protocol identifier is the first byte of the Call User Data (CUD) field. The 3746 Network Node includes the following values in the call request packets that it sends:

- X'C3' for an APPN/HPR or SNA peripheral node traffic, if the X.25 version is 1980
- X'CB' for an APPN/HPR or SNA peripheral node traffic, if the X.25 version is not 1980
- X'E3' for a SNA subarea node traffic (NCP), if the X.25 version is 1980
- X'EB' for a SNA subarea node traffic (NCP), if the X.25 version is not 1980
- X'CC' for an IP traffic whatever the X.25 version is.

These values can be overridden by CCM, when defining the switched X.25 station, or by the VTAM switched major node (DLCADDR operand) in case of DLUR and X.25 ODLC.

The 3746 can receive without differentiation:

- X'C3' or X'CB' for an APPN/HPR or SNA peripheral node traffic. The 3746 behavior is the same, whether it receives either a X'C3' or X'CB'.
- X'E3' or X'EB' for a SNA subarea node (NCP) or DLUR traffic. The 3746 behavior is the same, whether it receives either a X'E3' or X'EB'.

TOA/NPI Address Format

The 1993 version of the X.25 recommendation has introduced a new format for the X.25 addresses. It is referred to as the TOA/NPI format. This format is needed particularly in case of interworking with an ISDN network. With this format, the X.25 addresses can contain more than 15 digits, unlike previous versions. The address digits are preceded by two fields:

- Type Of Address (TOA) field

  It is a one-decimal digit field. Possible values are:

  0 Network dependent number
  1 International number
  2 National number
  5 Alternative address (can be used only to place an outgoing call)

- Numbering Plan Identification (NPI) field

  It is a one-decimal digit field. Possible values are:

  1 Address as defined in the ITU-T E.164 recommendation (ISDN and telephony numbering plan)

  3 Address as defined in the ITU-T X.121 recommendation (for public X.25 networks)

Example: TOA/NPI fields = 23 means an X.121 national number.

X.25 Security Considerations

APPN/HPR and IP Control Point

Applies for each virtual circuit controlled by the APPN/HPR or IP control points.

You can define the APPN/HPR X.25 port to accept any incoming call. In this case there is no verification of the incoming calls. In addition, the corresponding station is created dynamically at the call time, if there is no station configured by CCM and having the same remote DTE address.

In the other case, each incoming call is checked. The calling DTE address must correspond exactly to one of the remote DTE addresses coded at the station level in CCM (including the TOA and NPI fields, if any). If it does not, the call is rejected. In addition each station is created when the X.25 port is activated to ensure that the incoming call is not rejected due to a lack of CLP storage needed to create the corresponding station.

In case of DLUR traffic, the VTAM security mechanism (the VERIFY and VERID operands; see "NCP") is not used, but the APPN/HPR mechanism is used instead. The calling DTE address is checked against the remote DTE address of the station is predefined in the 3746 via CCM if the X.25 port is configured to not accept incoming calls.

NCP

Applies for each virtual circuit controlled by NCP.

If you do not need to check incoming calls, code VERIFY=NONE or do not code the VERIFY operand in the VTAM switched major node. All incoming calls will then be accepted.

If the VERIFY operand is coded with IN (or INOUT), VTAM checks that the calling DTE address received in an incoming call corresponds to one coded in the VERID operand. The VERID operand must be coded in decimal exactly as the expected calling DTE address. It must then include the TOA (Type Of Address) and NPI (Numbering Plan Identification) fields, if any.

Checking through VERIFY/VERID operands applies to peripheral node traffic, as well as subarea node traffic.

X.25 Port Subscription to an X.25 Network

Each X.25 port must be subscribed to in the public or private X.25 network.

Table 20 gives the X.25 parameters that a 3746-9x0 X.25 port can subscribe to. Although the 3746-9x0 itself does not need any X.25 network services, each of its X.25 ports must have a 'contract' with an X.25 private or public network that guarantees the value of certain X.25 parameters. This section can help you in subscribing an X.25 port of the 3746-9x0 communication controller.

Table 20. X.25 LAPB Subscription Parameters

Subscription Parameter	Subscription	Note	Section in X.25 (see note 1)
Extended sequence numbering (modulo 128)	Yes	2	2.1.4
Retransmission timer (X.25 parameter T1)	Yes	3	2.4.8.1
Acknowledgement timer (X.25 parameter T2)	Yes	3	2.4.8.2
Max number of retransmission (parameter N2)	Yes	3	2.4.8.4
Maximum frame size (X.25 parameter N1)	Yes	4	2.4.8.5
Frame window size (X.25 parameter K)	Yes	2	2.4.8.6
MultiLink Procedure (MLP)	No		2.5

Legend

No Do not subscribe to this parameter.

Yes You can subscribe to this parameter. This impacts the 3746-9X0 operation and therefore requires generally a parameter in the NCP or CCM configuration.

Notes :

1 Version 1993 of the X.25 recommendation.

2 For this parameter the DTE and DCE values must be exactly the same. You must therefore configure the X.25 port with the subscribed value.

3 The parameters T1, T2 and N2 need not to be the same for the DTE and DCE. However the network values must be known in order to ensure they are compatible with the DTE values or to calculate some DTE values. Especially the network T1 value is needed to calculate the DTE T2 value.

4 The parameter N1 need not to be the same for the DTE and DCE. However it is recommended to configure and subscribe the same value. Besides do not subscribe a value less than 135 bytes (including the address, control and FCS fields) or 131 bytes (excluding these fields).

Table 21. X.25 PLP Subscription Parameters			
Subscription Parameter	**Subscription**	**Notes Page 87**	**Section in X.25 (see note 1)**
Logical channel ranges for SVCs	Yes	2	Annex A
Permanent virtual circuits (PVC)	Yes	3	Annex A
On-line registration facility	No		6.1
extended packet sequence numbering (modulo 128 at packet level)	Yes		6.2
D-bit modification	No		6.3
Packet retransmission (reject packet)	No		6.4
Incoming calls barred	Any	4	6.5
Outgoing calls barred	Any	4	6.6
One-way logical channel outgoing	Any		6.7
One-way logical channel incoming	Any		6.8
Non-standard default packet size	Yes	5	6.9
Non-standard default window size	Yes	6	6.10
Default throughput class assignment	Any		6.11
Flow control parameter negotiation	Any	7	6.12
Throughput class negotiation subscription	Any		6.13
CUG (Closed User Group) subscription	Any	8	6.14.1
CUG with IA (Incoming Access) subscription	Any	9	6.14.3
CUG with OA (Outgoing Access) subscription	Any	10	6.14.2
CUG with IA and OA subscription	Any	11	6.14.2-3
CUG with IA subscription w/o preferential	Any	12	6.14.3
CUG with OA subscription w/o preferential	Any	12	6.14.2
CUG IA and OA subscription w/o preferential	Any	12	6.14.2-3
Incoming call barred within CUG	Any	13	6.14.4
Outgoing call barred within CUG	Any	14	6.14.5
Bilateral CUG subscription	No		6.15.1
Bilateral CUG OA subscription	No		6.15.2
Fast select acceptance	No		6.17
Reverse charging acceptance	Any	15	6.19
Local charging prevention	Any	16	6.20
NUI subscription	Any	17	6.21.1
NUI override	Any	17	6.21.2
Charging information related facilities	No		6.22
ROA subscription	Any	18	6.23.1
Hunt group	Any	19	6.24
Call redirection (CRD)	Any	20	6.25.1
ICRD prevention subscription	Any	21	6.25.4
Call deflection subscription	No		6.25.2.1
TOA/NPI address subscription	Yes	22	6.28
Alternative address usage subscription	Yes	23	6.28

Legend

No Do not subscribe to this parameter.

Yes You can subscribe to this parameter. This impacts the 3746-9X0 operation and therefore requires generally a parameter in the NCP or CCM configuration.

Any You can subscribe to this parameter which do not impact the 3746-9X0 operation. There is generally no impact in the NCP or CCM configuration.

Notes:

1 Version 1993 of the X.25 recommendation.

2 If you intend to use SVCs, you must define with the network administrator the logical channel ranges that will be used for SVCs, that is the lowest and highest values for the one-way incoming, two-way and one-way outgoing logical channels. You have to configure exactly the subscribed values.

3 If you intend to use PVCs, you must define the parameters of each PVC with the network administrator, especially the identification of the remote end, logical channel number at each end, packet size and window size which will apply over the PVC, etc.. You have to configure exactly most subscribed values.

4 Rather than to subscribe to this facility, it is preferable to assign with the network administrator all the logical channel numbers for SVCs to the one-way incoming or one-way outgoing channel range.

5 It is recommended to subscribe to this parameter and choose the largest packet size possible. This improves performances.

6 It is recommended to subscribe to this parameter and choose the largest window size possible. This improves performances, because the 3746-9x0 does not systematically acknowledge each packet. It does so when the window minus one is reached.

7 Flow control parameter negotiation allows for negotiation of the packet and/or window sizes. It is recommended to subscribe to this parameter.

8 Closed User Group (CUG) facility allows to form groups of DTEs with restricted access. A DTE can subscribe to one or more CUGs.

9 If the X.25 port subscribes to a CUG with Incoming Access (IA), it can communicate with any DTE within the same CUG and receive calls from any DTE which does not belong to any CUG.

10 If the X.25 port subscribes to a CUG with Outgoing Access (OA), it can communicate with any DTE within the same CUG and place calls to any DTE which does not belong to any CUG.

11 If the X.25 port subscribes to a CUG with Incoming and Outgoing Access (IA and OA), it can communicate with any DTE within the same CUG and receive calls from or place calls to any DTE which does not belong to any CUG.

12 A preferential CUG is a kind of default CUG. For instance, communicating within the preferential CUG does not require the CUG selection facility in the call request packet. CUG subscription without preferential CUG is mainly meant to gateways between two X.25 networks using the X.25 protocol. Therefore if you need the CUG facility, choose to subscribe to this function with a preferential CUG.

13 If the X.25 port subscribes this facility, it will not receive calls from any DTE that belongs to the given CUG.

14 If the X.25 port subscribes this facility, it cannot initiate calls to any DTE that belongs to the given CUG.

15 Subscribe to this parameter if you accept that the X.25 port be charged when requested by the calling DTE through the reverse charging facility in the call request. If this parameter is not subscribed to, the DTE will never receive incoming calls with reverse charging.

16 When the X.25 port subscribes to the Local Charging Prevention, all the calls it initiates will be charged to the called DTE and all calls it receives will be charged to the calling DTE.

17 Subscribe to the NUI (Network User Identification) facility for the following purposes:

- Detailed billing (the network user identifier is included in the bill)
- Security (access through a switched network)
- Network management (override of the subscription parameters by a set of parameters depending on the network user identifier provided).

Associated to the NUI facility subscription, one or more network user identifiers are also agreed to.

If the X.25 port has subscribed to the NUI facility in the network, each call request must include the NUI selection facility, which provides the network user identifier that applies to the call to be established. This can be performed either through CCM or the VTAM switched major node (DLCADDR operand).

The 3746-9x0:

- Does not support this facility in the call accepted packet
- Overrides all subscribed parameters, except packet size and window size.

18 Subscribe the X.25 port to the ROA (Recognized Operating Agency) facility, if you want that each internetwork call be routed, whenever possible, through a predefined sequence of ROA transit networks.

This sequence can be overridden by the ROA selection facility included in the call request.

Remark that the X.25 version 1993 has changed the name from RPOA (Recognized Private Operating Agency).

19 Hunt group consists in distributing calls on several X.25 lines. It is not supported by the 3756-9x0, but it can be subscribed on the network side. In that case, only the incoming calls are distributed on the X.25 lines. If there is a need to initiate calls over these lines, assign the X.25 stations to the X.25 lines (static assignment), in order to balance as far as possible the outgoing call traffic.

20 Subscribe an X.25 port of the 3746-9x0 to the call redirection, if you want incoming calls be redirected to another port of the same 3746-9x0 or another DTE:

- When the port is out of order (e.g. failed or not activated)
- When the port is busy (no logical channel available)
- Systematically (for instance, during an interim period, when migrating an application).

21 Subscribe the X.25 port to the Internetwork Call Redirection or Deflection (ICRD) prevention, if you want to prevent an outgoing call being redirected or deflected, except when the alternate DTE belongs to the same network as either the X.25 port (calling DTE) or the originally called DTE.

This subscription parameter can be overridden by the ICRD status selection facility included in the call request.

22 This facility allows the X.25 port to receive a calling DTE address with the TOA/NPI format in incoming calls. If this facility is not subscribed to, the calling DTE address is generally not included in incoming calls, when it exceeds 15 digits. This facility is mainly meant for ISDN interworking.

Since the 3746-9x0 supports the TOA/NPI format, it is recommended to subscribe to this facility, especially if the X.25 port:

- Needs to communicate with another DTE attached to an ISDN (directly or through a terminal adapter) and working in packet mode
- Itself is attached to an ISDN through a terminal adapter.

23 This facility allows the X.25 port to include a non-X.25 address, for instance a mnemonic, OSI (NSAP), MAC or IP address, in the call request packet.

The 3746-9X0 requires that the alternative address be limited to 8 bytes.

Chapter 4. Serial Line X.25 Configurations

X.25 APPN and X.25 IP Configuration

Configuration of 3746-9x0 X.25 APPN and X.25 IP resources is done via CCM. For more information refer to the *Controller Configuration and Management User's Guide*, SH11-3081.

X.25 ODLC Configuration

Configuration of the 3746-900 X.25 resources is done via the Network Definition Facility, that is, during NPSI and NCP generation.

- A physical line is defined by the X25.MCH definition statement.
- A PVC is defined by the X25.LINE and X25.PU definition statements. A peripheral node is defined by the X25.PU definition statement.
- A SVC is defined by either:
  - X25.LINE and X25.PU definition statements
  - X25.SVC definition statement.

  For more information, refer to the *NCP X.25 Planning and Installation* manual, SC30-3470.

For DTE-to-DTE SVCs

For X.25 ODLC SVCs that can be set up by either of the DTEs, the SVC must be defined with `CALL=INOUT`.

X25.OUFT Statement

For X.25 ODLC, each X25.OUFT definition statement defines an entry in the CCU Optional User Facilities Table (OUFT), one per network. The OUFT table of a network defined by the X.25.NET definition statement is shared by NPSI and X.25 ODLC when both are running in the CCU.

Specific X.25 Parameters

NCP Parameters for X.25 ODLC

- **STATION=(a,b)** in the **X25.MCH Definition Statement**

  a is the LAPB role: DTE or DCE
  b is the PLP role: DTE, DCE or NEG (Negotiable).

- **MAXPKTL=(a,b)** in the **X25.VCCPT Definition Statement**
  - For PVCs:
    - *a* is the packet size out
    - *b* is the packet size in.
  - For SVCs:
    - *a* is the packet size from the calling to the called DTE
    - *b* is the packet size from the called to the calling DTE.

- **VWINDOW=(a,b)** in the **X25.VCCPT Definition Statement**
  - For PVCs:
    - *a* is the window size out
    - *b* is the window size in.
  - For SVCs:
    - *a* is the window size from the calling to the called DTE
    - *b* is the window size from the called to the calling DTE.

X.25 ODLC PLP Piggybacking Disabling and NETTYPE3 Support (FC 5812)

The X.25 support feature (FC 5812) and NCP Version 7 Release 8 add two new parameters for the X.25 ODLC controlled by NCP:

- PLP piggy-backing disabling support (PLPPIGGYB=NO)
- NETTYPE3 support (NETTYPE=3)

Note: These parameters are not supported for NNP-controlled X.25 lines.

PLP Piggy-Backing Disabling Support: At the X.25 PLP level, the term *piggy-backing* signifies that the received data packets could be acknowledged by the sent data packets. In this case, the PLP does not systematically acknowledge each received data packet that is waiting for a data packet to be sent. In the case of disabled piggy-backing, each received data packet is acknowledged, either by a RR packet or by a data packet that is waiting to be sent.

The following is a sample of PLP traffic without piggy-backing.

```
PLP Remote
!    !
!<---! LCN=1 DATA (3, 4) M1
!--->! LCN=1 RR Pr=4
!<---! LCN=1 DATA (4, 4) M0
!--->! LCN=1 RR Pr=5
!<---! LCN=1 DATA (5, 4) M1
!--->! LCN=1 DATA (4, 6) M1
!<---! LCN=1 DATA (6, 5) M0
!--->! LCN=1 RR Pr=7
```

In all releases prior to FC 5812 and NCP Version 7 Release 8, PLPPIGGYB=YES is the default, and there is no way to deactivate it. (NPSI Version 3 Release 4 and later support PLPPIGGYB=NO.) X.25 networks that do not support the piggy-backing function at the packet level can experience disconnection at the PLP level, unless they define the PLP window size equal to 1. But some networks, for instance, some Japanese X.25 networks, use terminals that have a fixed PLP window size of 4, and they cannot decrease the PLP window size. FC 5812 and NCP Version 7 Release 8 allow them to avoid network disconnection by permitting PLPPIGGYB=NO.

NETTYPE3 Support: Some X.25 networks also experience network disconnection when they receive a RESET X'07' from the DCE. NPSI resolves this problem by allowing NETTYPE=3. With NETTYPE=3, NPSI retries the QSM packet according to the RETVCCT/RETVCTO. Without NETTYPE=3, NPSI does not retry the QSM packet, and the connection is broken. FC 5812 allows NCP X.25 ODLC to support NETTYPE=3, just as NPSI does.

NPSI Parameters Not Used in X.25 ODLC Environment

If you use your NPSI definition statements for the NCP generation, the following parameters, if used, are ignored:

- `BRKCON`
- `CAUSE`
- `CCX DELAY`
- `DCI`
- `DM`
- `INSLOW`
- `ITRACE` (NPSI LAPB trace)
- `SPNQLLC`.

If you use your NPSI definition statements for the NCP generation, the following parameters, if used, are automatically changed as follows:

- `MAXPUI`, replaced by the standard NCP parameter `TRANSFR`
- `ACTIVTO` is forced to 0
- `LCN0` is forced to NOT USED
- `RESTPVC` is forced to YES
- `SHM` is forced to NO.

Note: The inactivity timer can be coded as the operand T3 or T4 whether the LAPB role (operand STATION) is defined as DTE or DCE.

How to Define an Outgoing Call

X.25 ODLC and NPSI ODLC

All the parameters needed to place an outgoing X.25 call, in particular the remote DTE address, are provided in the ACF/VTAM® DLCADDR operand of the PATH definition statement in the VTAM® switched major node. Refer to the *NCP X.25 Planning and Installation Guide* SC30-3470 for the X.25 specifics, to the *VTAM Resource Definition Reference* for a complete syntax of the DLCADDR operand.

X.25 APPN (without DLUR), and X.25 IP

All the parameters needed to place an outgoing X.25 call, in particular the remote DTE address, are provided in the CCM when defining an APPN or IP switched station. refer to the *CCM User's Guide* for more information.

X.25 DLUR

As for X.25 ODLC, all the parameters needed to place an outgoing X.25 call are provided in the VTAM DLCADDR operand of the PATH definition statement in the VTAM switched major node. But in this case the DLCADDR is coded slightly differently from X.25 ODLC. A X.25 SVC connection for a DLUR resource has these elements:

1. DLC type: X25SVC (required)
2. Port name (required)
3. Protocol Identifier (Optional)
4. Called DTE address (required)
5. Calling DTE address (optional)
6. Optional User Facilities
7. Optional Call User Data (CUD) field.

Code a DLCADDR keyword for each element using the following syntax:

```
DLCADDR=(subfield_id,data_type,data_string)
```

where:

`subfield_id`
: Specifies the subfield identification number:

1	DLC type identifier
2	Port name
4	Protocol Identifier
21	Called DTE address
22	Calling DTE address
30	User facilities
61	Call User Data Field, bytes 1 to 15.

`data_type`
: Specifies one of the following data types:

C
: Specifies EBCDIC characters. The value is sent in EBCDIC to the DLUR.

I
: Specifies ASCII characters. The value is converted into ASCII before being sent to the DLUR.

X
: Specifies hexadecimal, two digits per byte. The value coded is sent as is to the DLUR

D
: Specifies decimal. The value coded is converted in binary before being sent to the DLUR.

BCD
: Specifies Binary Coded Decimal, two digits per byte. The value coded is sent as is to the DLUR.

`data_string`
: The actual data sent to the DLUR.

Use the following procedure to code `DLCADDR`:

Step 1. To specify an X.25 SVC DLC type, code:

```
DLCADDR=(1,C,X25SVC)
```

Step 2. Identify the port name of the X.25 port:

```
DLCADDR=(2,I,portname)
```

where `portname` is the port name defined in CCM. The 3746 network node expects the port name in ASCII. The ASCII type is indicated by I and requires for:

- VTAM V4 R2 that PTF UW28497 is installed
- VTAM V4 R3 that PFT UW28498 is installed.

Step 3. If you need to specify a protocol identifier different from `X'CB'`, code:

```
DLCADDR=(4,X,hh)
```

where `hh` is the protocol identifier inserted as the first byte of the call user data field in the sent call request packet. This field is optional and should only be used when the called DTE does not support receiving the value `X'CB'` in the first byte of the call user data field. The only values you can code are `X'CB'` or `X'C3'`. The value `X'CB'` is the default value used when you omit to code this field.

Step 4. Specify the X.25 Called DTE address. For a:

Non-TOA/NPI address, code `DLCADDR=(21,X,000Ldddd)`, where:

- `L` is, in binary, the number of decimal digits of the Called DTE address, the maximum value is F.
- `dddd` is the called DTE address coded in BCD (Binary Coded Decimal: decimal digits coded onto 4 bits and 2 digits in each byte), the maximum number of digits is 15. If the address contains an odd number of digits, the last byte is padded with a zero on the right.

TOA/NPI address, code `DLCADDR=(21,X,80LLtndddd)`, where:

- `LL` is, in binary, the number of decimal digits of the Called DTE address. This number includes the TOA and NPI subfields `tn` described below but does not include this length field itself, the maximum value is X'12'.
- `t` is a nibble that contains the type of address (TOA). The four bit value is:

```
B'0000' = Network dependent number
B'0001' = International number
B'0010' = National number
B'0101' = Alternative address, limited to 8 bytes
```

- `n` contains in four bits the Numbering Plan Identifier (NPI)

```
B'0001' = Address as defined in ITU-T Recommendation E.164
B'0011' = Address as defined in ITU-T Recommendation X.121
```

- `dddd` is the called DTE address coded in Binary Coded Decimal (BCD: decimal digits coded onto 4 bits and 2 digits in each byte), the maximum number of digits is 17. If the address contains an odd number of digits, the last byte is padded with a zero on the right.

Step 5. Specify the X.25 Calling DTE address. For a:

Non-TOA/NPI address, code `DLCADDR=(22,X,000Ldddd)` with `Ldddd` as in step 4.

The calling DTE address is optional. It is included by the X.25 network if you do not define it.

TOA/NPI address, code `DLCADDR=(22,X,80LLtndddd)` with `LLtndddd` as in step 4.

Step 6. Specify the Optional User Facilities (if needed,) code:

`DLCADDR=(30,X,hhhh)`

where `hhhh` are the X.25 user facilities as coded in an X.25 call packet, but the facilities length field must not be coded.

Step 7. Specify the data to insert in the Call User Data field of a sent Call Request packet, code:

`DLCADDR=(61,X,hh)`

where `hh` is the data in hexadecimal that is inserted in the Call User Data field at offset 1, just after the Protocol Identifier specified in the subfield 4. A maximum of 30 hexadecimal digits can be defined; the number of hexadecimal digits must be even. This field can be specified using any of the data_type defined above: C, I, BCD, D, X. When specified in characters (data_type C or I), the length cannot exceed 15 characters.

For example, suppose you need to make an outgoing connection from DLUS to a DTE with a non-TOA/NPI X.121 address = 0492114583, using a X.25 SVC on the port name X25P01 and asks for reverse charging. You have to code in the PATH definition statement:

```
DLCADDR=(1,C,X25SVC),              X.25 SVC
DLCADDR=(2,I,X25P01),              Port name
DLCADDR=(21,X,000892114583),       Called DTE address
DLCADDR=(30,X,0101),               Facility, reverse charging
DLCADDR=(61,C,CUDATA)              CUD data
```

Note: The protocol identifier need not be coded when the called DTE support QLLC with SNA diagnostic codes indicated by a protocol identifier of X'CB', which is the default value for an outgoing connection.

How to Define an X.25 PVC for DLUR

Each PVC is defined in the CCM as a leased station, which contains the PVC characteristics (LC number, packet and window sizes, QLLC retry count and timer). The advantage of this method is to define all the X.25 parameters in a single place.

In the VTAM switched major node, you have to define a PU statement to provide VTAM with mainly the ID block and ID number (operands IDBLK and IDNUM). No VTAM PATH statement is required.

Each PVC must be activated using CCM (this is not possible using VTAM).

How to Configure IP over an X.25 Network

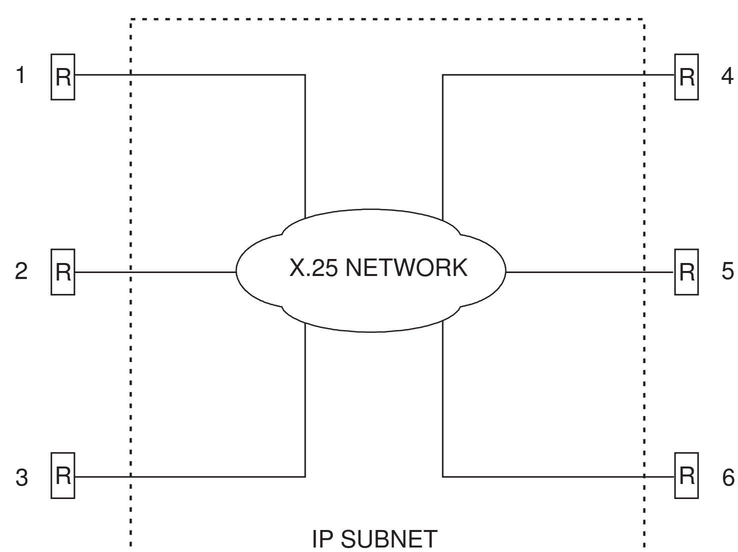


Figure 32. IP over X.25 Configuration Sample

The simplest way to configure IP over an X.25 network is to create one IP subnet that includes all the X.25 ports of routers and only the X.25 ports. See Figure 32. So each X.25 port is allocated an IP address within this subnet. Once this is performed, IP stations that can reach all the remote routers should be created for each X.25 port in the network. Therefore if there are N routers around the X.25 network, you have to create N-1 IP stations in each router, hence N(N-1)/2 stations for the whole network.

Each IP station binds in fact an X.25 address with an IP address, the X.25 address being that of the remote port in the X.25 network and the IP address that of the remote port in the IP subnet. The IP stations are configured through CCM. They allow therefore for router interconnection. For instance from router R2, you have to create a station towards R5, which provides router R2 with the X.25 and IP addresses of router R5. If this station does not exist, it is not possible to reach R5 from R2.

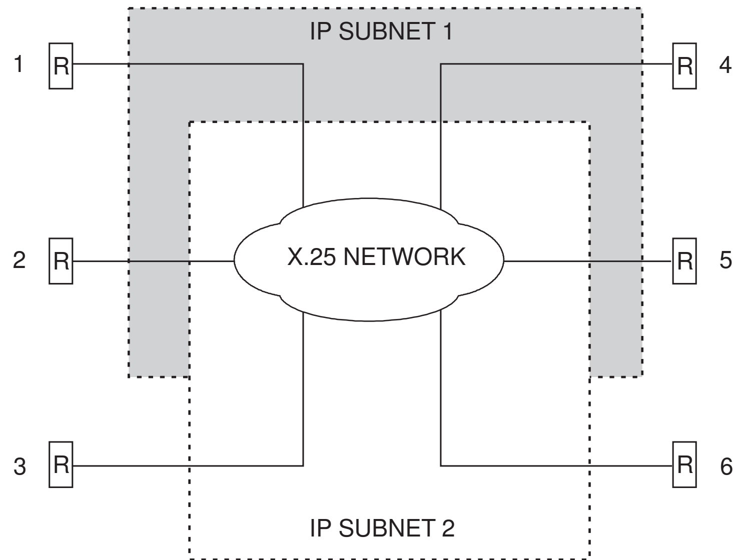


Figure 33. Another Configuration Sample

Another way to configure IP over an X.25 network is to create several IP subnets (for instance two, as in the sample of Figure 33) including together all the X.25 ports, each subnet including only X.25 ports. At least one port must belong to the two subnets. Otherwise there would be no connectivity between the routers of each subnet. In the above sample two routers belong to the two subnets (R2 and R5). These two routers must be given two IP addresses, one in each subnet. Each other router must be given one IP address in the subnet it belongs to.

For an X.25 port that belongs to more than one IP subnets, an IP station binds one X.25 address with one or more IP address, the X.25 address being that of the remote port in the X.25 network and the IP addresses that of the remote port in the IP subnets.

For example, when you define for the port R2 the IP station towards R5, you have to provide the X.25 address of the router R5 and two IP addresses, those of R5 in each subnet.

When there are more than one IP subnets for one X.25 network, be careful of the following:

- No SVC will be established between two routers that do not belong to the same IP subnet. So the IP traffic from R1 to R6, for instance, will flow from R1 to R2 (or to R5), then forwarded from R2 (or R5) to R6. Each packet flows therefore twice in the X.25 network and is paid twice. In addition the router R2 (or R5) could be overloaded unnecessarily.
- If a PVC already exists in the X.25 network, its two ends must belong to the same IP subnet. Otherwise no IP traffic could flow through this PVC.
- If OSPF is used over the X.25 network, allocate different weights to the two links R2-R5 (one link in each subnet) in order to avoid that two virtual circuits be set up between R2 and R5 with an unnecessary load balancing between them.

Choose therefore to define only one IP subnet for an X.25 network, except for specific reasons, for instance in order to decrease the number of IP stations to configure or when the IP address space prevents all the X.25 routers be included in the same IP subnet. Anyway the traffic between IP subnets should be low enough in order not to overcharge the X.25 traffic.

In summary:

- An X.25 port is allocated one or more IP addresses.
- Each IP address of a given X.25 port must belong to a different IP subnet.
- For each X.25 port, one or more IP stations must be configured.
- Each IP station is configured with the X.25 address of the remote router.
- Each IP station is configured with one or more IP addresses, those of the remote router.
- Each IP address configured for a given station must be unique for all the stations related to the same port. This means that an IP address of an X.25 port can be reach only through one X.25 address.
- Two IP addresses configured for a given station cannot belong to the same IP subnet.
- Each IP address configured for a given station must belong to the IP subnet of one IP address of the port.

3746 IP/APPN over X.25 Configuration Example

This section gives an example of how to configure X.25 ports, and how to configure IP to use these ports.

See “3746 Machine A” on page 100 and “3746 Machine B” on page 107 for information on how to configure the most important parameters for the configuration shown in Figure 34.

Assumptions:

- Direct DTE to DTE attachment (no X.25 network).
- The ports are shared between APPN and IP, on both machines.
- Two virtual circuits are defined: one PVC dedicated to APPN and one SVC dedicated to IP.

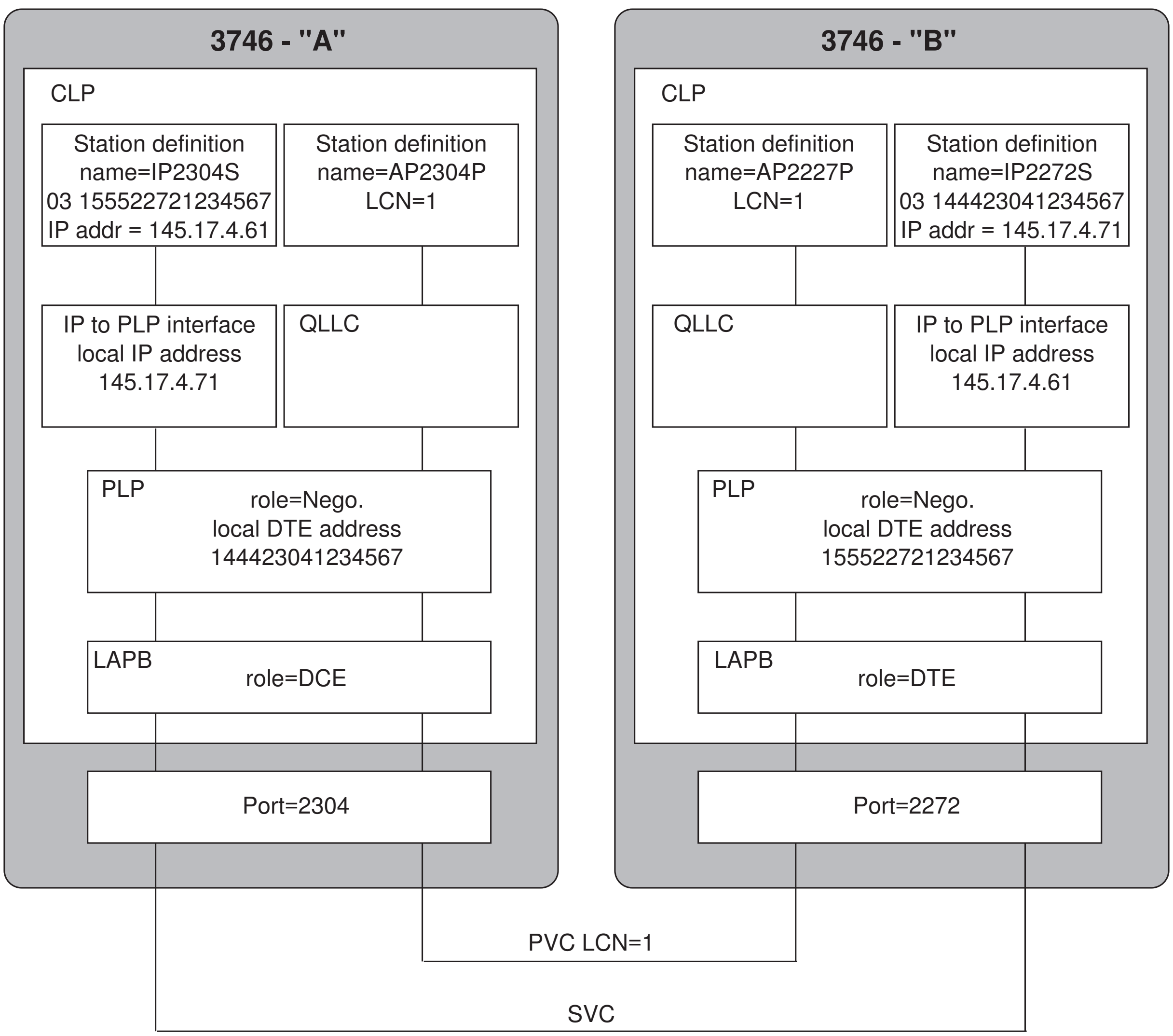


Figure 34. IP/APPN over X.25 Example Network

3746 Machine A

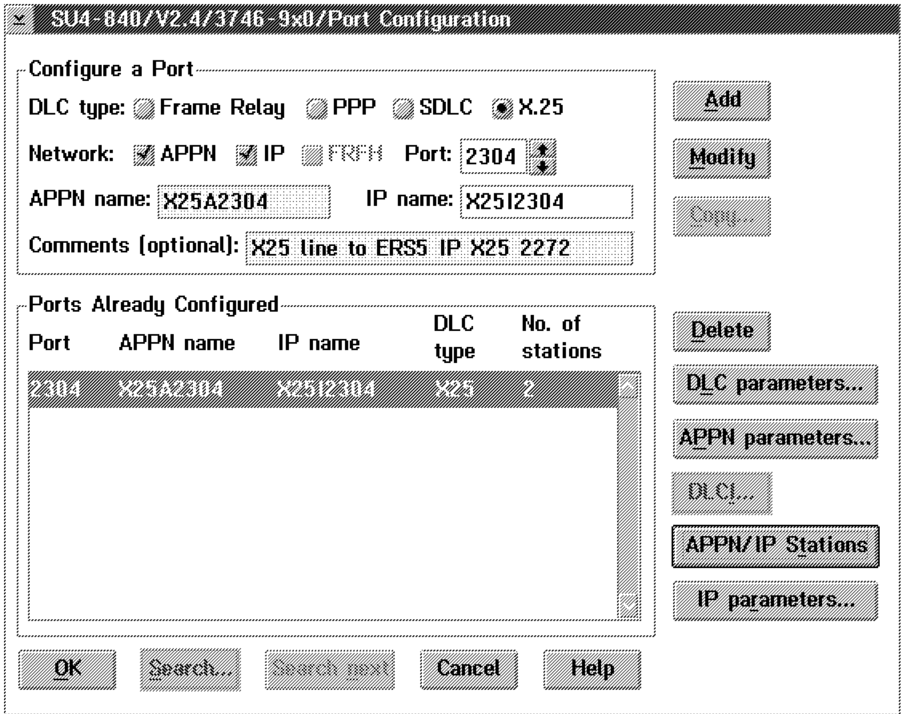


Figure 35. Port 2304 Configuration

Step 1. Select the port to be configured, in this case **2304**.

Step 2. Select **X.25** and the other parameters.

Step 3. Click **Add** to register the port.

Step 4. Click **DLC parameters...**

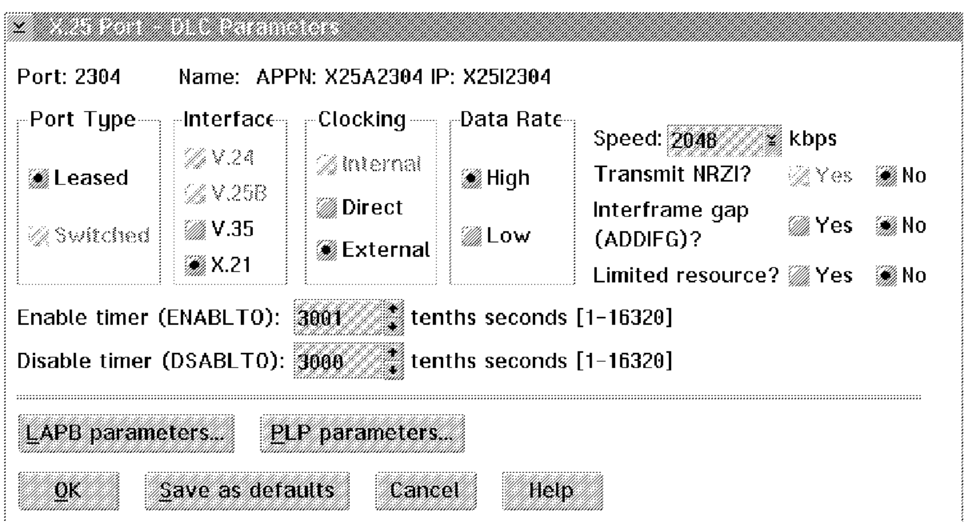


Figure 36. DLC Parameters for Port 2304

Step 5. Select the right parameters (interface, speed, etc..)

Step 6. Click **LAPB parameters....**

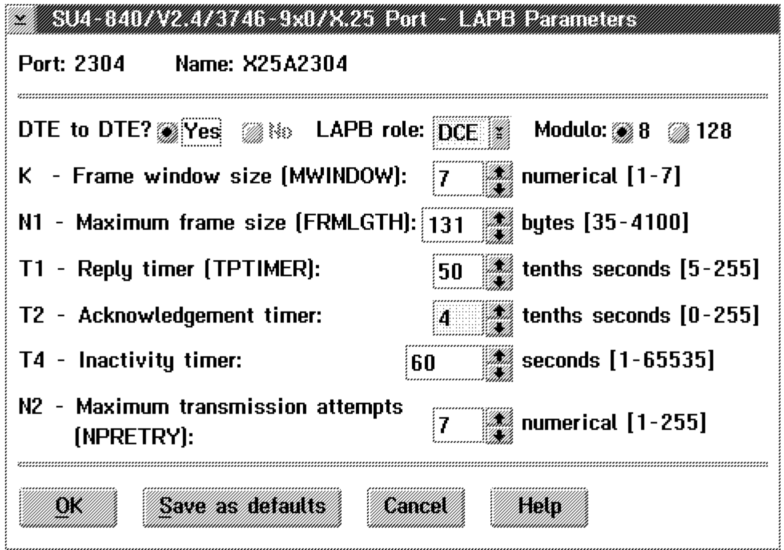


Figure 37. LAPB Parameters for Port 2304

Step 7. Set DTE to DTE? to **YES**, LAPB Role. to **DCE** and LAPB Modulo to **8**.

Step 8. Configure the other LAPB parameters if needed.

Step 9. Click **OK** to return to the DLC Parameters dialog and save the parameters.

Step 10. From this panel, select **PLP parameters...**.

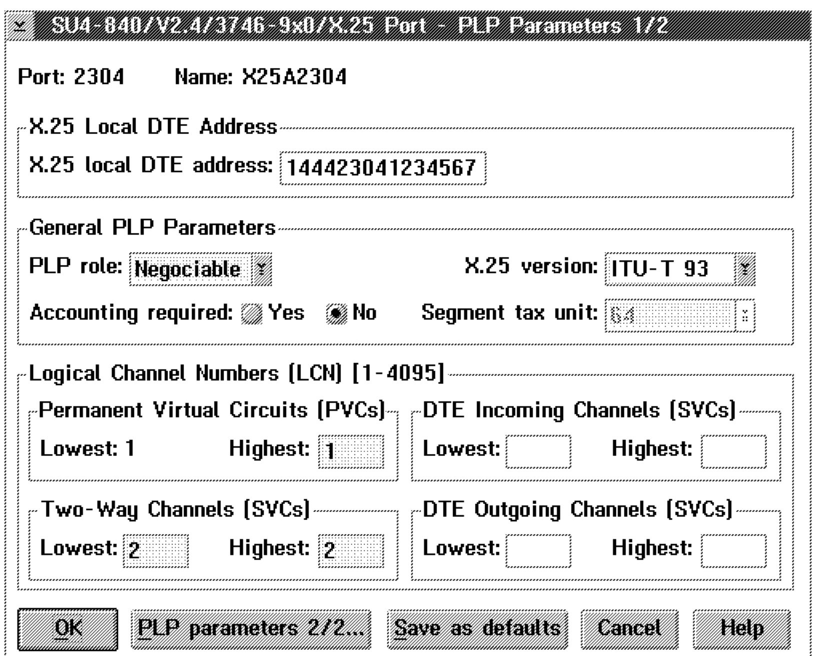


Figure 38. PLP Parameters 1/2 for Port 2304

Step 11. Set Local DTE Address to **144423041234567**.

Step 12. Configure the Logical Channel Numbers.

In the DTE-to-DTE environment, the logical channel numbers must be the same on both ends of the same physical line. When connected to an X.25 network, the logical channel numbers must be those subscribed to in the network.

Step 13. Click **PLP parameters 2/2...**.

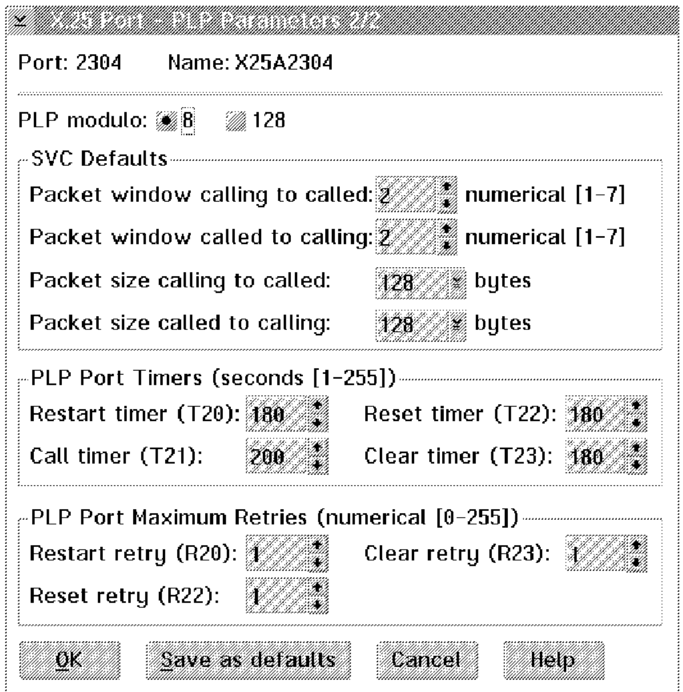


Figure 39. PLP Parameters 2/2 for Port 2304

Step 14. Set PLP Modulo to **8**.

Step 15. Change the packet sizes and/or window sizes, if needed.

Step 16. Click **OK** three times to return to the Port Configuration dialog and save the parameters in the corresponding panels.

Step 17. From the Port Configuration panel, select **IP parameters...**.

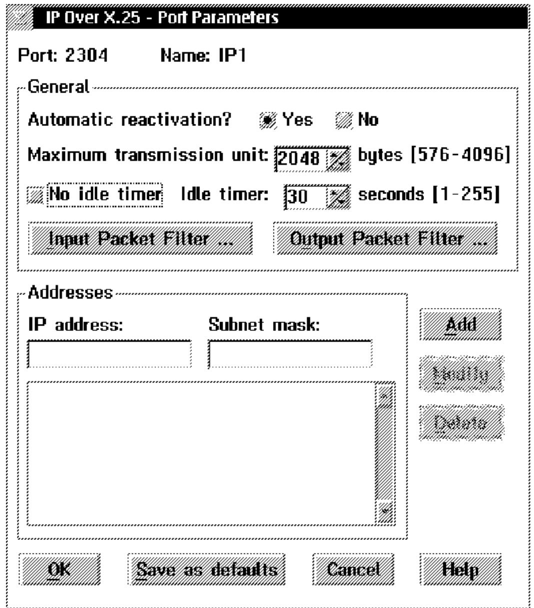


Figure 40. IP Port Parameters for Port 2304

Step 18. Set the MTU size for this port.

Step 19. Configure the IP address of this port to 145.17.4.71

Step 20. Configure the Subnet mask to 255.255.255.0. Port 2272 of machine B must have the same value, because both ports belong to the same IP subnet.

Step 21. Click **Add** to register this address

Step 22. Click **OK** to return to the Port Configuration dialog and save the IP parameters.

Step 23. From this panel, select **APPN/IP Stations** to define the IP and APPN link stations in the adjacent node.

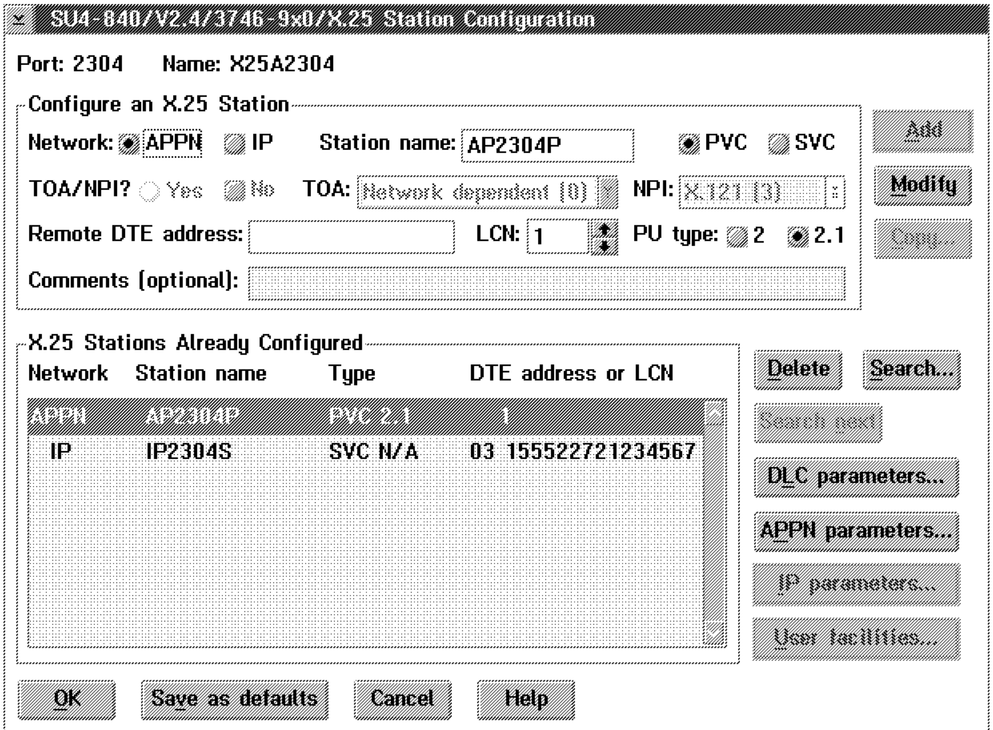


Figure 41. X.25 Station Configuration for Port 2304

Step 24. Configure the APPN station:

- Select **APPN**.
- Set Station name to **AP2304P**.
- Select **PVC**.
- Set **LCN** to **1**.
- Set **PU type** to **2.1**.

Step 25. Click **Add** to register this station.

Step 26. Click **APPN parameters...** to define additional parameters for this station, especially the HPR support, adjacent node identification or MLTG parameters, DLUR parameters.

Step 27. From the X.25 Station Configuration panel, configure now the IP station:

- Select **IP**.
- Set Station name to **IP2304S**.
- Select **SVC**.
- Select **TOA/NPI?**.
- Set TOA to **Network dependent (0)**.
- Set NPI to **X.121 (3)**.
- Set Remote DTE address to **155522721234567**.

Step 28. Click **Add** to register this station.

Step 29. Click **IP parameters...** to define the destination IP address. Note that the IP parameters panel must be selected for each IP station, if more than one IP station is to be configured.

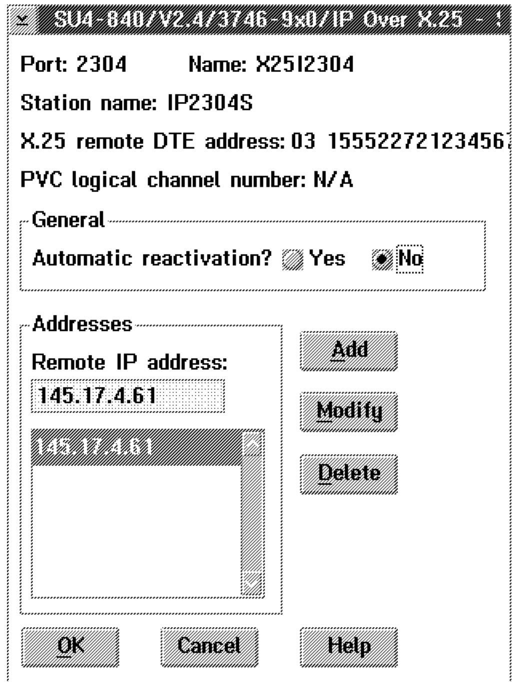


Figure 42. Remote DTE IP Address for Port 2304

Step 30. Enter `145.17.4.61` in the Remote IP address field.

Step 31. Click **Add** to register this address.

Step 32. Click **OK** to return to X.25 Station Configuration dialog and save parameters.

Step 33. Click **User Facilities**.

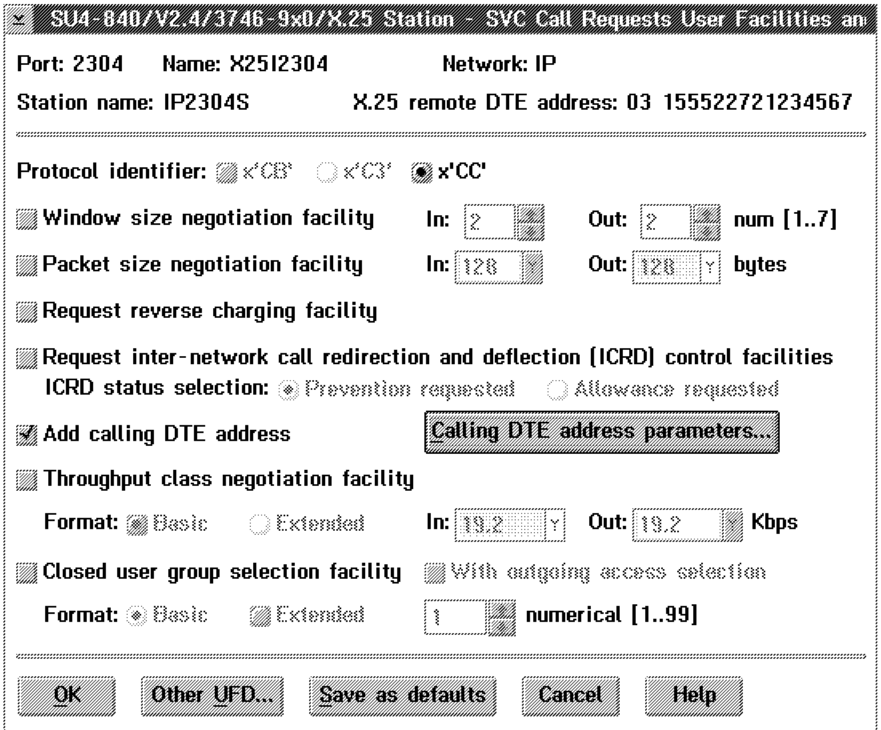


Figure 43. SVC Call Requests, User Facilities and Data for Port 2304

Step 34. Select **Add calling DTE address**.

Remark that the calling DTE address must be included in the call request in the DTE to DTE environment.

Step 35. Click **Calling DTE address parameters...**.

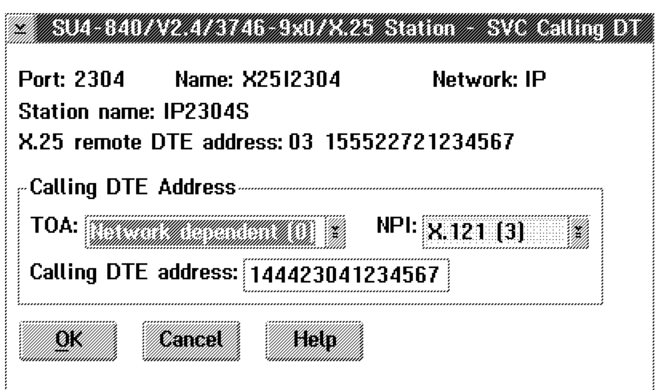


Figure 44. SVC Calling DTE Address for Port 2304

Step 36. Check that the proposed value for the calling DTE address is right. This one is the local DTE address configured in the PLP Parameters 1/2 dialog, in addition to default values for TOA and NPI, because the remote DTE address has been configured with the TOA/NPI format in the X.25 Station Configuration panel.

This concludes the parameter definitions for port 2304.

3746 Machine B

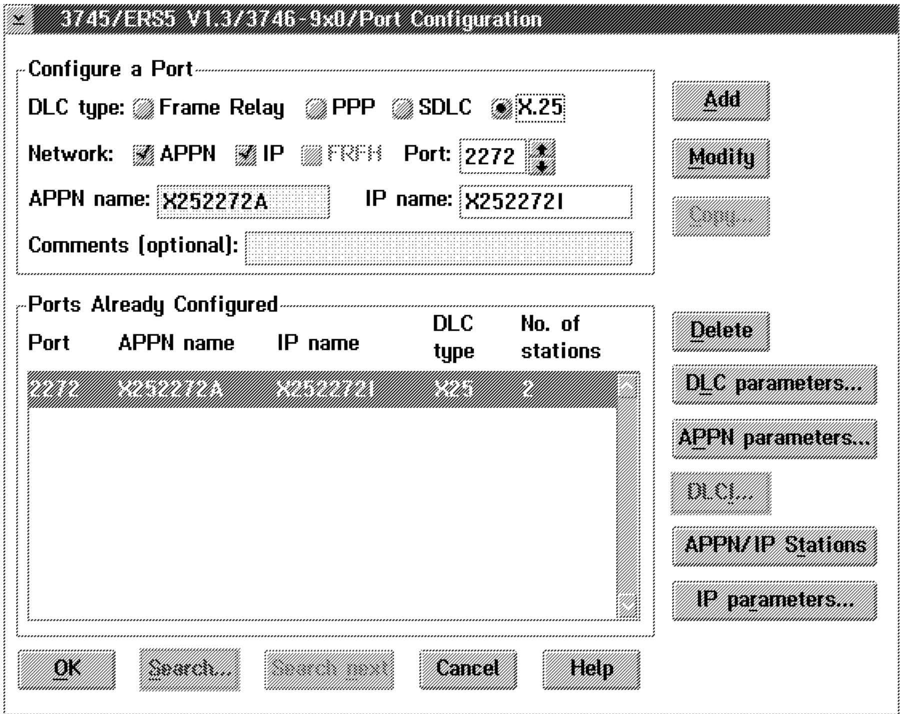


Figure 45. Port 2272 Configuration

1. Select the port to be configured, in this case **2272**.
2. Select **X.25** and the other parameters.
3. Click **Add** to register the port.
4. Click **DLC parameters...**.

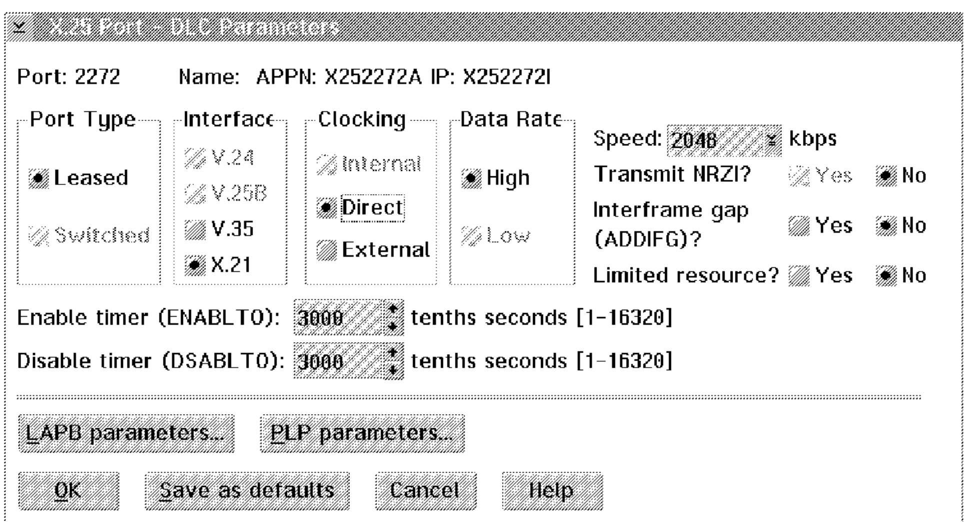


Figure 46. DLC Parameters for Port 2272

5. Select the right parameters (interface, speed, etc..)

6. Click **LAPB parameters...**.

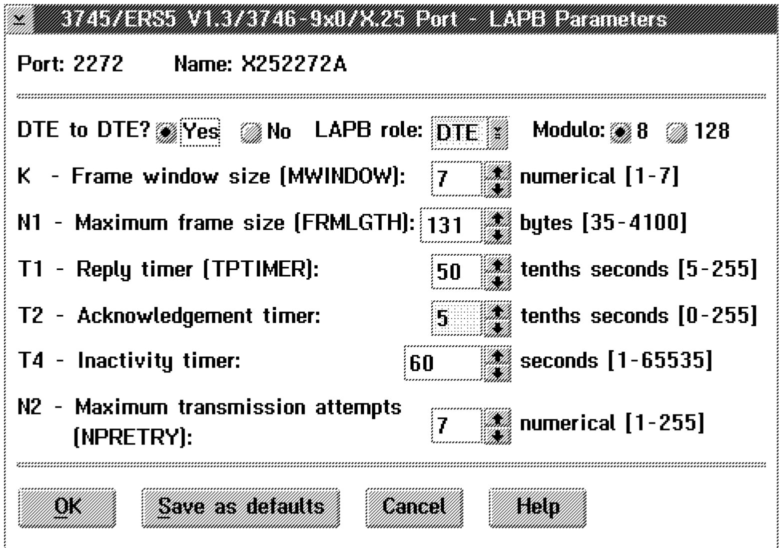


Figure 47. LAPB Parameters for Port 2272

7. Set **DTE to DTE?** to **YES**, **LAPB Role** to **DTE** and **LAPB Modulo** to **8**.
8. Configure the other LAPB parameters if needed.
9. Click **OK** to return to the DLC Parameters dialog and save the parameters.
10. From this panel, click **PLP parameters...**

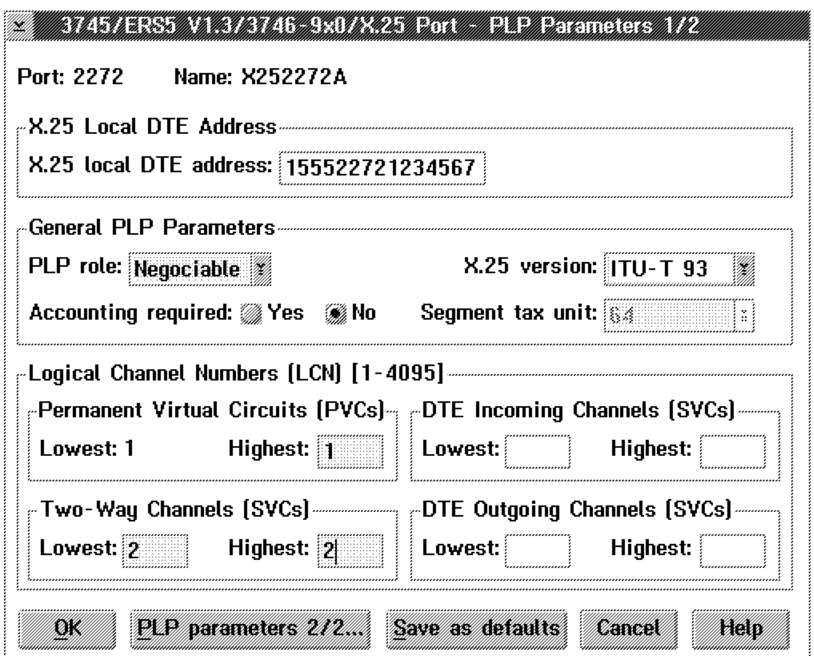


Figure 48. PLP Parameters 1/2 for Port 2272

11. Set **Local DTE Address** to **155522721234567**.

12. Configure the *Logical Channel Numbers*.

    In the DTE-to-DTE environment, the logical channel numbers must be the same on both ends of the same physical line. When connected to an X.25 network, the logical channel numbers must be those subscribed to in the network.

13. Click **PLP parameters 2/2...**.

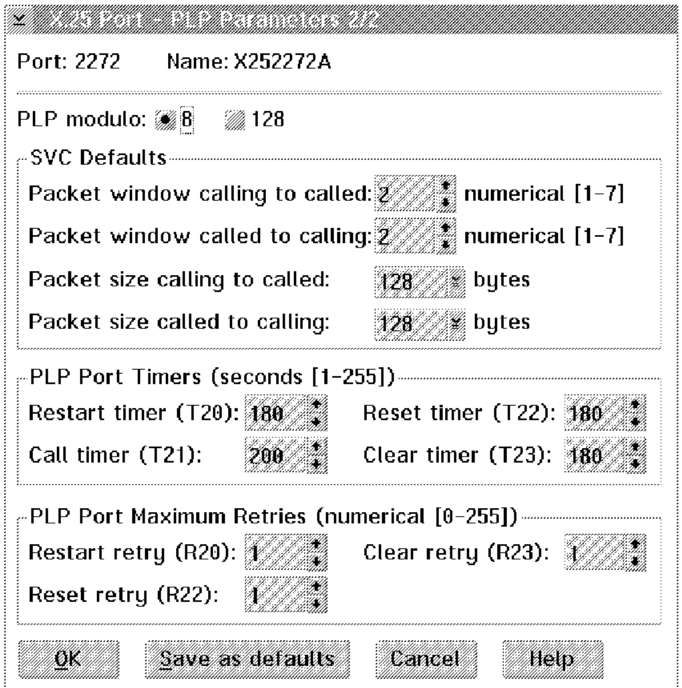


Figure 49. PLP Parameters 2/2 for Port 2272

14. Set **PLP Modulo** to **8**.

15. Change the packet sizes and/or window sizes, if needed.

16. Click **OK** three times to return to the Port Configuration dialog and save the parameters in the corresponding panels.

17. From the Port Configuration panel, click **IP Parameters...**.

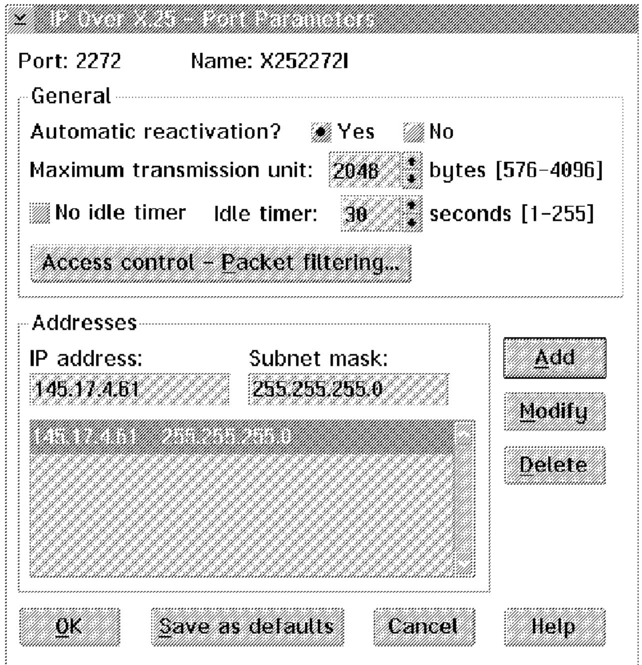


Figure 50. IP Port Parameters for Port 2272

18. Set the MTU size for this port.
19. Configure the IP address of this port to 145.17.4.61.
20. Configure the Subnet mask to 255.255.255.0. Port 2304 of machine A must have the same value, because both ports belong to the same IP subnet.
21. Click **Add** to register this address
22. Click **OK** to return to the Port Configuration dialog and save the IP parameters.

23. From this panel, select **APPN/IP Stations** to define the IP and APPN link stations in the adjacent node.

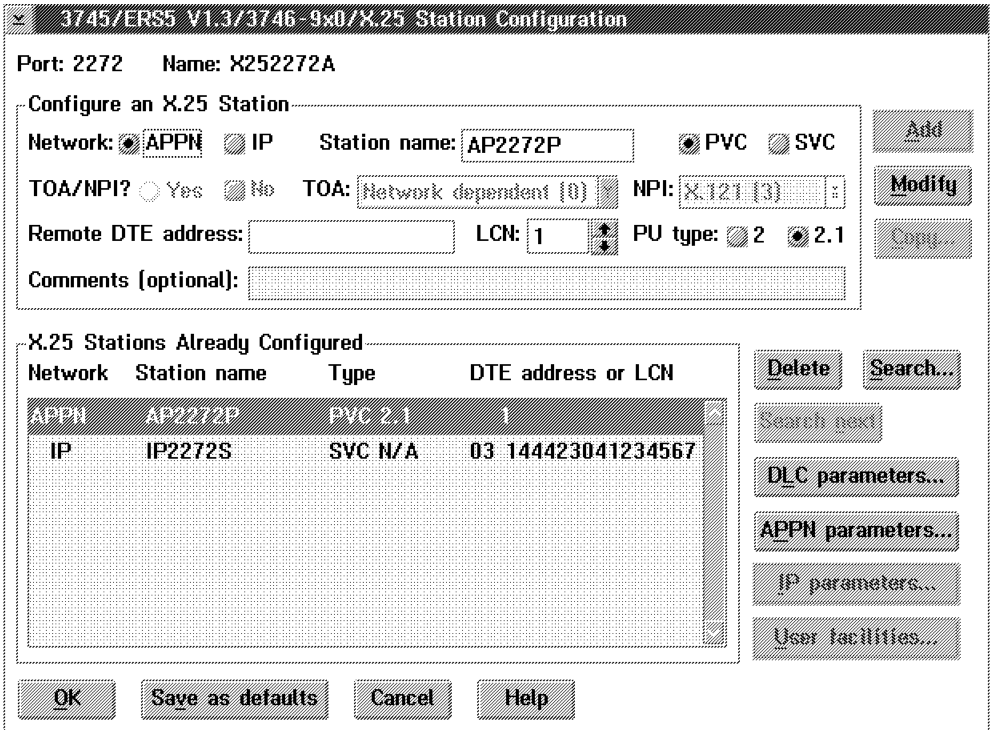


Figure 51. X.25 Station Configuration for Port 2272

24. Configure the APPN station:

    - Select **APPN**.
    - Set Station name to **AP2272P**.
    - Select **PVC**.
    - Set **LCN** to **1**.
    - Set **PU type** to **2.1**.

25. Click **Add** to register this station.

26. Click **APPN parameters...** to define additional parameters for this station, especially the HPR support, adjacent node identification or MLTG parameters, DLUR parameters.

27. From the X.25 Station Configuration panel, configure now the IP station:

    - Select **IP**.
    - Set Station name to **IP2272S**.
    - Select **SVC**.
    - Select **TOA/NPI?**.
    - Set *TOA* to **Network dependent (0)**.
    - Set NPI to **X.121 (3)**.
    - Set Remote DTE address to **155522721234567**.

28. Click **Add** to register this station.

29. Click **IP parameters...** to define the destination IP address. Note that the IP parameters panel must be selected for each IP station, if more than one IP station is to be configured.

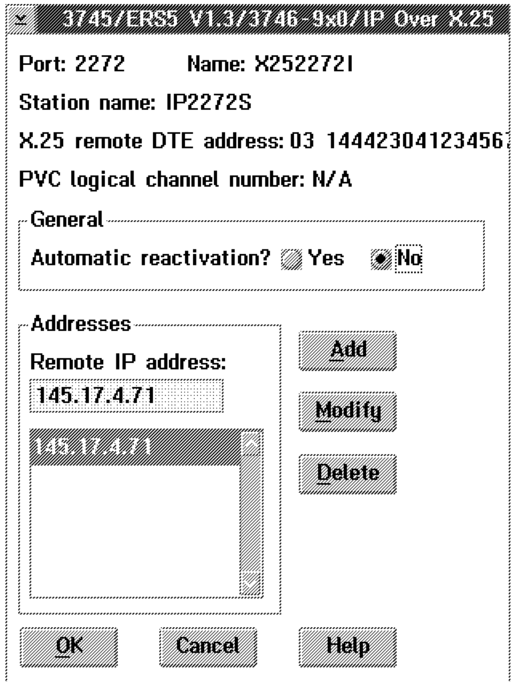


Figure 52. Remote DTE IP Address for Port 2272

30. Enter `145.17.4.71` in the Remote IP address field.
31. Click **Add** to register this address.
32. Click **OK** to return to 25 Station Configuration dialog and save parameters.

33. Click **User Facilities**.

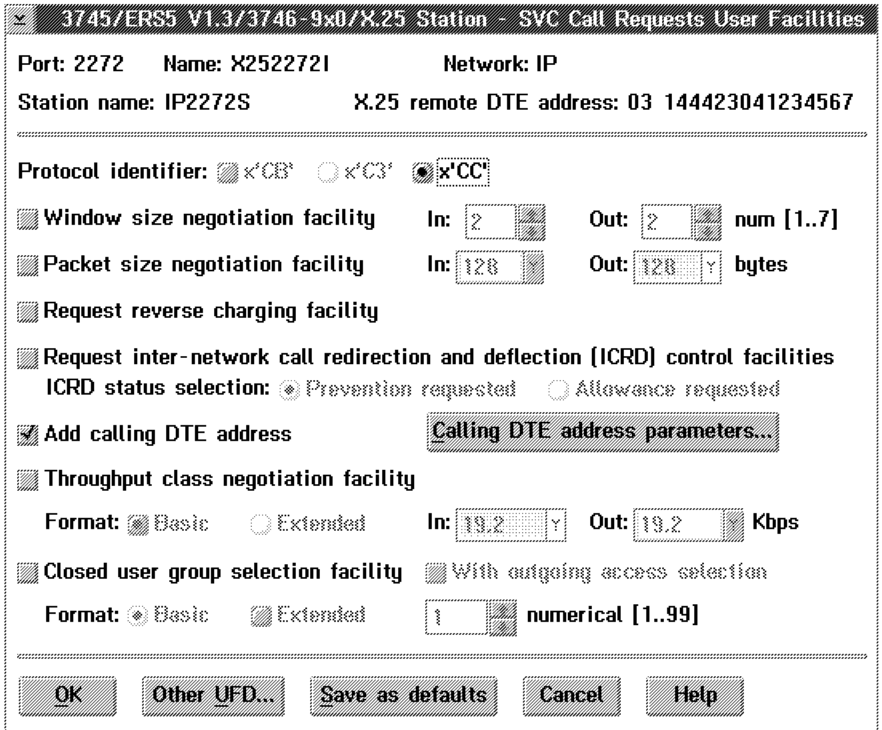


Figure 53. SVC Call Requests User Facilities and Data for Port 2272

34. Select **Add calling DTE address**.

    Remark that the calling DTE address must be included in the call request in the DTE to DTE environment.

35. Click **Calling DTE address parameters...**.

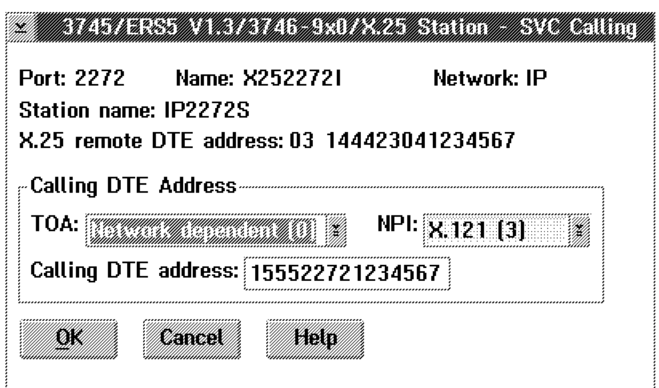


Figure 54. SVC Calling DTE Address for Port 2272

36. Check that the proposed value for the calling DTE address is right. This one is the local DTE address configured in the PLP Parameters 1/2 dialog, in addition to default values for TOA and NPI, because the remote DTE address has been configured with the TOA/NPI format in the X.25 Station Configuration panel.

This concludes the parameter definitions for port 2272.

Chapter 5. Point-to-Point Protocol

The Point-to-Point Protocol (PPP) provides communication between stations connected on a simple point-to-point link and has three main components:

1. A method for encapsulating IP datagrams over serial links.
2. A Link Control Protocol (LCP) for establishing, configuring, and testing the data-link connection.
3. A family of PPP Network Control Protocols (PPPNCP) for establishing and configuring different network-layer protocols.

The 3746 Network Node provides the following support for PPP:

- Base PPP and Line Control Protocols (LCP) (RFC 1331).
- PPP uses LIC11 and LIC12 and is supported for ***leased*** lines only, not for ***switched*** lines.
- Compressed TCP/IP headers (RFC 1144).
- IP Control Protocol (IPCP) (RFC 1332).
- PPP Link Group MIB (RFC 1471).

PPP in Operation

To establish communication over a point-to-point link:

1. Each end of the link must first send LCP packets to configure and test the data link.
2. After the link has been established and optional facilities have been negotiated as required by the LCP, PPP must send PPPNCP packets to choose and configure one or more network layers.
3. Once each of the chosen network layers has been configured, datagrams from each network layer protocol can be sent over the link.

Once the link has been established, the two stations can start communicating.

The PPP Frame

The unit of communication is the PPP frame which consists of the following items:

- A flag, indicating the start of the frame
- An address field
- A control byte
- A two-byte protocol field
- The information being communicated between the two stations
- Padding
- FCS (Frame Check Sequence)
- A flag, indicating the end of the frame.

The Protocol field is defined by PPP and is ***not*** a field defined by HDLC. All protocol field values are odd, and assigned so that the least significant bit of the most significant octet is 0. Protocol field values are shown in Table 22 on page 116.

Protocol Field value	Protocol Name
0x0021	IP data frame
0x002B	IPX data frame
0x0031	Bridging data frame
0x004B	APPN ISPR data frame
0x004D	APPN HPR data frame
0x8021	IP control protocol
0x802B	IPX control protocol
0x8031	Bridging control protocol
0x804B	APPN ISPR control protocol
0x804D	APPN HPR control protocol

Table 22. PPP Protocol Field Values

Note: For IP over PPP, the IP Control Protocol is the ***only one*** that is supported.

LCP Options Supported by the 3746 Network Node

The following LCP options are supported by the 3746 PPP:

- Maximum Receive Unit (MRU). The minimum value for the MRU is such that 576 data bytes plus the PPP header will fit into one packet. The default value for the MRU is 1500. The maximum value for an MRU is 4096 bytes.
- Async Control Character Map (ACCM). This option is used for control character transparency on async links. The PPP handler will always accept this option, but will ignore it. It will never generate this option.
- Magic number. The PPP handler will always request this option, but will accept a rejection from the other end. It will always accept this option.

LCP Options Not Supported by the 3746 Network Node

The 3746 PPP network handler will always reject these options and never generate them:

- Authentication protocol
- Link Quality Monitoring (LQM)
- Protocol field compression
- Address and control field compression
- 32-bit FCS.

IP over PPP Support

The 3746 Network Node supports IP over PPP:

IP Compression Protocol
Van Jacobson (VJ) Compressed TCP/IP is supported for headers only, not for data. Up to 16 slots will be supported by the PPP handler for VJ compression.

IP address
The PPP handler will always report its IP address to the other side in a configuration request message. If the other side reports its IP address, the PPP handler simply stores it for future use. It does not check for equality between the IP addresses assigned to the two ends of the link.

If the other end of the link requests its own address to be reported to it (by sending a zero value as its own address), the PPP handler will reject the option.

Chapter 6. Serial Line Performance Tuning

Frame-Relay Tuning Recommendations

Note: Proper operation of the 3746 requires correct setting of the configuration parameters. When making frame-relay line definitions with the CCM, this section should be used for guidance.

NCP Frame-Relay Tuning Recommendations

For additional information that you cannot find in this guide, refer to *IBM 3746-900 and NCP Version 7, Release 2*, GG23-4464 (a “redbook”).

Link Transmission Group (TGCONF in the PU Statement)

`TGCONF` specifies whether this subarea link station is in a multilink or single-link transmission group. The default is:

```
TGCONF=MULTI
```

For single-link transmission groups, code:

```
TGCONF=SINGLE
```

Coding `TGCONF=SINGLE` for a transmission group that contains a single SDLC, token-ring, or frame-relay line can improve NCP performance for the transmission group. Therefore, it is recommended to code `TGCONF=SINGLE` for any transmission group that will contain a single frame-relay connection.

FRTE Resources (LOCALTO or T1TIMER in LINE Statement)

`LOCALTO` or `T1TIMER` specifies the T1 reply timer (for example, the time a 3745/3746-900 FRTE will wait to receive the acknowledgment from the frame sent to its FRTE partner). When coding the T1 timer, the time taken by a frame to reach the remote partner and the time taken for the reply to come back must be taken into account. This time is the round trip delay and is mainly dependent on:

- The speed of the lines on each hop
- The number of hops to reach the partner
- The level of congestion that can create queuing in the transiting nodes.

Therefore, the minimum value to code is twice the time taken by a frame of an average size to be transmitted from the FRTE (that you are defining) to the FRTE partner.

For example, for an average frame size of 256 bytes, a speed of 19.2 kbps, and a path with two hops (FRTE to intermediate FRFH and FRFH to FRTE) the minimum transmit time is:

```
(256 × 8) ÷ 19200) × 2 = approximately
0.2 seconds
```

In addition, you may assume an average queue of four frames in the sending FRTE and the intermediate FRFH (transit node). This means an overall transmit time of:

```
0.2 + (4 × 0.2) = 1 second.
```

Therefore the time taken to send a frame and receive the reply is 2 seconds. There will be additional queueing during peak periods and additional processing time. To avoid unnecessary retries it is recommended that the LOCALTO value be set to three times the minimal value calculated in the above fashion. In the above example use a `LOCALTO` of approximately 6 seconds.

Blocking Factor (BLOCK in the PU Statement)

`BLOCK`, in the PU statement, can be used to improve the throughput of the frame-relay INN links and reduce the processing load of the CLP. Blocking is only supported between PU4. NCP can support multiple path information units (PIUs) in frame-relay frames when they are routed over transmission group links. `BLOCK=(bytes,pius)` specifies the maximum frame size and the maximum number of PIUs per frame.

Blocking occurs in NCP when a high traffic load leads to queuing in NCP before transfer to the 3746-900. For NCP queueing to occur, one of the following must take place:

- Queueing in the 3746-900 because the line speed is not large enough to transmit all the traffic for all the DLCIs
- The partner NCP node does not acknowledge fast enough
- The intermediate network is congested.

If you have blocking, defining `BLOCK` can improve the performance in the 3746-900 (as there are fewer frames to transmit) and can result in better line utilization (as there is less overhead due to frame-relay headers).

Note: Blocking was originally created for SDLC lines running on LSS and HSS lines, which have an inter-frame gap of flags between frames. This does not apply to 3746-900 lines.

If `BLOCK` is coded, NCP verifies that the sender of the XID2 supports PIU blocking. If not, NCP uses one frame per PIU. If the sender of the XID2 supports a smaller block size, NCP adjusts its block size to the value in the XID2.

Code the blocking factors at each side of the transmission group links connecting two subarea nodes. The values recommended are:

```
BLOCK=(4096,16)
```

This means that each SDLC frame is up to 4096 bytes long and will contain up to 16 PIUs.

Blocking is also dependent on the line speed. With a speed less than or equal to 64 kbps, the values recommended are:

```
BLOCK=(2048,8)
```

Interframe gap (ADDIFG in the LINE statement)

The ADDIFG support was enhanced in NCP V7 R5.

When the line adapter (often a 3745 LSS or HSS) of the partner controller is experiencing a high rate of overrun errors, code ADDIFG for frame-relay physical link as:

NO Transmit a minimum of one flag between frames.

YES

Transmit a minimum number of flags between frames as determined by NDF using the line speed. This increases the gap between frames and decreases the frame rate. The number of flags is calculated as follows:

- If line speed ≤ 25 000 bps, minimum flags = 10
- If speed > 25 600 bps and < 256 kbps, minimum flags = line speed / 2560
- If line speed ≥ 256 kbps, minimum flags = line speed / 8500.

NNN
Transmit at least NNN number of flags between frames, where NNN is a decimal value from 1 to 255.

For more details about these values, refer to the *NCP Resource Definition Reference* manual.

Communication Rate (DATABLK in the LINE Statement)

In the 3745 and 3746-900 the input is not policed, that is, the DTE can enter data up to the lined speed with any distribution on the DLCIs. For instance, one DLCI can enter data at line speed and take the whole bandwidth for it.

The 3745 and 3746-900 applies an *outbound* congestion control mechanism called *communication rate* (CR) during transmission.

The communication rate function in the 3745 and 3746-900 allows you to prioritize virtual circuits (VCs) on a physical link. When the available transmission bandwidth is fully used, the CR allows each virtual circuit (DLCI) to have a guaranteed portion of the physical link bandwidth.

Communication Rate (COMRATE in the PU Statement)

xrefd3text='COMRATE'. A numeric value (*n*), specified in `COMRATE`, is assigned to each virtual circuit. This value represents the number of transmission units sent for this virtual circuit at each of its transmit opportunities when the outbound link is congested. The `DATABLK` keyword defines the size of the transmission unit. By assigning different (*n*) values to different virtual circuits, the virtual circuits with higher (*n*) values will be able to use more of the available bandwidth than those with a lower (*n*) value.
Communications Rate Definition

The CR is defined by a numeric value (*n*) on the `COMRATE` keyword at the station level (FRSE or FRTE). This value is multiplied by the value of the `DATABLK` keyword value, defined at the physical link level, to determine the maximum number of bytes sent by this station at each transmit opportunity:

- `COMRATE` = (FULL|NONE,n):
  - FULL|NONE applies only to FRTE.
    - FULL = DE bit is off in all frames
    - NONE = DE bit is on in data frames.
  - *n* applies to both FRTE and FRSE.
    n = the relative priority of this DLCI. *n* ranges from 1, low, to 64, high, with a default value of 1.
- `DATABLK` = transmission unit size in bytes
  `DATABLK` defines the minimum transmission unit allocated to one DLCI of this physical link. It is coded in the Physical LINE definition statement.

  `DATABLK` ranges from 265 to 16372 with a default value of 2048.

Note: When a frame larger than DATABLK is sent and n= 1, the frame is not segmented before being sent. For example, if DATABLK = 500 and a one kilobyte frame is sent, the DLCI is serviced as if n = 2.

Communications Rate Value Recommendations

There is a relation between the:

- Line speed of a physical port
- Number of DLCIs defined on this port
- Communication rate (CR) defined for each DLCI.

In case of congestion, the 3746-900 will transmit, for each DLCI, the number of bytes defined by CR with a round-robin service mechanism. This means that the maximum time elapsed between each opportunity to send a CR for a DLCI is the total time required to send a CR for each DLCI:

```
(Sum (n*DATABLK)) * 8 / line speed
```

This value represents the maximum duration taken to send a CR for a given DLCI when all the virtual circuits are exceeding their share of the bandwidth. It is the time the CR burst may wait in a node on a busy transmitting line. It is recommended that this not exceed 3 seconds for any low speed line. The recommended maximum duration calculated for higher speed lines is less. Recommendations are below:

- 0.4 s for E1 speed
- 0.5 s for T1 speed
- 1 s for 256 kbps
- 2 s for 64 kbps
- 3 s for 19.2 kbps.

Communications Rate and the Transmit Panel

In case of congestion, the data to be transmitted may be held up in the outbound queue before it is transmitted over the line. The time elapsed in the queue should be taken into consideration when calculating the overall round trip delay that is used to define the T1 timer. See FRTE Resources (LOCALTO or T1TIMER in LINE Statement) on page 119.

For FRTE, the burst of data at each transmission opportunity (n * DATABLK) should be at least as large as the average amount of data transmitted in a panel (MAXOUT * average frame size).

Note: If XID2 or XID3 is used, MAXOUT is taken from the XID field defined as the maximum number of I-frames that can be received by the XID sender before an acknowledgment is sent.

For type 1 and type 2.0 nodes that do not send XID3s, MAXOUT is taken from the VTAM PU statement.

Communications Rate Coherence across the Network

The bandwidth allocated to a permanent virtual circuit (PVC) should be the same all along the PVC, that is, for a given PVC, the portion of the bandwidth allocated to the PVC all along the path, (n / Sum (*n*))*SPEED, must be the same on each transmitting leg of each hop.

For example, take a congested line with a speed of 19.2 kbps and two DLCIs defined, the first DLCI with n = 2 and the second with n = 3. If DATABLK = 1000, the first DLCI will be allowed 2000 bytes (16 000 bits) and the second DLCI will be allowed 3000 bytes (24 000 bits) out of the next 5000 bytes to be sent.

3746 Frame-Relay Tuning Recommendations

Frame-Relay Port: DLC Parameters

When the line adapter of the partner controller is experiencing a high rate of overrun errors, code `YES` for the Interframe gap (ADDIFG). This increases the gap between frames (that is, the number of flags sent between frames), and decreases the frame transmit rate.

Frame-Relay LMI Parameters

LMI Mode, ANSI versus ITU-T: Be sure to define the same LMI mode in the 3746 and in the partner attached equipment. The attached equipment may not have the same default mode as the 3746, which is ITU-T (ITU-T was previously CCITT).

LMI Echo: This is a unique feature of the 3745 and the 3746. If you are connected to any other equipment other than a 3745 or a 3746, you must keep the default value, which is `Neither`.

LMI Timers: When you do not use the default values you must code t392 on one side higher than t391 on the other side. A recommended ratio is 1.5 between them, such that:

$t392 = 1.5 \times t391$.

Maximum Number of DLCIs: It is important to code the actual maximum number of DLCIs that are used on this interface when attaching devices that only support the LMI User to Network Interface (UNI) such as the IBM 2210, 2216, or 3174. When attaching devices that only support UNI LMI, the 3746 sends a PVC full status message each time the DTE polls the 3746 with a full status inquiry. If the maximum number of DLCIs is specified too high, the PVC full status message is too long and wastes the bandwidth.

Direct Connection with a Router: When there is no intermediate network for the LMI on the 3746-9x0 side, we recommend coding the LMI as *NUI*, which in turn forces *orphanage off* for both the 3746-9x0 and the router. Remember that orphanage off will require explicit DLCI definitions. The directly connected router should have orphanage off. If the router can not turn orphanage off we should take care to code a minimum number of DLCIs for this connection. This can be done using the MAXDLCI.

Frame-Relay Frame Handler Interface: When the 3746-9x0 functions as a frame handler, we recommend coding the LMI as *adoptive* and specifying *orphanage on*.

Frame Handler and Direct Connection: When the 3746-9x0 functions both as a frame handler as well as direct connection, we recommend coding the LMI as *NUI*, which forces *orphanage off*. The remote can have orphanage on; this is a designer choice.

Frame-Relay DLCI/COMRATE Parameters

Communication Rate: The 3746 9x0 applies a congestion control mechanism called *communication rate* (CR) for both NCP and NNP resources during transmission.

The communication rate function in the 3746 allows you to prioritize stations on a physical link. When the available transmission bandwidth is fully used, the CR allows each station to have a guaranteed portion of the physical link bandwidth.

A numeric value (*n*) is assigned to each station. This value represents the number of transmission units, defined by `DATABLK`, sent for this station at each of its transmit opportunities when the link is congested. By assigning different (*n*) values to different stations, if the bandwidth is totally used the station with higher (*n*) values will use more of the available bandwidth than the other stations.

`DATABLK` is defined in the Frame-Relay Port-DLC Parameters panel. The numeric (*n*) value per station is defined in the Frame-Relay DLCI Parameters panel in CCM. The value defined for APPN/HPR is applicable to each APPN/HPR or SNA (DLUR) station of the DLCI. The value defined for IP is applicable to all IP traffic over the DLCI.

Notes:

1. When a frame larger than `DATABLK` is sent and n = 1, the frame is not segmented before being sent. For example, if `DATABLK = 500` and a one kilobyte frame is sent, the DLCI is serviced as if n = 2.
2. When there is less than `n * DATABLK` in a queue, the 3746 will send what is queued for this station if the panel permits. The 3746 does not wait for the amount of data queued for this station to reach `n * DATABLK` before sending data.
3. For NCP/VTAM, the range for COMRATE is 1 to 64, which means:

   ```
   COMRATE (BYTES) = (1 to 64) * DATABLK
   ```

   In the CCM, the value for COMRATE is shown and set in bits, this means:

   ```
   COMRATE (bits) = (1 to 64) * DATABLK * 8
   ```

   This explains why the default value in the CCM panel is set to 16384 bits (default DATABLK=2048 bytes * 8).

Communication Rate Value Recommendations: The following factors influence the Communication Rate value used:

Line Speed

There is a relation between the:

- Line speed of a physical port (SPEED)
- Number of DLCIs and stations defined on this port
- Communication rate (CR) defined for each station.

In case of congestion, the 3746 will transmit, for each station. the number of bytes defined by CR with a round-robin service mechanism.

This means that the maximum time elapsed between each opportunity to send a CR for a station is the total time required to send one CR for every station:

```
(Sum (n*DATABLK)) * 8 / SPEED)
```

This value represents the maximum duration taken to send a CR for a given station when all the stations are exceeding their share of the bandwidth. It is the time the CR burst may wait in a node on a busy transmitting line and must not exceed t seconds. This value must be lower than 0.4 s for high-speed lines, 1.5 s for medium-speed lines, and must never exceed 3 s for low-speed lines.

Transmit Panel

In case of congestion, data to be transmitted may be held up in the outbound queue before it is transmitted over the line. The time elapsed in the queue should be taken into consideration when calculating the overall round trip delay that is used to define the T1 timer. See “Frame-Relay DLC Parameters for FRTE Stations” on page 126.

For FRTE, the burst of data in each transmission (`n * DATABLK`) should be at least as large as the average amount of data transmitted in a panel (`MAXOUT * average frame size`):

(n * DATABLK) ≥ (MAXOUT * average frame size) `MAXOUT` is defined as the maximum number of I-frames that can be received by the XID sender before an acknowledgment is sent.

To give priority to the DLCIs that transport interactive traffic over DLCIs that transport batch traffic, it is recommended that you assign:

- High panels (10 to 20) and high `COMRATE` to interactive traffic
- Small panels (3 to 6) and small `COMRATE` to batch traffic.

Notes:

1. If XID3 is used, the 3746 uses whichever is the lowest `MAXOUT`, either the value received in the XID3 or defined in the configuration file by the CCM.

   The 3746 will set the field of the transmitted XID3 to the value of `MAXIN` defined by the CCM.

2. For type 1 and type 2.0 nodes that do not send XID3s, `MAXOUT` is taken from the CCM FRTE Station-DLC Parameters 2/2 dialog panel.

MAXFRAME and DLCIs

- It is recommended that MAXFRAME be set at no more than 2 kbps for reasons of congestion control and CRC effectiveness. This is set at the line level. When LMI is enabled, LMI exchanges require 5 bytes per DLCI. Thus, MAXFRAME/5 provides another limit on the number of DLCIs per physical line. (Because there is other data in the LMI exchange, this number should be further reduced by 5.)

- CLP level constraints suggest that 500 DLCIs should be an upper limit for the physical frame-relay lines they support.

- In NUI LMI configurations, MAX_DLCI can be used to limit the number of DLCIs, since each DLCI contributes to full status exchanges and I_ARP traffic.
- The burst of data in each transmission (`n * DATABLK`) is recommended to be at least four times as large as `MAXFRAME` in order for the communication rate mechanism to work when there is congestion.

Communication Rate Coherence across a 3746 Network: The bandwidth allocated to a permanent virtual circuit (PVC) should be the same all along the PVC, that is, for a given PVC the portion of the bandwidth allocated to the PVC all along the path ((n / Sum (*n*)) * Speed) must be the same on each transmitting leg of each hop.

For example, take a congested line with a speed of 19.2 kbps and two DLCIs defined, the first DLCI with n = 2 and the second with n = 3. If `DATABLK = 1000`, the first DLCI will be allowed 2000 bytes (16 000 bits) and the second DLCI will be allowed 3000 (24 000 bits), so that each will get its proportional use of the physical line.

Frame-Relay DLC Parameters for FRTE Stations

T1TIMER: `T1TIMER` specifies the T1 reply timer, for example, the time a 3746-950 FRTE will wait to receive the acknowledgment for the frame sent to its FRTE partner. When coding the T1 timer, the time taken by a frame to reach the remote partner and the time taken for the reply to come back must be taken into account. This time is the round trip delay and is mainly dependent on:

- The speed of the lines on each hop
- The number of hops to reach the partner
- The level of congestion that can create queuing in the transiting nodes

Therefore, the minimum value to code is twice the time taken by a frame of an average size to be transmitted from the 3746 that you are defining to the FRTE partner.

For example, for an average frame size of 256 bytes, a speed of 19.2 kbps, and a path with two hops (FRTE to intermediate FRFH and FRFH to FRTE), the minimum transmit time is:

$(256 \times 8) \div 19200) \times 2 = \text{approximately } 0.2 \text{ seconds}$

In addition, you may assume an average queue of four frames in the sending FRTE and the intermediate FRFH (transit node). This means an overall transmit time of:

$0.2 + (4 \times 0.2) = 1 \text{ second.}$

Therefore the time taken to send a frame and receive the reply is 2 seconds. To take into account additional queueing during peak periods and prevent useless retries, use three times this value (for example use a `T1TIMER` of approximately 6 seconds).

RETRIES: The total number of times that a frame can be sent is $(m + 1) \times (n + 1)$.

The corresponding total time that can elapse before using all of the retries is $(m \times (n + 1) \times \text{T1TIMER}) + (n \times t)$ where:

- *m* = the number of retries per retry sequence
- *n* = the number of retry sequences
- *t* = the pause between retry sequences.

T2TIMER and N3: These parameters permit the delay of sending isolated RR (Receiver Ready). An RR is sent either when the T2TIMER elapses or when n3 frames have been received. In the meantime, when the traffic is not uni-directional there is a high chance that the acknowledgment is sent within a data frame (802.2 “piggybacking”). When you decrease the number of isolated RRs, less CLP processing power is required to handle the 802.2 LLC and the line utilization is better.

Notes:

1. T2 and n3 are recommended for file transfer.
2. Caution should apply when using T2 and n3 when there is interactive traffic because the response time may be degraded.

IP over Frame-Relay Parameters

Orphanage is *disabled* when LMI=NO. When the attached router is directly connected and supports only the LMI user side, then LMI should be set to NUI, which in turn disables orphanage.

VTAM DLCADDR for Frame-Relay DTE

When the frame-relay DTE connection with a dependent PU is initiated from VTAM, the following connection parameters must be defined in the VTAM Path definition statement by the DLCADDR keyword. Refer to the *VTAM Resource Definition Reference* for the syntax.

A frame-relay connection for an SNA peripheral resource has these elements:

1. DLC type: FRPVC
2. Port name
3. DSAP (destination service access point)
4. DLCI (data link connection identifier of the FR PVC)
5. SSAP (source service access point)
6. Destination MAC address (if BAN attached)

Code a DLCADDR keyword for each element as following the syntax:

```
DLCADDR=(subfield_id,type,string)
```

The procedure to set the SNA peripheral resources follows:

Step 1. To specify a frame-relay DLC type, code:

```
DLCADDR=(1,C,FRPVC)
```

Step 2. Identify the port name of the frame-relay physical line:

```
DLCADDR=(2,I,portname)
```

where `portname` is the port name defined in CCM. The 3746 NN expects the port name in ASCII. The ASCII type is indicated by I and requires:

- For VTAM V4 R2, PTF UW28497
- For VTAM V4 R3, PTF UW28498.

Step 3. To specify the DSAP, code:

```
DLCADDR=(3,X,hh)
```

where hh is the SAP of the remote frame-relay device in hexadecimal. The value must be even, in the range X'02' to X'FE'.

Step 4. To specify the DLCI of the frame-relay PVC, code:

```
DLCADDR=(4,D,nnn)
```

or

```
DLCADDR=(4,X,hhh)
```

where nnn and hhh are the local DLCI number of the remote frame-relay device in decimal and hexadecimal respectively. The value must be in the range of 16 to 991 in decimal, that is, X'10' to X'3DF' in hexadecimal.

Step 5. To specify the SSAP, code:

```
DLCADDR=(5,X,hh)
```

where hh is the SAP of the source NNP in hexadecimal. If you choose to specify the source SAP, the value must be the same as the local SAP defined for the frame-relay port - DLC parameters.

Step 6. To specify the destination MAC address for the BAN, code:

```
DLCADDR=(6,X,hhhhhhhhhhhh)
```

where hhhhhhhhhhhh is the destination MAC address of the BAN attached peripheral device on the LAN which connects it to the remote BAN router. The range is from X'1' to X'7FFFFFFFFFFF'.

For example, suppose you need to make outgoing connections from DLUS to a device using a frame-relay PVC with a DLCI of X'20' and a DSAP of 8 on the port name FRP001. If the connection is with BAN, code:

```
DLCADDR=(1,C,FRPVC)                 Frame-relay PVC
DLCADDR=(2,I,FRP001)                Port name
DLCADDR=(3,X,08),                   DSAP=8
DLCADDR=(4,D,32)                    DLCI=32
DLCADDR=(6,X,400000071088)          Remote MAC address.
```

Note that the SSAP need not be coded, as the frame-relay port local SAP will be used.

LMI T391 and T392 Timers

The T391 timer on the user side must be lower than the T392 timer on the network side. A good ratio is T392 = 1.5xT391.

Note: NCP decides on the user and/or network side support dynamically. The NCP defaults are T391 = 10s and T392 = 15. These are usually adequate; however, they should be checked when connecting remote NCPs via frame relay.

Frame-Relay 802.2 Values

The following describes the 3746 support for setting 802.2 timers for frame-relay connections.

802.2 parameters can be set for stations individually. These values are used when the 3746 established dial-out connections. For dial-in connections, the 3746 uses hard-coded values. These values are listed below (timer values are in tenths of a second):

```
rsap                  = 0x04;
retrans_t1_timer      = 0x20;

ack_wait_t2_timer     = 0x00;

inact_err_ti_timer    = 0x60;
xmit_panel_cnt        = 0x08;
receive_panel_cnt     = 0x01;

max_retry_count       = 0x10;

second_level_retry    = 0x00;

pause_between_retry   = 0x00;

rnr_limit             = 0x708;
infinit_retry         = 0x01;
hpr_sap_value         = 0x04;

hpr_timer_t1          = 0x06;
hpr_timer_ti          = 0x30;
hpr_max_retry_count   = 0x03;

panel_increment       = 0x04;

panel_dec_for_cgst    = 0x01;

panel_dec_for_lost    = 0xFF;

discard_eligibility   = 0x01;
echo_defeat           = 0x00;
pu_type               = PUTYPE_2_0;
```

File Transfer with IP over Frame Relay

For the best possible throughput for file transfer over IP connections, use the CCM to specify a maximum BTU, or maximum IP transmission unit greater than the default value of 2052. This should take into account the transmission quality of the lines that will be traversed.

PPP Performance Tuning

Use CCM to increase file transfer speed using IP over PPP. Specify a maximum IP transmission unit (MTU) greater than the default value of 2052, according to the transmission quality of the lines.

X.25 Performance and Tuning

Note: This section applies only to X.25 ODLC and NPSI ODLC.

Operating Modulo 8 and Modulo 128 Lines

Make sure the frame level Panel Size parameter is set to 7 for modulo 8 lines, or more for the modulo 128 lines, if possible. Otherwise, you may limit the number of non-acknowledged transmitted frames to less than these lines are capable of handling.

Line Utilization

The X.25 lines attached to a 3746-900 can be used at media speed. This means that:

- The CLP can send frames separated by only a single flag when the data rate coming from the CCU is high.
- The CLP can receive frames at the line speed and is not subject to overrunning the input buffer, as happens for the 3745 LSS and HSS adapters. There are enough input buffers to receive one complete panel of frames. When the CCU or CLP cannot handle the rate, normal X.25 flow control at the PLP level can lower the pace of the partner as necessary.

CCU Utilization for X.25 ODLC

The CCU utilization is independent of the speed and the active parameter definitions of the X.25 lines. The CCU is only able to process a certain number of PIUs. The same amount of traffic, whether over four X.25 ODLC lines running at 64 kbps or over a single X.25 ODLC line running at 256 kbps, loads the CCU almost the same amount.

CCU Utilization for X.25 Lines (ODLC and NPSI)

An application builds messages that are called request/response units (RUs). These RUs are then packaged in a physical information unit (PIU). When the PIU is larger than the partner maximum received basic transmission unit (BTU) size, the PIU is segmented by NCP into PIU segments. These PIU segments are then packaged in X.25 packets and finally an X.25 frame that contains one packet is sent. When the PIU segment is larger than the packet size, the PLP layer splits the segment into smaller packets.

To decrease CCU and CLP utilization you may:

1. Use the exception response mode that creates the least number of responses when it is supported by the destination application.
2. Increase the pacing panel sizes, or work with no pacing when possible.
3. Use the largest segment size that the partner devices support, for example, 521 or 1033. This is either defined in `MAXDATA` or received in XID3.
4. Fit an RU into a PIU.
5. Fit a PIU into a packet.
6. Use the largest packet size possible, for example 512 or 1024.
7. Increase packet panel size above 2 and code `PLPIGGYB=YES` in the X25.MCH definition statement.

Table 23 on page 131 shows which items in the above list are the most important for tuning the CCU and CLP hardware running the two different implementations of X.25 lines.

Table 23. CCU and CLP compared to ODLC and NPSI Lines		
Type of X.25 Line	**CCU**	**CLP**
ODLC	1,2,4,5	3,4,6,7
NPSI	1,2,3,4,5,6,7	-

For example, peripheral devices using an RU size of 480 gives an FID2 PIU of 489 bytes. If you use a packet size of 512, the initial data from the application will not be segmented into SNA PIU segments and will not be segmented into X.25 packets. This lack of segmenting reduces the CCU overhead.

Segmentation Example

The following example of SNA segmentation is shown in Figure 55:

- The application RU is 600 bytes.
- `BFRS = 240` (NCP buffer size)
- `MAXDATA = 521`
- The PIU of 609 bytes therefore occupies three NCP buffers.

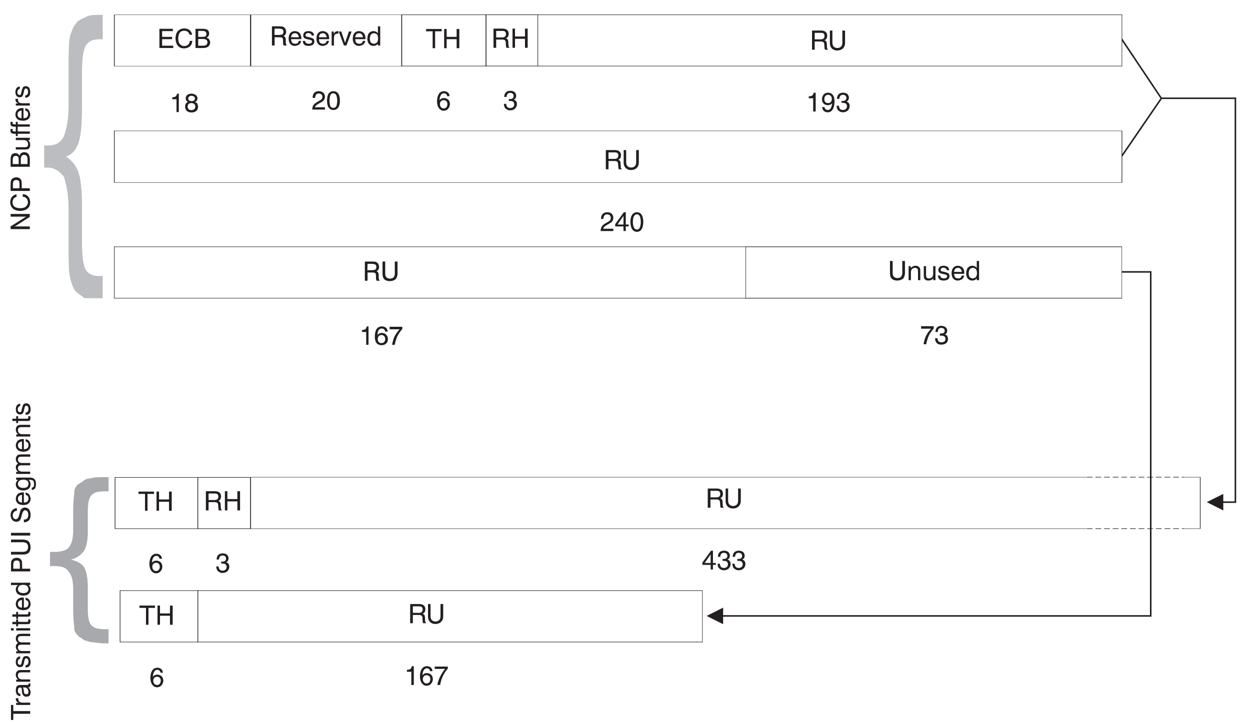


Figure 55. NCP Segmentation Example

Legend:

ECB Event control block
RH Request/response header
RU Request/response unit
TH Transmission header

Before transmission, NCP divides the 609 byte PIU (600 bytes for the RU and 9 bytes for the TH/RH) into two PIU segments. Each segment contains a whole (integer) number of buffers. The RU data is not moved, that is, the NCP buffers are not broken up so that the PIU segments can be filled up to their maximum of MAXDATA.

This is done in the following manner:

- The first segment PIU is built with as many buffers as possible while leaving the segment less than or equal to MAXDATA bytes long. In this example, the first segment length is TH + RH + RU, which equals 442 bytes:
  RU = 193 + 240 = 433, TH = 6 bytes, and RH = 3 bytes.
- The second segment is built with the remaining RU data + TH, which equals 173 bytes:
  RU = 167, TH = 6 bytes.

  If necessary, the PIU segments are adjusted according to the X.25 packet size. The number of actual packets sent depends on the X.25 packet size:

  – If the X.25 packet size is 128:

    - The first segment is split into four packets: 3 of 128 bytes and 1 of 58 bytes.

    - The second segment is split into two packets: 1 of 128 bytes and 1 of 45 bytes.

    Thus six data packets are sent.

  – If the X.25 packet size is 256:

    - The first segment is split into two packets: 1 of 256 bytes and 1 of 186 bytes.

    - The second segment is not split: 1 packet of 173 bytes.

    Thus three data packets are sent.

  – If the X.25 packet size is 512 or above, each PIU segment will be sent in a single packet.

    Thus only two data packets are sent.

  For the same sized application RU, as the number of X.25 packets used decreases, the amount of CCU and CLP resources (time and memory) used to transmit data decreases.

NNP-Controlled Line Tuning

Note: Proper operation of the 3746-9X0 requires correct setting of the CCM parameters.

There are parameter values that need to be changed when moving lines from a 3745 adapter to a CLP.

When making line definitions, this section must be used.

Proper tuning optimizes the performance of the CLP and related lines. This section gives recommendations to increase the throughput and reduce the response time over SDLC links.

CCM Definitions for SDLC Links

The CLP handles the data link control (DLC) for the lines connected to the 3746 Network Node. Proper tuning has to be done to optimize the performance of the SDLC links after line migrations from the 3725/3745 to the 3746.

In the following sections the following format is used:

Parameter name (CCM panel name)

For All Link Configurations

- **Poll pause (SDLC Port - DLC Parameters 3/3 panel)**

  As polling takes up a large part of the CLP processing power, the Poll pause value has to be used judiciously. A compromise has to be reached between the response time and the non-productive polling. This must take into account all the resources of a CLP. If the interactive transaction rate is low on the link, reduce the Poll pause value in order to obtain an acceptable response time.

For Point-to-Point Links

- **Transmit-Receive Capability (SDLC Port - DLC Parameters 1/3 panel)**

  Like NCP, a CLP can provide outbound and inbound services concurrently for an active secondary station. For a duplex line, select Full duplex

- **Full duplex data (SDLC Station - DLC Parameters 1/2 panel)**

  To take advantage of the duplex line and the point-to-point environment, select Yes.

- **Modulo'?' (SDLC Station - DLC Parameters 1/2 panel)**

  It is recommended that the value of Modulo must be selected according to the values of Maximum transmitted frames before acknowledgment sent (MAXOUT) and Maximum number of frames (PASSLIM):

  - For MAXOUT and PASSLIM values up to 7, use MODULO = 8
  - For MAXOUT and PASSLIM values up to 127, use MODULO = 128.

- **Maximum number of frames (PASSLIM) (SDLC Station - DLC Parameters 1/2 panel)**

  PASSLIM is only relevant for multipoint lines. However, for point-to-point lines, it should be coded at its maximum value: PASSLIM=254. This will save CLP cycles by eliminating the checking at the end of each `PASSLIM` sequence of frames.

For Multi-Point Links

- **Transmit-Receive Capability (SDLC Port - DLC Parameters 1/3 panel)**

  Like NCP, a CLP can provide outbound services to one physical unit (PU) while performing inbound services for a second PU.

  In a multi-point environment, the Transmit-Receive Capability may be defined as Yes for duplex even if the peripheral PUs or nodes are not capable of duplex operation. This is the case for IBM 3174 controllers that are performing as token-ring gateways when the B or C code level is used, but not if the A or S level is used.

- **Full duplex data (SDLC Station - DLC Parameters 1/2 panel)**

Since the CLP cannot perform the outbound and inbound services for two different PUs at the same time, the secondary stations have to be defined as half-duplex. The Transmit-Receive Capability is defined as `No` for half-duplex.

- **Maximum number of frames (PASSLIM) (SDLC Station - DLC Parameters 1/2 panel)**

  If the value of PASSLIM for one secondary station is much greater than those of the other secondary stations, the response times for the other users might be affected.

  However, if a user needs to transfer a large file (for example, a graphic image) all at once, the PASSLIM value should be large enough to allow sending all the necessary PIUs for the file at one time without service slicing.

Maximum BTU Size

The maximum basic transmission unit (BTU) size supported by the 3746 Network Node is 8000 bytes. For SDLC links, the CCM parameters Maximum received PIU size and Maximum sent PIU size in the Port Configuration - APPN Configuration panel of the CCM should be set to 8000 bytes if possible.

The value of the send and receive PIUs (BTU size) should be the maximum value of 8000 bytes since it has the least amount of overhead due to frame headers.

Chapter 7. 3746 SDLC Support

This chapter covers VTAM DLCADDR keyword sets that should be used for SDLC-dependent LU/PU traffic, recommendations when migrating SDLC lines from a 3745 to the 3746.

VTAM DLCADDR Keyword for SDLC Leased Line (3746 APPN/DLUR)

Refer to the "APPN / HPR Overview" chapter in the *3745/3746 Planning Series: Protocols Description*, GA27-4241, for a list of possible VTAM DLCADDR keyword coding formats.

You must have SDLC switched major node definitions in VTAM, even if you are using leased lines. The SDLC data link control information for a peripheral resource controlled by the 3746 NN (DLUR) on a leased line has the following elements:

- DLC type=SDLCNS
- Port name
- Secondary SDLC address.

The DLCADDR keywords are coded as follows:

Step 1. Specify the SDLC type of non-switched:

```
DLCADDR=(1,C,SDLCNS)
```

Step 2. Identify the name of the SDLC port where the peripheral resource is attached:

```
DLCADDR=(2,I,port_name)
```

where port_name is the port name defined in the CCM in alphanumeric characters.

Step 3. Specify the secondary station SDLC address:

```
DLCADDR=(3,X,hh)
```

where hh represents the secondary station SDLC address. DLUR is always primary to its downstream link stations.

See the VTAM switched major node examples on page 136.

SDLC switched major node for a VTAM DLUS triggered activation over a leased line example:

```
***************************************************************
*   SWITCH MAJOR NODE FOR DLUR/DLUS                           *
*   --> SDLC LEASED LINES MUST HAVE A VTAM DEFINITION         *
*       ( PUS AND LUS)                                        *
*       (IN THIS CASE NO MORE NCP DEFINITION)                 *
*                                                             *
***************************************************************
B8DU2240 VBUILD TYPE=SWNET,MAXDLUR=3
*-------------------------------------------------------------*
* SDLC LINE 2240                                              *
*-------------------------------------------------------------*
PU224000 PU    ADDR=01,                                       X
               NETID=SYSTSTAP,                                X
               IDBLK=05D,                                     X
               IDNUM=22400,                                   X
               MAXDATA=265,                                   X
               DISCNT=NO,                                     X
               MAXPATH=2,                                     X
               ISTATUS=ACTIVE
*
PATH2240 PATH  PID=1,                                         X
               DLURNAME=NNBS8,                                X
               DLCADDR=(1,C,SDLCNS),                          X
               DLCADDR=(2,I,DL2260NS)
               DLCADDR=(3,X,01)
LU224000 LU    LOCADDR=02,PACING=1,VPACING=1
*-------------------------------------------------------------*
```

SDLC switched major node for DLUR triggered activation over a leased line example:

```
***************************************************************
*   SWITCH MAJOR NODE FOR DLUR/DLUS                           *
*   --> SDLC LEASED LINES MUST HAVE A VTAM DEFINITION         *
*       ( PUS AND LUS)                                        *
*       (IN THIS CASE NO MORE NCP DEFINITION)                 *
*                                                             *
***************************************************************
DL2624L3 VBUILD TYPE=SWNET
*-------------------------------------------------------------*
* SDLC LINE 2624                                              *
*-------------------------------------------------------------*
PU262400 PU    ADDR=01,                                       X
               IDBLK=05D,                                     X
               IDNUM=26240,                                   X
               MAXDATA=265,                                   X
               DISCNT=NO,                                     X
               ISTATUS=ACTIVE
*
LU262400 LU    LOCADDR=02,PACING=1,VPACING=1
*
*-------------------------------------------------------------*
```

VTAM DLCADDR Keyword for SDLC V.25 Switched Line

The SDLC data link control information for a peripheral resource controlled by the 3746 NN (DLUR) on a V.25 bis switched line has the following elements. These elements *must* be specified in the following order:

- DLC Type=SDLCSW
- Port name
- Secondary SDLC Address
- DLC Type=V25BIS
- V.25 bis command and address string.

Step 1. Specify the SDLC type of switched line:

```
DLCADDR=(2,I,SDLCSW)
```

Step 2. Identify the name of the port where the V.25 bis modem is attached:

```
DLCADDR=(2,I,port_name)
```

where port_name is the port name defined in the CCM in alphanumeric characters.

Step 3. Specify the secondary station SDLC address:

```
DLCADDR=(3,X,hh)
```

where hh represents the secondary station SDLC address. DLUR is always primary to its downstream link stations.

Step 4. Specify the DLC type of V25 bis:

```
DLCADDR=(1,C,V25BIS)
```

Step 5. Identify the same port name as above:

```
DLCADDR=(2,I,port_name)
```

Step 6. Specify the composite command and address string used to pass dialing information to the modem:

```
DLCADDR=(5,C,CRx:nnnnn)
```

The value is a three-character bis command followed by those addresses, separators and special characters that are appropriate for that command. Any character that is acceptable by the V.25 bis modem being used may be included in this value. No reordering of this signalling information is made before passing it to the modem.

See the VTAM switched major node examples on page 138.

SDLC switched line major node for call-out over switched line example: (See the “APPN / HPR Overview” chapter in the *3745/3746 Planning Series: Protocols Description* for a list of possible coding formats.)

```
***************************************************************
*   SWITCH MAJOR NODE FOR DLUR/DLUS ON NNBS8 MACHINE          *
*   --> SWITCHED LINES MUST HAVE A VTAM DEFINITION            *
*       ( PUS AND LUS)                                        *
*                                                             *
*    NNBS8: SDLC LINES 2263 TO 22..                           *
*    ----                                                     *
***************************************************************
B8DLSW07 VBUILD TYPE=SWNET,MAXDLUR=8,MAXNO=50
*-------------------------------------------------------------*
* SDLC LINE 2266                                              *
*-------------------------------------------------------------*
PU224000 PU    ADDR=01,                                       X
               NETID=SYSTSTAP,                                X
               IDBLK=05D,                                     X
               IDNUM=22660,                                   X
               MAXDATA=265,                                   X
               DISCNT=NO,                                     X
               MAXPATH=2,                                     X
               ISTATUS=ACTIVE,                                X
               DYNADJCP=YES,                                  X
               PUTYPE=2

*
PATH2266 PATH  PID=1,                                         X
               DLURNAME=NNBS8,                                X
               DLCADDR=(1,C,SDLCSW),                          X
               DLCADDR=(2,I,DL2263SW),                        X
               DLCADDR=(3,X,01)                               X
               DLCADDR=(1,C,V25BIS),                          X
               DLCADDR=(2,I,DL2263SW),                        X
               DLCADDR=(5,C,CRN:T307100),REDIAL=2
LU226600 LU    LOCADDR=02,PACING=1,VPACING=1
LU226601 LU    LOCADDR=03,PACING=1,VPACING=1
LU226602 LU    LOCADDR=04,PACING=1,VPACING=1
LU226603 LU    LOCADDR=05,PACING=1,VPACING=1
LU226604 LU    LOCADDR=06,PACING=1,VPACING=1
*-------------------------------------------------------------*
```

Migrating Lines from the 3745 to the 3746

This section shows the main architecture differences between the 3745 and the 3746.

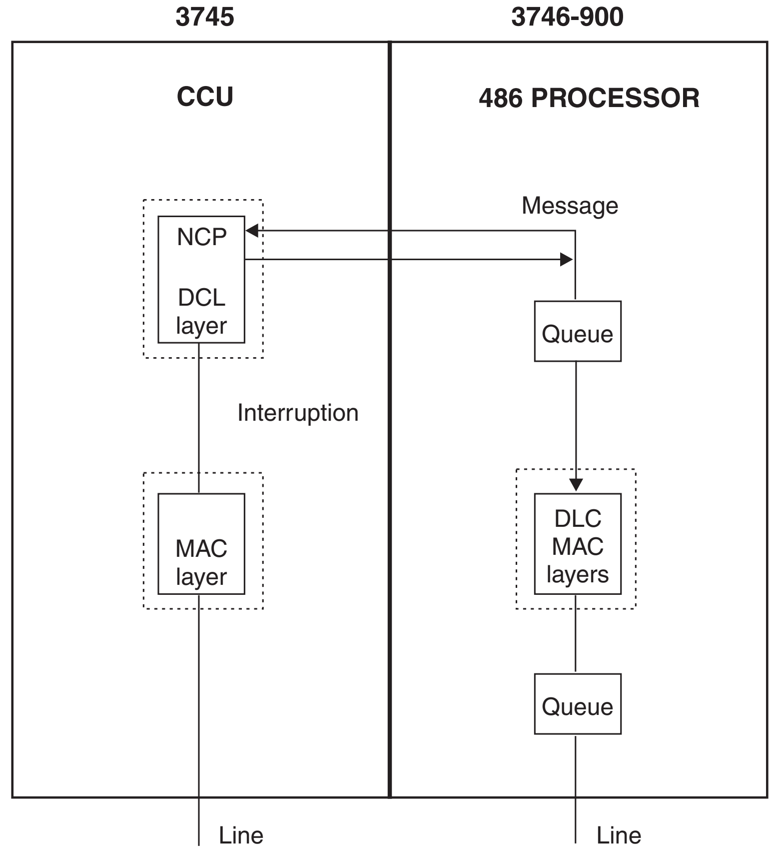


Figure 56. Architecture Differences between 3745 and 3746

DLC Layer

On the 3746, the DLC layer runs on a separate processor to the NCP. This difference allows the 3746 to be faster than the 3745 in handling the protocol, and to transmit and receive data. This reduces the NCP load.

Outbound Flow

On the 3745

The DLC layer takes CCU cycle time to answer the protocol. This means NCP is waiting for a MAC acknowledgment before sending data on the line. It must complete this action prior to processing the next burst of data.

On the 3746

A message up to MAXOUT or PASSLIM is put in a hardware queue. When the code transmits data, up to the full MAXOUT/PASSLIM can be put on the line.

Consequences

When the data is in this hardware queue, it is not possible to change the value of the Ns (transmit sequence value) or Nr (receive sequence value). This architecture gives a different flow between the 3745 and 3746. This can be handled by adjusting the poll pause timer.

Inbound Flow

On the 3745

The MAC layer is dispatched on a fixed number of bytes received. So for an input message (from the line), the DLC/NCP layer is interrupted more than one time.

On the 3746

The hardware handles the complete reception of a message. So for the same message the 3746-900 microcode is dispatched once and NCP is interrupted only once.

Consequences

The 3746 is much faster than the 3745 on protocol management. Therefore, data is received at NCP at a faster rate from the 3746 than from the 3745.

DLC Protocol Management

The 3745 and the 3746 manage the SDLC protocol in the same way. The only difference is that the 3746-900 SDLC does not support the Service Order Table (SOT). This is now handled as the Service Order Chain (SOC) in the CLP.

For example, for NCP generation:

Service order = (S1, S2, S3, S1, S1, S1, S1, S2).

This results in the following polling sequence:

3745-Line : S1, S2, S3, S1, S1, S1, S1, S2
3746-Line : S1, S2, S3, S1, S2, S1, S1, S1.

In other words, the 3745 polls as the service order, while the 3746 assigns a polling weight according to the number of times a station is defined in the service order. If no service order is defined, the default value of one is used.

In the previous example:

S1 has a weight of 5.
S2 has a weight of 2.
S3 has a weight of 1.

General Consequences Related to NCP Tuning

When migrating lines from the 3745 to the 3746-9X0 it may be necessary to tune certain parameters in NCP. This is to ensure the same behavior for connected lines. The main parameters that need to be taken into account are:

ADDIFG, MAXOUT, PAUSE, REPLY, PASSLIM and the SOT.

Interframe Gap Tuning

- **Interframe gap (ADDIFG in the LINE statement)**

  When the line adapter of the partner DTE is experiencing a high rate of overrun errors, code:

  ```
  ADDIFG=YES
  ```

  This increases the gap between transmitted frames and decreases the frame rate.

NCP Definitions for Externally Clocked Lines

- **Line Speed (SPEED in the LINE Statement)**

  Refer to the NCP Version 7 *Resource Definition Reference* publication that corresponds to your release of NCP.

  For lines connected to the 3745 base unit or 3746 Models L13, L14, and L15, externally clocked lines (CLOCKING=EXT: in the NCP definition) do not require the SPEED keyword to be defined, unless NPM (NetView Performance Monitor) is used to monitor the line utilization, which is based on the SPEED value.

  For lines connected to the CLPs of the 3746-900, the SPEED keyword needs to be defined, whether the line uses external clocking (CLOCK=EXT) or provides clocking (CLOCKING=DIRECT). The line speed information is used as follows:

  – LIC11 line at speeds above 64 kbps (up to 256 kbps).

    The speed information is required by the CLP to scan only this line among the 3 or 4 addresses that are in the same LCB area. This allows the total scanning capacity of the LCB area (256 kbps[11]) to be dedicated to this line address.

    Notes:

    1. If the speed of an externally clocked line is changed, the SPEED. keyword value does not need to be modified, as long as the new line speed value stays in the same range (see Table 24 on page 142), and you are not using NPM for line statistics (see below).
    2. If you are not using NPM for line statistics (see below), you may define the SPEED keyword with the highest line speed that you expect to use.

  – Monitoring the line utilization.

    NPM needs the SPEED information to accurately determine the line statistics.

  – Direct clocking

    The CLP uses the SPEED information to provide correct clocking to the directly attached DTE.

  – External clocking

[11] Four lines at 64-kbps scanning capacity per line equals 256 kbps.

The CLP uses the SPEED information to verify that this speed is supported by the installed LIC (and ARC) type. Table 24 on page 142 shows the allowed LIC/ARC types depending on speed range.

Table 24. LIC and ARC Assemblies Line Speeds

LIC Type	Line Speed Range	ARCs
LIC11	From 600 bps up to 32 kbps	ARC V24 ARC V35 ARC X21
	Above 32 kbps up to 64 kbps	ARC V35 ARC X21
	Above 64 kbps up to 256 kbps (see note)	ARC V35 ARC X21
LIC12	From 256 kbps up to 2048 kbps	N/A

Note: There can be only one such active ARC in an LCB area of 3 or 4 slots, see "LCB Areas" on page 8.

NCP Definitions for SDLC Subarea Links (INN)

- **Polling Timer (PAUSE in the SDLCST or LINE Statement)**
- **Reply Timer (REPLYTO in the GROUP Statement)**

CLP efficiency may be negatively affected by improper settings of the PAUSE timer. A small value results in non-productive polling which abnormally loads the CLP, reduces the amount of CLP cycles available for the traffic processing, and therefore may reduce CLP and line throughputs. This is especially true for high-speed lines carrying small messages. The CLP efficiency can be easily improved by increasing the value of PAUSE parameter.

For a primary station, set the value between 0.5 and 1 second for both modulo 8 and modulo 128 operating lines:

```
PAUSE=(0.5,1)
```

For a secondary station, set a value between 1.0 and 2.0 seconds for both the modulo 8 and modulo 128 operating lines.

For the primary and the secondary stations, the value must be selected in conjunction with the Reply Timer (REPLYTO) of the primary station. The following general rule applies:

REPLYTO (primary NCP) must be greater than PAUSE (secondary NCP).

PAUSE (secondary NCP) must be greater than PAUSE (primary NCP).

An example based on the above recommendations:

```
REPLYTO (primary) = 1.1 second
PAUSE (secondary) = 1.0 second
PAUSE (primary)   = 0.5 second.
```

Large values of PAUSE for the secondary station may improve the data throughput from the secondary to the primary, without affecting the throughput in the other direction (from the primary to the secondary station).

Note: `PAUSE = 0` must not be used for the secondary station, as this would cause link performance degradation due to retransmissions and transmission delays.

For more information on the PAUSE operand, refer to the *NCP Resource Definition Reference* manual (Line Definition Statement).

- **Transmission Group Flow Control Thresholds (ER in the PATH Statement)**

  Code these threshold values as high as possible in the network. The maximum allowed values are the following:

  `ERn=(adjsa,tgn,448000,448000,448000,512000)`

  For more information on the Transmission Group Flow Control Threshold, refer to the *NCP Resource Definition Reference* manual (Path Definition Statement).

- **Virtual Route Pacing Window Size (VRPWSnm in the PATH Statement)**

  Code the Virtual Route Pacing Window size in the PATH statement definitions. These parameters have an important impact on response time through the network. Feeding a virtual route with a window size that is too small may result in detecting too quickly (and erroneously) node level congestion thus causing frequent interruptions during data transmission. For the links at speeds less than 64 kbps, code at least:

  `VRPWSnm=(10,30)`

  Increase these values for higher speeds: at 2 Mbps the maximum values are:

  `VRPWSnm=(128,255)`

  In order to further improve the response time, code the highest priority for n:

  `VRPWSn0` or `VRPWSn1`.

- **Blocking Factor (BLOCK in the PU Statement)**

  BLOCK, in the PU statement, can be used to improve the throughput of the SDLC subarea links and reduce the processing load of the CLP. NCP can support multiple path information units (PIUs) in SDLC frames when they are routed over transmission group links. This results in fewer inter-frame gaps per transmission than if the sender transmitted the PIUs in individual frames. BLOCK specifies the maximum frame size and the maximum number of PIUs per frame.

  If `BLOCK` is coded, NCP verifies that the sender of the format 2 XID supports PIU blocking. If not, NCP uses one frame per PIU. If the sender format 2 XID supports a smaller block size, NCP adjusts its block size to the XID value. A performance increase may be obtained when this parameter is coded.

  Code the blocking factors at each side of the transmission group links connecting two subarea nodes. The values recommended for BLOCK are:

  `BLOCK=(4096,16)`

  This means that each SDLC frame is up to 4096 bytes long and will contain up to 16 PIUs.

- **Transfer (TRANSFR in the LINE Statement)**

  TRANSFR defines the maximum number of buffers necessary to contain the maximum amount of data that NCP can receive in a single data transfer operation. If a channel adapter is being defined, it determines the maximum length PIU that the channel adapter will accept in a single data transfer operation.

Note: It is highly recommended to make the TRANSFR value the same for all lines in the same multi-link transmission group. Otherwise, there are problems with link activation.

For optimal CLP performance (line and machine throughputs), coding as high a value as possible is recommended. However, this TRANSFR must comply with the following two rules:

1. The TRANSFR value multiplied by the BFRS value minus 18 must match the value of MAXDATA in the PCCU definition statement.
2. The TRANSFR value must be less than or equal to the ratio:

   `((MAXBFRU x UNITSZ) - BFRPAD) / BFRS.`

For more information on the TRANSFR operand, refer to the *NCP Resource Definition Reference* manual (Line Definition Statement).

- **Maxout (MAXOUT in the PU and SDLCST Statement)**

  MAXOUT specifies the maximum number of information frames (I-frames) that an NCP sends over a line before requesting a response from the NCP of the adjacent subarea. At activation, an NCP informs the adjacent NCP of its MAXOUT. This value is used by the adjacent NCP as its transmit limit; it is the maximum number of frames the adjacent NCP will send before waiting for a response.

  If this NCP is the secondary NCP, the value used comes from the SDLCST statement with MODE set as:

  ```
  MODE=SECONDARY
  ```

  If this NCP is the primary NCP, the value used comes from the PU statement.

  A higher MAXOUT value improves link throughput. However, a higher value also causes more PIU re-transmissions if an error occurs. You might want to select a lower value for links with high error rates (or operating at a low speed) and a higher value for links with low error rates (or operating at a high speed).

  The maximum value for MAXOUT is 127.

  The optimal value depends on the number of active PUs connected to the CLP. This value corresponds to the maximum utilization of the CLP buffer storage, which is reached just before RNR (receive not ready) control frames are observed on the line. RNRs are sent by the flow control mechanism of the CLP to prevent the CLP from congestion.

- **Modulo (MODULO in the PU Statement)**

  MODULO must be selected according to the value of `MAXOUT`:

  – For MAXOUT values up to 7, use `MODULO=8`
  – For MAXOUT values from 8 to 127, use `MODULO=128`.

- **Link Transmission Group (TGCONF in the PU Statement)**

  TGCONF specifies whether a subarea link station is in a multilink or single-link transmission group (TG). The default is:

  ```
  TGCONF=MULTI
  ```

  To improve the performance of transmission groups that contains a single SDLC line (a single-link TG), code:

  ```
  TGCONF=SINGLE
  ```

NCP Definitions for SDLC Peripheral Links

The CLP (instead of NCP) handles the Data Link Control (DLC) for the lines connected to the 3746-900. Proper tuning has to be done to optimize the performance of the SDLC peripheral links after line migrations from the 3725/3745 to the 3746-900.

For All Peripheral Link Configurations

- **Polling Timer (PAUSE in the LINE Statement)**

  As polling takes up a large part of the CLP load, the PAUSE value has to be used judiciously. A compromise has to be reached between the response time and the non-productive polling. This must take into account all the resources of a CLP. If the interactive transaction rate is low on the link, reduce the PAUSE value in order to obtain an acceptable response time. For example, if PAUSE were 0.4 on the 3745 line, 0.1 is recommended for the 3746-900.

For Peripheral Point-to-Point Links

- **To have a Duplex Line (ADDRESS in the LINE Statement)**

  Like NCP, a CLP can provide outbound and inbound services concurrently for an active secondary station. To do this, code:

  `ADDRESS=(lnbr,FULL)`

- **To have a Duplex Station (DATMODE in the PU Statement)**

  In order to take advantage of the duplex line and the point-to-point environment, the physical unit has to be defined as:

  `DATMODE=FULL`

- **Modulo (MODULO in the PU Statement)**

  It is recommended that the value of `MODULO` be selected according to the values of `MAXOUT` and `PASSLIM`. Use for:

  - `MAXOUT` and `PASSLIM` values up to 7, use `MODULO = 8`
  - `MAXOUT` and `PASSLIM` values up to 127, use `MODULO = 128`.

- **Passlim (PASSLIM in the PU Statement)**

  `PASSLIM` is only relevant for multi-point lines. However, for point-to-point lines, it should be coded at its maximum value:

  `PASSLIM=254`

  This will save CLP cycles by eliminating the checking at the end of each `PASSLIM` sequence.

For Peripheral Multi-Point Links

- **Duplex Line (ADDRESS in the LINE Statement)**

  Like NCP, a CLP can provide outbound services to one physical unit (PU) while performing inbound services for a second PU.

  In a multi-point environment, the line may be defined as duplex:

  ```
  ADDRESS=(lnbr,FULL)
  ```

  even if the peripheral controllers are not capable of duplex operation. This is the case for IBM 3174 controllers which are performing as token-ring gateways when the B or C code level is used, but not if the A or S level is used.

- **Half-Duplex Station (DATMODE in the PU Statement)**

  Since the CLP cannot perform the outbound and inbound services for two different PUs at the same time, the secondary stations have to be defined as half-duplex:

  ```
  DATMODE=HALF
  ```

- **Passlim (PASSLIM in the PU Statement)**

  If the value of PASSLIM for one secondary station is much greater than those of the other secondary stations, the response times for the other users might be affected.

  However, if a user needs to transfer a large file (for example, a graphic image) all at once, the PASSLIM. value should be large enough to allow sending all the necessary PIUs for the file at one time without service slicing.

Chapter 8. ISDN Adapters

Note: The LIC16 ISDN adapter is no longer available from IBM. For information about the currently available ISDN adapters, refer to the *3745/3746 Planning Series: Multiaccess Enclosure Planning*, GA27-4240.

Integrated services digital network (ISDN) is an Open Systems Interconnection (OSI) protocol for digital telecommunications network, based on the 64-kbps circuit switched technology. ISDN supports multiple services including voice and data transmission. Some examples of devices that might have an ISDN interface are a digital telephone, an integrated digital voice or data terminal, and digital facsimile equipment. ISDN is advantageous for data transmission, when you do not need a constant, dedicated connection because you only pay for the duration of a call.

There are two ways to connect a 3746 Model 900 to an ISDN:

- Through the LIC16, which is a native ISDN adapter; see Chapter 1, “Serial Line Adapters” on page 1.
- Through a terminal adapter which is external to 3746 base frame; see “ISDN Terminal Adapter” on page 161.

The 3746-9x0 offers also the ISDN connectivity for non-NCP controlled traffic through the 3746 MultiAccess Enclosure (MAE). Refer to the “ISDN Support” chapter in the *3745/3746 Planning Series: Multiaccess Enclosure Planning*, GA27-4240.

Figure 57 on page 148 shows how NCP controlled traffic can access ISDN networks.

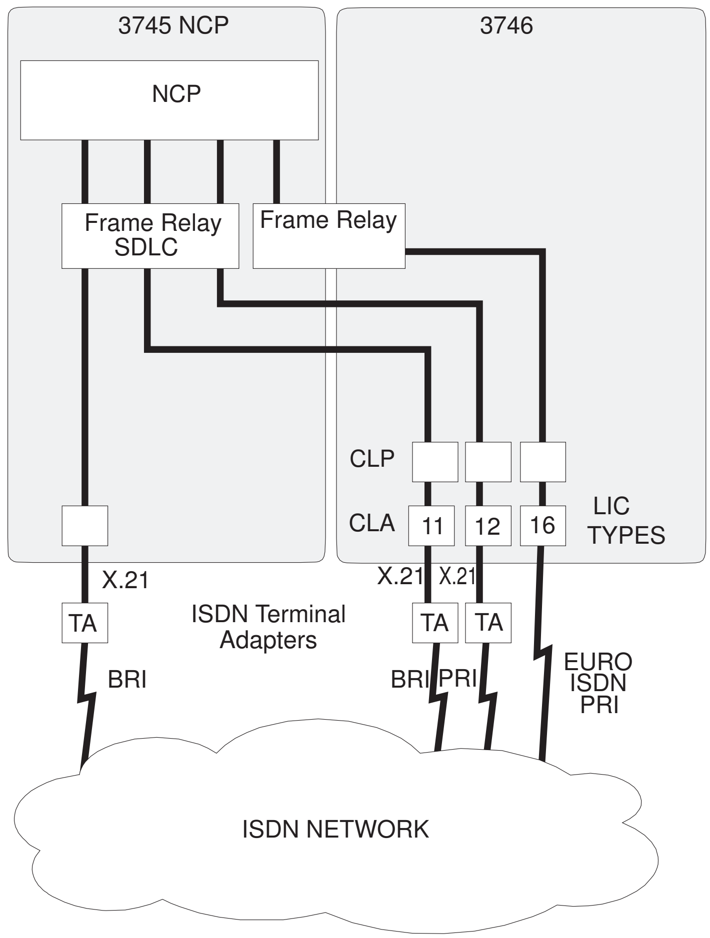


Figure 57. ISDN on the 3746-900 for NCP Controlled Traffic

Native Adapter Through LIC16

Primary Rate Interface Support

The 3746 Model 900 supports frame relay over ISDN Primary Rate Interface (PRI) conforming to Euro-ISDN standard.

An ISDN PRI port of the 3746 Model 900 (LIC16) provides one ISDN D channel, which is reserved for ISDN signalling, and 30 ISDN B-channels for simultaneous full-duplex transport of user data at 64 kbps, see Figure 58 The ISDN B-channels of a PRI port are separately used to establish connections with one or multiple remote equipment. The 3746 Model 900 does not support ISDN connections that include multiple B-channels, such as H0, H11, or H12 channel.

A B-channel connection, when established, constitutes a 64-kbps end-to-end pipe. The 3746 Model 900 uses the frame-relay protocol over this pipe to transport user data.

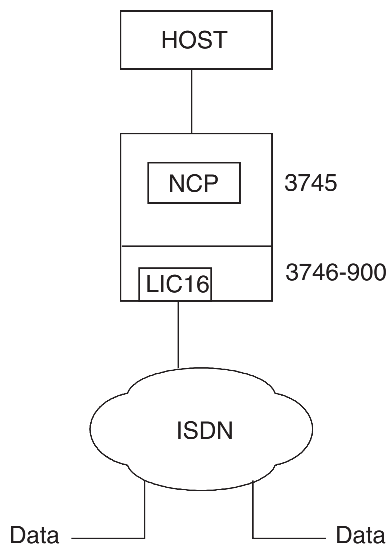


Figure 58. ISDN on the 3746-900

SNA Connectivity

Starting with NCP V7R5, the ISDN PRI ports of the 3746 Model 900 allow ACF/NCP to route SNA traffic to remote equipment supporting frame relay over ISDN, such as the IBM 2210 Nways Multiprotocol Router, the IBM 2216 Nways Multiaccess Connector, or another IBM 3746 Model 900.

Although the 3746 Model 900 supports connections including only one B channel, multiple ISDN B-channels connecting two 3746 Model 900s can be used as a single logical connection (MultiLink Transmission Group) to provide high bandwidth for communication between two ACF/NCPs.

The 3746 Model 900 can automatically call remote equipment over ISDN. For incoming calls over ISDN, the ISDN number and subaddress of the calling party is passed to VTAM for possible verification via user exit routine. Figure 59 on page 151 represents a sample network that uses frame-relay and ISDN connections, both primary (PRI) and basic (BRI). The 3746 Model 900 PRI ports enable the following SNA connections over ISDN:

ISDN subarea links

Two NCPs can exchange data over a frame-relay subarea link which passes through the ISDN network.

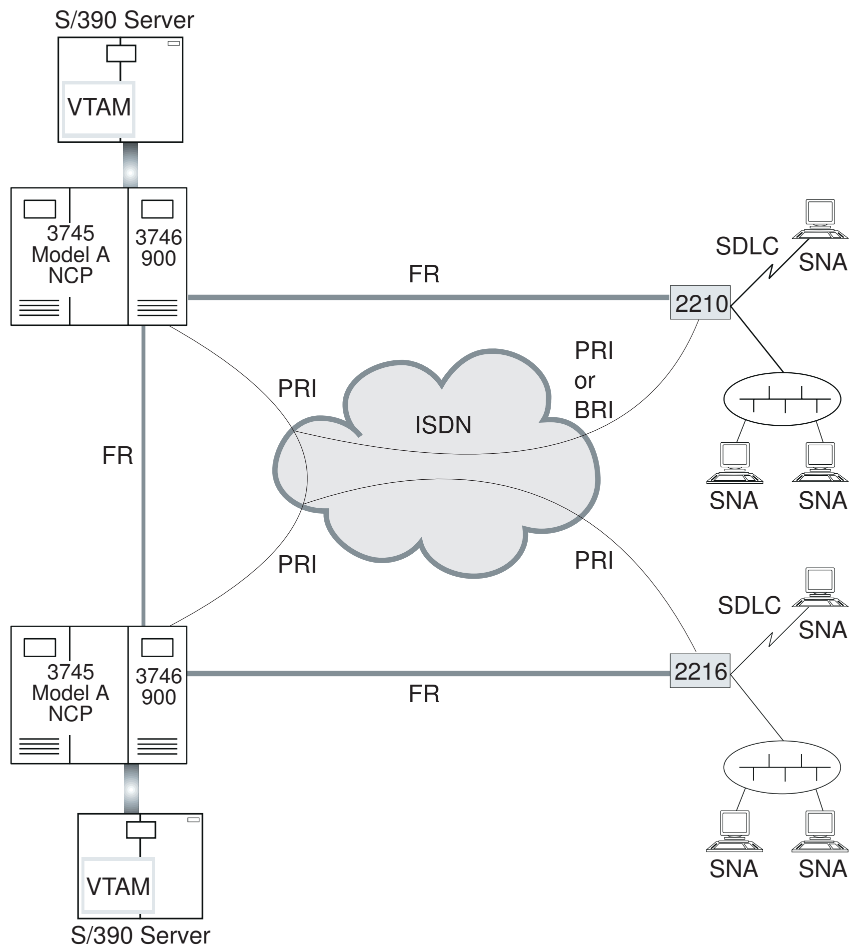
Multiple subarea links over multiple B-channels between two NCPs can be aggregated using the Mixed Media Multilink TG (MMMLTG) feature.

A 3746 Model 900 with LIC16 can connect with a remote 3745 or 3746 Model 900 attached to the network via a terminal adapter, for example a 7820, or via a BAN device, such as a 2210 and a token-ring. In that case the APAR IR34013 is required on the NCP V7R5.

ISDN peripheral links

A NCP can exchange data with peripheral devices over frame-relay peripheral links that pass through the ISDN network.

Two NCPs can also connect together over a frame-relay APPN peripheral link, when each belongs to a Composite Network Node (CNN).



Legend:

BRI Basic Rate Interface (2B + D channels)

FR Frame Relay (via leased connections or Frame relay network)

Figure 59. Connectivity to ISDN Network

Functions Supported

Attachment to an Integrated Services Digital Network (ISDN) through a LIC16 provides the following functions:

Call on demand

When equipment does not need to be permanently connected to the 3746 Model 900, ISDN can be used to established connections only for the duration of data transmissions. The 3746 Model 900 can initiate or receive ISDN calls.

See “How an Incoming Call Is Processed” on page 152.

In case of a subarea node traffic, you can define a MultiLink Transmission Group (MLTG) to the subarea node and as many ISDN connections within the MLTG as you need. The bandwidth of the subarea link can reach up to 30 x 64 = 1920 kbps through ISDN.

Backup through ISDN

See “Backup through ISDN” on page 153.

Bandwidth on demand

See “Bandwidth on Demand” on page 156.

Calling party verification

See “Security Considerations” on page 157.

Remote loading and activation

A NCP can load and activate a remote NCP through a subarea node connection established over an ISDN.

Performance monitoring

The Network Performance Monitor (NPM) program can monitor the traffic on each B-channel, exactly as if the B-channel was a frame-relay physical line.

There is no performance monitoring for the D-channel, because it flows a very low traffic (less than 0.5 kbps compared to its 64 kbps speed, for an average call duration of one minute and the 30 B-channels permanently used).

Accounting

The data of each ISDN call, such as the call duration, called and calling party numbers, called and calling subaddresses, and cause for call clearing, are reported to the Network Performance Monitor (NPM) program for accounting purposes. This allows you to check and dispatch the carrier’s charges, as well as to have detailed statistics at the call level.

How an Incoming Call Is Processed

An ISDN incoming call can be destined to the NCP (call on demand) or initiate an automatic backup (see “Automatic Backup” on page 153). So an incoming call is checked for both call on demand and backup as follows:

1. If a called party subaddress is present in the ISDN incoming call setup and if it is identical to the local party subaddress configured for the ISDN line, then the call is accepted and transmitted to the NCP (call on demand).
2. Each frame-relay line eligible for the automatic backup over this ISDN line is examined.

   If a called party subaddress is present in the ISDN incoming call setup and if it is identical to the local party subaddress configured for the frame-relay line being checked, then the call is accepted and the backup for that frame-relay line starts. If not identical, the next frame-relay line is checked.

   If the called party subaddress that is received in the incoming call does not correspond to any frame-relay line that is eligible for automatic backup, the call is rejected.

   Note that the called party subaddress identifies the frame-relay line for which the backup is being performed. Therefore each frame-relay line, eligible for automatic backup and selectable through the called subaddress, must be allocated a *unique* subaddress. One subaddress must be additionally allocated for the calls on demand. The latter identifies the NCP.
3. If there is no called party subaddress in the incoming call setup, the called party number is checked. If the called party number, received in the incoming call setup, is identical to the local party number configured for the ISDN line, then the call is accepted and transmitted to the NCP (call on demand).

4. If there is no called party subaddress in the incoming call setup, and if the called party number, received in the incoming call, is identical to the local party number configured for the frame-relay line being checked, then the call is accepted and the backup for that frame-relay line starts. Otherwise the next frame-relay line is checked.

   If the called party number that is received in the incoming call, does not correspond to any frame-relay line that is eligible for automatic backup, the call is rejected.

   Note that the called party number identifies the frame-relay line for which the automatic backup is being performed, when the called party subaddress is not provided by the remote end.

   Therefore each frame-relay line, eligible for backup and selectable through the called party number, must be allocated a *unique* number. This requires to subscribe either the Direct Dialling Inward (DDI) or Multiple Subscriber Number (MSN) supplementary service to the network, in order to have as many ISDN numbers as frame-relay lines eligible to automatic backup (plus one for the calls on demand).

In summary, the 3746 Model 900 uses two methods to detect whether an incoming ISDN call is for call on demand or for automatic backup and, in the latter case, to identify the line to be backed up:

- Subaddress method
- Number method.

Checking subaddresses is the preferred method, whenever possible, because ISDN networks always transparently carry the subaddress. On the other hand, ISDN networks can change the format of the ISDN number, for example, from a national to an international number. Also some networks (for example, the French Numeris network) can truncate the called party number. If you intend to use the number based-method, ask your service provider how the network delivers the called party number.

The subaddress method can also help avoid unexpected backup attempts if used as a kind of password. See “Security Considerations” on page 157.

If you plan to use the subaddress method, see “Allocating Subaddresses” on page 159.

Backup through ISDN

Backup of a subarea or peripheral line is possible through ISDN either automatically or by means of C-list or operator commands.

Automatic Backup

A frame-relay line attached to a 3746 Model 900 can be automatically backed up through an ISDN line attached to the same 3746 Model 900. When the frame-relay line fails, the 3746 Model 900 automatically reroutes the frame-relay traffic over a B-channel of the ISDN line, see Figure 60 on page 154.

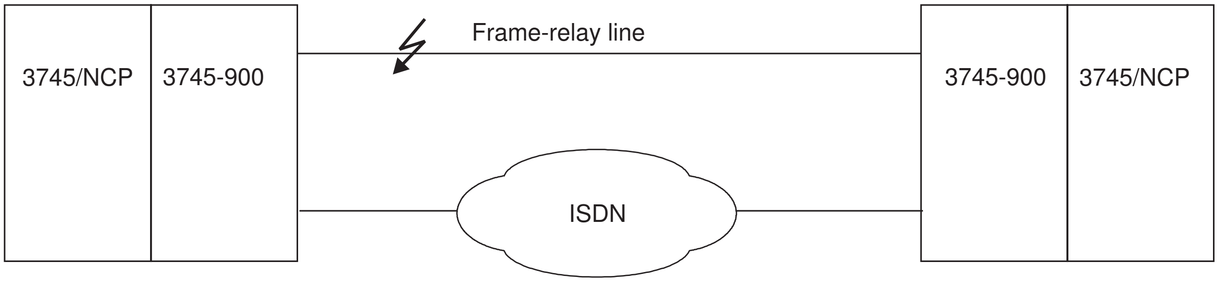


Figure 60. Automatic Frame-Relay Backup over an ISDN

Backup of a frame-relay line over ISDN provides the following benefits:

- Backup is automatic, requiring neither a CLIST nor manual intervention to operate.
- Backup is non-disruptive. The frame-relay terminating equipment recovers any lost frames. Frame-relay resources are not impacted. A resource can be activated or de-activated on the failed frame-relay line.

Since the remote end of the failed frame-relay line must be aware of the backup, because it participates in establishing the ISDN connection, it must be a 3746 Model 900 or have equivalent backup capability.

How automatic backup operates: One end of the frame-relay line is configured as the backup initiator and the other as the backup recipient. When the backup initiator detects a failure, it triggers the backup function by placing an ISDN call over one of the two ISDN lines predefined to back up this frame-relay line.

The failure can be:

- External hardware failure (such as line, or modem)
- Internal hardware failure (such as LIC, or ARC)
- LMI failure.

When an ISDN call arrives, it is first checked to determine whether it is a call on demand or a backup call, according to the algorithm described in “How an Incoming Call Is Processed” on page 152.

When the backup recipient detects a failure, it waits for the backup call. If it does not arrive within about one minute, it enters the normal failure processing by reporting the error to NCP.

For further information on the automatic backup function, refer to the NCP V7 R6 (or later) *Resource Definition Guide*, SC31-6223-05.

Manual or Automated Backup of a Subarea Link

To backup through ISDN a subarea link without traffic disruption, define the subarea link to be backed up as part of a Mixed Media MultiLink Transmission Group (MMMLTG) together with another link defined as a “hot standby” link (`TGCONF=STANDBY`) and as many ISDN links as necessary to carry all of the subarea traffic, see Figure 61 on page 155.

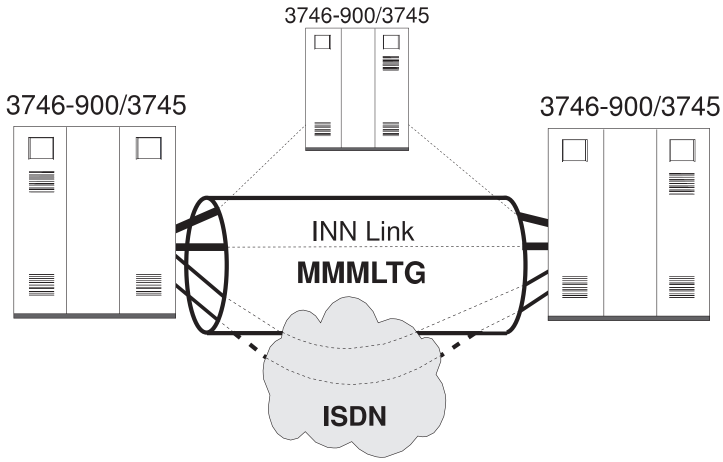


Figure 61. MMMLTG with ISDN Backup

This “hot standby” link must be activated, but does not carry any MMMLTG traffic, except for a short period during the ISDN backup establishment. So it can be normally used for other purposes, as shown on Figure 61.

The subarea link to be backed up can carry SDLC or frame-relay traffic.

If the subarea link fails, the MMMLTG does not fail because its traffic immediately begins to flow over the standby link.

Failure of the subarea link causes an alert to be sent to NetView. This alert can trigger a C-list, which establishes one or more ISDN connections between the two 3746-900s. As soon as established, the whole subarea traffic flows through ISDN, no longer through the standby link. So the backup of a subarea link can be automated through a C-list without any traffic disruption. The standby link prevents disruption of the traffic during the setup of ISDN connections.

Up to 30 B-channels (up to 1.92 Mbps) can be used for backup per ISDN port.

Note: If no standby line is specified in the MMMLTG, backup is still possible (see Figure 62 on page 156). But in this case, the backup is disruptive, because there is no link available in the MMMLTG during the ISDN link setup.

When the MMLTG leased line goes up again, NCP sends a CONTACTED message to VTAM, after the XID exchange. This message can trigger another CLIST that releases all the ISDN connections (B-channels) being used for backup. Thus, the switch back can also be automated through a CLIST without any traffic disruption.

Manual or Automated Backup of a Peripheral Line

Three configurations are possible:

1. Frame-relay leased line to an IBM 2210 or 2216 router.

   In this case use the WAN reroute capability of the 2210 or 2216.

2. Access line to a frame-relay network.

   The frame-relay network must provide a backup function through ISDN.

3. Access to a IBM 2210 or 2216 router via a frame-relay network.

In this case only one DLCI must be subscribed to the network (or several DLCIs, if all terminate to the same 2210 or 2216). In addition the DLCI number must be the same on both sides of the network.

The WAN reroute capability of the 2210 or 2216 is also used for backup.

In cases 1 and 3, the ISDN call can be initiated either by the 2210 or the 3746-900.

Backup can be automated through a CLIST triggered by the NetView alert caused by the line failure. Only one B-channel (64 kbps) can be used for backup. Backup is disruptive.

Bandwidth on Demand

When the traffic rate exceeds the capacity of permanent connections, temporary connections over ISDN can be used to provide additional bandwidth. Therefore, the maximum bandwidth that might be required at peak traffic time does not need to be permanently available over leased connections. For NCP-to-NCP traffic between two 3745/3746-900s (see Figure 59 on page 151), the frame-relay connection can be complemented at peak hours by one or multiple ISDN B-channel connections. The Mixed Media MultiLink Transmission Group (MMMLTG) support of NCP allows the frame-relay and all the ISDN connections to be aggregated as a single logical connection between the two controllers. See Figure 62.

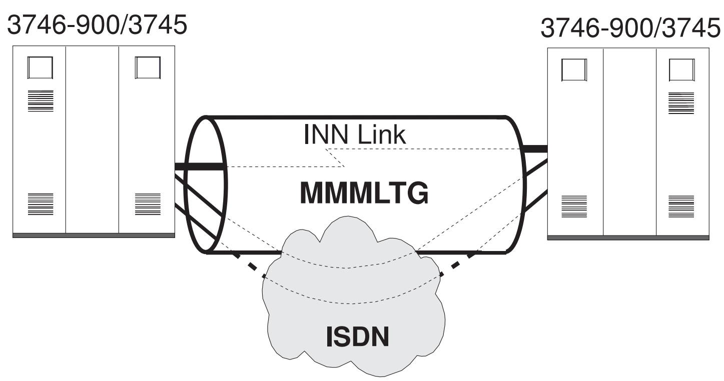


Figure 62. ISDN Bandwidth on Demand

When additional bandwidth is needed, establish the ISDN links between the two subarea nodes. The B-channel connections are in parallel with the normal subarea links to give additional bandwidth to the MMMLTG. When the additional bandwidth is no longer needed, the ISDN connections are to be released.

Increasing or decreasing bandwidth using ISDN channels does not disrupt the MMMLTG traffic.

Bandwidth on demand over ISDN can be automated through CLISTS either:

- Scheduled at a given time of day
- Started at the beginning and end of jobs requiring bulk data transfer.

The subarea link that bandwidth is to be added to can carry SDLC or frame-relay traffic.

Up to 1.92 Mbps (30 B-channels) can be added to a subarea link per ISDN port.

Security Considerations

An unexpected ISDN call could break down connections over a frame-relay line eligible for backup, if the called party subaddress or called party number, that is included in the ISDN call setup, is identical to the local party subaddress or local party number configured for that frame-relay line. This is the reason why it is important to protect against unexpected or malicious calls.

For that purpose, it is recommended that you use the subaddress method described in section “How an Incoming Call Is Processed” on page 152. The subaddresses can be chosen long enough to act as a kind of password.

However if the subaddress method is not sufficient or if you do not plan to use it, you can improve security by writing a Configuration Services XID exit routine (ISTEXCCS) at VTAM level.

When VTAM receives a request contact for a B-channel station, it invokes this exit routine, which can use the DLC Connection Data Control Vector (CV57) coming from the 3746-900 through NCP to check the incoming call parameters. The CV57 contains mainly the calling party number and the calling party subaddress, which were received from the network in the incoming call. The exit routine can therefore check these call parameters and abort the call if necessary.

For ISDN, the DLC type at offset 2 is `X'05'`. The specific subheads for ISDN are:

`X'05'` which contains the remote party number (calling party number).

`X'09'` which contains the remote subaddress (calling party subaddress).

`X'0A'` which contains the allocated bandwidth (in bits/sec). It therefore contains 64000 for one B-channel.

`X'0F'` which imbeds the DLCI information. This subfield contains other subfields. Refer to the NCP documentation.

The format of the subfields `X'05'` and `X'09'` is shown in Table 25 on page 158 and Table 26 on page 159.

Table 25. Remote Party Number Subfield (X'05')			
Offset (dec)	**Length**	**Format or value**	**Contents Description**
0	1	hex	Subfield length (from 6 to 20) (see note 1)
1	1	X'05'	Subfield key
2	1	X'00'	Subfield flags
3	1	hex	Party number length (see note 2)
4	1	bit 0... .... .xxx xxxx	TON/NPI fields Reserved Type Of Number (TON): 000 : Unknown 001 : International number 010 : National number 011 : Network specific number 100 : Subscriber number. Numbering Plan Identification (NPI): 0000 : Unknown 0001 : ISDN/Telephony numbering plan (E.164) 1000 : National standard numbering plan 1001 : Private numbering plan.
5	max 15	IA5	Number digits (see note 3)

Note:
Each subfield is optional. For instance, if the incoming setup message does not include the calling party number, the subfield X'05' is not present in the CV57. If neither the calling party number nor the calling party subaddress is present in the incoming call, none of the subfields X'05' and X'09' is present in the CV57.

1. The subfield length includes the length field itself, that is it equals the sum of the party number length plus 4. The minimum length of the subfield X'05' assumes that the calling party number consists of only one digit.
2. The party number length does not include the length field itself.
3. The digits are decimal and expressed in IA5 characters (that is, like ASCII).

Table 26. Remote Party Number Subfield (X'09')			
Offset (dec)	**Length**	**Format or value**	**Contents Description**
0	1	hex	Subfield length (from 6 to 25) (see note 1)
1	1	X'09'	Subfield key
2	1	X'00'	Subfield flags
3	1	hex	Subaddress length (see note 2)
4	1	bit 1... .... .xxx .... x... .... .000	 Reserved Type of subaddress: 000 : NSAP (specified in X.213 or ISO 8348 addendum 2) 010 : User-specified. Odd/even indicator (used only if subaddress is user-specified and coded in BCD): 0 : even number 1 : odd number. Reserved
5	max 20		Subaddress information

Note:
Each subfield is optional. For instance if the incoming setup message does not include the calling party number, the subfield X'05' is not present in the CV57. If neither the calling party number nor the calling party subaddress is present in the incoming call, none of the subfields X'05' and X'09' is present in the CV57.

1. The subfield length includes the length field itself, that is, it equals the sum of the subaddress length plus 4. The minimum length of the subfield X'09' assumes that the subaddress information field is only one byte long.
2. The subaddress length does not include the length field itself.

Allocating Subaddresses

If you intend to use the subaddress method, described in “How an Incoming Call Is Processed” on page 152, you have to allocate a subaddress to:

- Each NCP of your network that might receive ISDN calls
- Each frame-relay line that is eligible for automatic backup

This subaddress is coded in the ISDNLSA operand.

The subaddress format is either user specified or a NSAP (Network Service Access Point) specified by ISO (standard ISO8348 Addendum 2) or ITU-T (recommendation X.213).

Each subaddress must be *unique*, at least within the customer network. One subaddress identifies one NCP or one frame-relay line eligible for automatic backup.

Note: Usage of a NSAP ensures uniqueness of subaddresses. There is, however, one exception for the AFI=50, because the IDI field of the NSAP is not present for this AFI. See Figure 63 on page 160. The DSP field of the NSAP must be unique within the customer network, whatever the AFI value is.

Format of the NSAPs

There are several formats for a NSAP, depending on the Authority and Format Identifier (AFI) that is included in the first octet of the NSAP, see Figure 63. The AFI specifies both the format of the rest of NSAP and which authority allocates the IDI. Depending on the AFI, the DSP and IDI fields are coded with binary, BCD or IA5 (similar to ASCII) syntax. The length of NSAP cannot exceeds 20 octets.

AFI	Initial Domain Id (IDI)	Domain Specific Part (DSP)

```
<-------------------------------------->
     Initial Domain Part (IDP)

AFI : Authority and Format Identifier (one octet long)
```

Figure 63. General Format of NSAPs

There are two possible formats of NSAP:

1. AFI=50

   For this AFI, there is no IDI. The DSP field must be decimal digits (therefore from 0 to 9), coded with IA5 syntax (similar to ASCII and specified in ITU-T recommendation T.50).

   For example: `50 30313233343536373839`

   Note that, for clarity, the AFI and DSP fields are separated by a blank character.

2. AFI=45

   For this AFI, the IDI contains the ISDN number allocated to the port. The international format, as defined in recommendation E.164, is used. The length of the IDI field is 8 octets, while the E.164 number can be up to 15 digits long. The digits of this number are coded in Binary Coded Decimal syntax (BCD: 2 decimal digits per octet). The E.164 number is padded with leading semi octet 0000 to obtain the maximum length (15 digits). semi-octet value 1111 is used as a pad after the final semi-octet to obtain an integral number of octets. The decimal digits of the DSP is coded with BCD syntax too.

   For example: `45 000033492115220F 0123456789`

   Note that, for clarity, the AFI, IDI and DSP fields are separated by blank characters.

Other formats of NSAP can also be used.

Configuration

To configure ISDN resources, refer to the *NCP V7R5 Resources Definition Guide*, and *NCP V7R5 Resources Definition Reference*. The following terms define NCP ISDN resources:

ISDN D-Channel
: A full-duplex digital channel that carries signaling information to the ISDN network. An NCP D-channel definition represents the physical line.

ISDN B-Channel
A full-duplex digital channel that carries user data through the ISDN network. An NCP B-channel definition represents a time slot on an ISDN interface. Each B-channel has an access rate of 64 kbps.

ISDN Terminal Adapter

ISDN terminal adapters can connect the 3746-900 to remote SNA PUs over an ISDN network for the call-on-demand and backup functions. The X.21 call setup procedure can be used in the 3746-900 to automatically call out (autocall) or answer (autoanswer) via an ISDN network. The framing is SDLC after a call is set up.

The dial digits for a call out are defined in the VTAM switched major node. A call out is initiated by either:

- An application for call on demand
- A CLIST for dial backup

When the call is initiated by the remote DTE, the 3746-900 has to answer the call.

In both modes (autodial or autoanswer), the 3746-900 acts as an X.21 serial interface. The terminal adapter translates the X.21 switched protocol into ISDN call setup messages and conversely.

The ISDN terminal adapter attaches to a X.21 cable (for the LIC11, an X.21 ARC), which is connected to a 3746-900 LIC11 or LIC12.

This line is defined as a switched line in NCP by coding `DIAL=YES` in the GROUP definition statement. In this statement the `X21NKWT` and `X21SW` are not required, as they are only defined for an X.21 network connection.

Basic Rate Interface

The LIC11 is compatible with Basic Rate Interface (BRI) terminal adapters such as the IBM 7820. Two 64-kbps LIC11 lines can attach the two 64-kbps ports of the IBM 7820. See Figure 64.

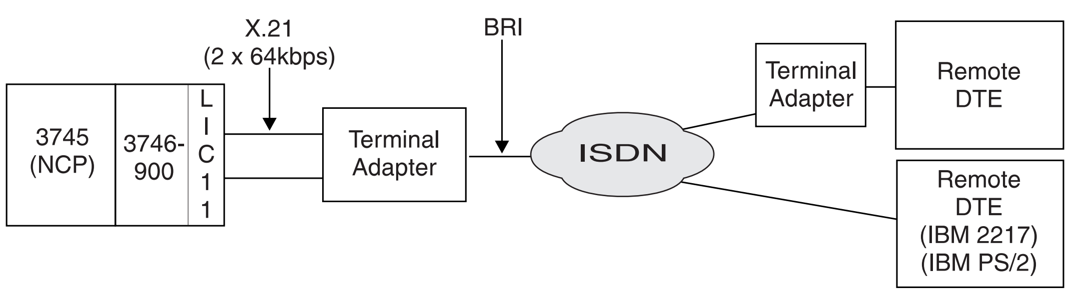


Figure 64. BRI-ISDN Terminal Adapter

Primary Rate Interface

The LIC11 and LIC12 are compatible with Primary Rate Interface (PRI) terminal adapters such as the Hitachi HN-5110-24. A LIC11 line or LIC12 line is required for each connected DTE destination:

- Using a LIC11 with 64 kbps lines, the number of ISDN B-channels that can be used by the terminal adapter (see Figure 65) depends on how the terminal adapter is connected:
  - For a T1 or J1 terminal adapter-ISDN network connection, up to 24 ARC can attach up to 24 ports at 64 kbps.
  - For an E1 terminal adapter-ISDN network connection, up to 30 ARCs can attach up to 30 ports at 64 kbps.
  - The LIC11 can be connected to terminal adapter ports with different speeds: 64, 128, 192, or 256 kbps.

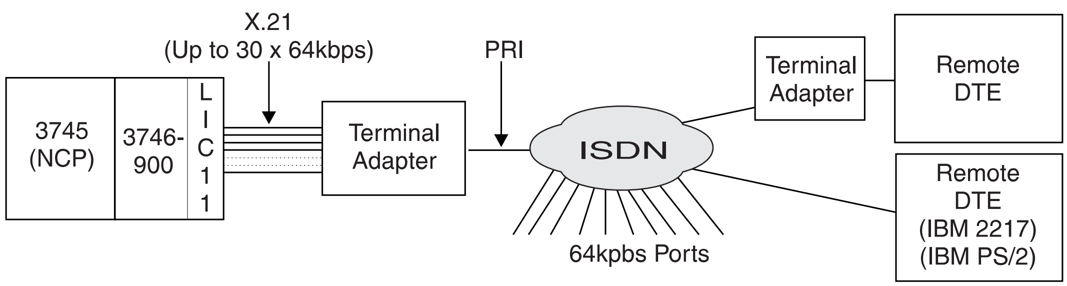


Figure 65. PRI-ISDN Terminal Adapter with a LIC11

The number of lines between the 3746-900 and the terminal adapter corresponds to the maximum number of remote DTEs simultaneously connected. The speed of the line attached to the 3746-900 corresponds to the speed supported by the remote DTE attachment. For example, if the line speed is 128 kbps, the remote DTE is either attached:

  - To a terminal adapter by a 128-kbps line
  - Directly to the ISDN network over two B-channels (2 x 64 kbps).

- Using a LIC12, a single line attaches the 3746-900 to the PRI terminal adapter at any speed up to E1 (including the various H-channel speeds). See Figure 66.

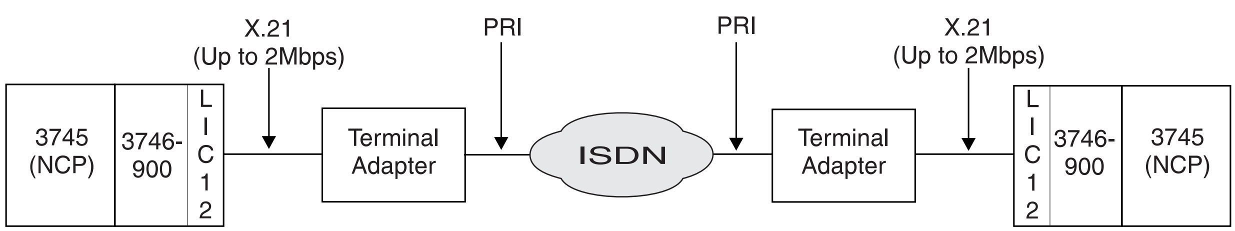


Figure 66. PRI-ISDN Terminal Adapter with a LIC12

The line between the LIC12 and the PRI-ISDN terminal adapter supports only clear channel traffic. The PRI-ISDN terminal adapter converts the LIC12 interface (clear channel) into n x B-channels on the PRI ISDN port. For example, if the X.21 interface runs at 1536 kbps, n = 24.

- The terminal adapters at both ends of the network are responsible for data synchronization to keep the data arriving at one of the DTE interfaces in the same order as its partner DTE sent it. This data synchronization is accomplished through "bonding" protocols when multiple B-channels are used. The two terminal adapters must, therefore, have compatible bonding protocols.

Direct Call

The terminal adapter can also be attached to the 3746-900 over a nonswitched V.35 or X.21 interface. In this case, the terminal adapter can:

- Set up a call to a remote DTE. It can do this automatically when the line is activated. This *direct call* function uses a called number that is predefined in the terminal adapter.
- Automatically answer a call from a remote DTE without involving the 3746-900.

The line is defined as a nonswitched line in NCP by coding `DIAL=NO` (the default value) in the GROUP definition statement.

Appendix A. ACF/NCP 3745 and 3746 Frame-Relay Support

The following sections give an overview of frame-relay 3745 and 3746 support in different levels of ACF/NCP.

ACF/NCP Version 7 Release 7

NCP V7 R7 has the following frame-relay support enhancements:

Configure CIR on 3746-900 Frame-Relay Lines
The CIR can be configured per DLCI for the 3746 frame-relay lines. A DLCI definition statement with different CIR values may be coded for each DLCI. Also, a DLCI definition statement can be coded for default CIR parameters: Bc and Be are multiplied by the value of the DATABLK keyword of the LINE definition statement.

For more details on 3746 CIR support, refer to the NCP V7 R7 books in “Related Documentation” on page 190.

ACF/NCP Version 7 Release 6

NCP V7 R6 has the following frame-relay support enhancements:

DYNWIND: More Granularity
With NCP V7 R6, more granularity is supported for dw (frame loss) over 3745 lines and for dwc (congestion) over 3745 and 3746 lines. Now, you can reduce the working window in a ratio of 7%, 12%, 25%, 50%, 75%, 87%, or 93%.

3746 Line Congestion
Frame-relay congestion parameters of the 3746 can now be tuned in the NCP configuration. Previous to this release, these parameters were internally fixed with medium values (that worked for 90% of the configurations).

ACF/NCP Version 7 Release 5

NCP V7 R5 has the following frame-relay support enhancements:

Frame-Relay Port Sharing
NCP V7 R5 together with 3746-900 microcode allows 3746 frame-relay ports to be shared by NCP, 3746 NNP and 3746 IP functions.

Boundary Access Node (BAN) for Subarea Links
Boundary access node (Bridged format) support over subarea (PU4) connections is provided as an additional frame-relay connectivity option. This support allows 3746 Model 900 connections to remote token-ring capable physical units (PUs) through a remote frame-relay BAN router such as an IBM 6611 or IBM 2210. The 3745 does not support BAN for subarea traffic.

Frame-Relay Inoperative “error count” management upgrades
Previously, if NCP received 64 consecutive frames in error, the frame-relay physical link and all its associated resources were brought down. This change allows the user to configure the allowed number of

consecutive error-seconds before the physical link resources are brought down. This allows a frame-relay physical line to survive a large burst of errors occurring in a very short time. With this change, NCP only counts one error in each 100-ms period for which an error occurs, thus allowing greater network control for the system manager.

3746 DLCI Sharing

For FRTES, 3746-900 microcode together with NCP V7 R5 supports the following sharing options per 3746 DLCI:

- One INN station (routed or bridged frame format) per DLCI
- On IP traffic (3746) and multiple BNN/APPN stations (routed or bridged frame format) each being controlled by NCP or NNP.

Enhanced dynamic windowing algorithm

Currently, NCP uses the IEEE 802.2 dynamic window algorithm in place of a Committed Information Rate (CIR) implementation to regulate the amount of bandwidth each logical SNA station is offered. NCP V7 R5 provides two changes to support an enhanced dynamic windowing algorithm for 3745 frame-relay logical lines:

1. To more closely approximate a CIR for Permanent Virtual Circuits (PVCs) that are assigned a low CIR on a high-speed link, NCP enables the transmission rate for a logical SNA station to be slowed even further than the dynamic windowing algorithm allows. NCP V7 R5 introduces a variable time delay between I-frame transmissions when network congestion continues while the station's dynamic working window is 1. In order to keep the delays within reason, NCP V7 R5 adds a new configuration parameter, DYNWIND, to specify the upper boundary of this delay.
2. To prevent NCP from over reacting to mild congestion, NCP ignores subsequent Backward Explicit Congestion Notification (BECN) for 100 ms after an initial BECN is received and the dynamic working window is adjusted. NCP V7 R5 adds a new configuration parameter to adjust this timer-DYNWIND.
3. NCP lines in 3745 and the base 3746-900 frame do not support CIR. In the case that CIR lines in the 950 talk to NCP 3745 lines, a fix must be applied to that NCP. It is APAR IR 35193 applied to the NCP V7.5 in the base box. (This is not a recommended configuration. Both partners should be configured the same.)

ACF/NCP Version 7 Release 4

NCP V7 R4 had the following frame-relay support enhancements:

Frame-Relay Internal Frame Switching Support

This function will provide customers the ability to couple the 3745/NCP frame-relay frame handler support function (FHFH) with the 3746 connected lines. For those customers using an external frame-relay line to switch traffic between 3745 and 3746, this function will allow them to eliminate this external line by defining an internal PVC segment between a 3745 base line (either a frame-relay physical line or NTRI frame handler logical line) and a 3746 line so that traffic can switched internally. This allows users to frame switch between a 3746 Model 900 frame-relay line and either a 3745 frame-relay line or a 3745 Token-Ring Interface Coupler (TIC1 or TIC2) supporting frame relay over token-ring.

Improvements in performance, usability, and the elimination of the cost of external connections are advantages that can be achieved by frame-relay users who employ this capability.

ACF/NCP Version 7 Release 3

NCP V7 R3 has the following frame-relay support enhancements:

Multiple BNN stations per DLCI for 3746 lines
Support of multiple BNN stations per DLCI on 3746 connected lines was added.

Data Link Control for SNA support in the 3746-900
The RFC1490 routed format is used to identify the type of SNA support

- Advanced Peer-to-Peer Networking® (APPN)
- Boundary access node (BAN)

  The RFC 1490 bridged format, in conjunction with NCP V7 R3 and above, can be used to carry traffic from downstream physical units (PUs) attached to the IBM 2210 and 6611 routers. This support is called *boundary access node* (BAN).

Frame Relay over token-ring
Frame relay over the TIC2 token-ring in the 3745 gives ACF/NCP Version 7 Release 3 the capability to support frame-relay frame handler functions (FRFHs) between NCPs over token-ring (IEEE 802.5) physical connections. This will allow customers who interconnect NCPs with token-ring to provide a private frame-relay network over these token-ring connections.

Frame relay over token-ring requires ACF/VTAM® Version 4 Release 2 with the appropriate PTF.

IP over Frame Relay
NCP only supports IP on frame-relay lines in the base 3745. IP over frame relay is an enhancement to NCP's frame-relay function that allows IP frames to be transmitted over and received from a frame-relay network without being encapsulated in SNA frames. This is termed *native IP routing*. Previously IP traffic routed from one 3745/NCP to another 3745/NCP over a communications link required SNA encapsulation.

With the implementation of IP over frame relay, NCP Version 7 Release 3 also supports dynamic reconfiguration (DR) of IP frame-relay interfaces. It is possible to permanently define a frame-relay IP PU on a frame-relay physical link that does not already have IP resources defined. This requires the use of permanent dynamic reconfiguration function available with VTAM Version 4 Release 3.

The IP over frame-relay capability is RFC-1490 compliant. This is for IP that is under NCP control.

Frame-Relay BAN Support
Frame-relay boundary access node (BAN), which uses the RFC1490 bridged frame format, provides an extension to the frame-relay

Boundary Network Node (BNN) capability. BAN supports APPN and BNN traffic on 3745 and 3746 connected lines.

Increased DLCI Range

The DLCI range is increased from 16-215 to 16-991 for all lines. This allows greater flexibility in specifying DLCI numbers to match those assigned by frame-relay providers when attaching to a frame-relay network.

DLCI Sharing

NCP V7 R3 supports the following DLCI sharing options:

- One INN station and IP per DLCI (3745 only)
- One INN station per DLCI (3746 only)
- Multiple BNN/APPN stations and IP (3745 only)
- Multiple BNN/APPN stations per DLCI (3746 only).

ACF/NCP Version 7 Release 2

NCP V7 R2 provides support for frame-relay connections on the 3746 Model 900 that use the LIC11 and LIC12 couplers. The frame-relay support on the 3746 Model 900 is similar to the support in the base frame. This support includes:

FRTE support

- Subarea frame-relay connections to other NCPs
- Frame-relay virtual circuits from peripheral devices to the boundary function in NCP

FRFH support

Switching of frames from a data link connection identifier (DLCI) of one port (called a subport) to another DLCI of another port. The switching paths are downloaded from NCP to the CLP at activation time. The frame switching between 3746-900 subports is done via the 3746-900 connectivity switch (or within the CLP) without going through the CCU. This improves the switching capacity of the 3745.

The same hardware as for SDLC and X.25 is used. SDLC, X.25, and frame-relay lines can be attached to the same CLP.

Data Link Control for SNA support in the 3746-900

The RFC1490 routed format is used to identify the type of SNA support:

- Boundary Network Node (BNN)
- Intermediate Network Node (INN)

For SNA over frame-relay 802.2 is used to provide a reliable transport. Both RFC1490 and 802.2 LLC run in the CLPs of the 3746-900.

Mixed media multilink transmission groups

Mixed media multilink transmission groups (MLTGs) are supported over an FRTE SA subport of the 3746-9x0.

3746 LMI Support

LMI support was added for 3746 Model 900 connected lines. The LMI support in the 900 will free up 3745 CCU cycles.

Communication Rate Support

NCP V7 R2 introduces communications rate (CR) support for the 3746-900, which allows users to allocate a minimum bandwidth to each virtual circuit, depending on the traffic needs of the corresponding end stations. This guarantees that traffic will flow on a given virtual circuit at least at its communications rate. At the same time, any unused bandwidth is made available for use in active virtual circuits.

Comrate

NCP V7 R3 extends the comrate support to the 3745 lines. The actual bandwidth assigned to a virtual circuit is defined either by COMRATE or CIR. These two parameters are mutually exclusive; either one or the other must be defined.

CIR is supported only by 3746 lines, which are controlled by the NNP or IP components of the 3746. There is no NCP support for CIR (see "Committed Information Rate (CIR) and Burst Sizes" on page 45 for details on CIR). The 3746 NNP and IP lines also support COMRATE. See "Communication Rate (CR) and Committed Information Rate (CIR)" on page 47 for details on COMRATE.

Thus frame-relay lines that are shared between NCP (V7 R5), NNP and 3746 IP functions only support COMRATE. For details on COMRATE, see "Communication Rate (CR) and Committed Information Rate (CIR)" on page 47

Note: The communications rate must be defined per PVC segment. An end-to-end communications rate requires consistent definitions on each of the PVC segments that comprise a virtual circuit.

ACF/NCP Version 7 Release 1

NCP V7 R1 provides SNA peripheral device connectivity via frame-relay This is referred to as NCP's BNN FRTE function, and uses the RFC1490 routed frame format. BNN FRTE, FRFH and INN FRTE functions can be shared on a single frame-relay line. IBM networking equipment such as the IBM AS/400® server, IBM 3174, IBM 3172, and RouteXpander/2 can be used to directly access the SNA network, making use of the boundary function, and also transfer other frame-relay traffic over different virtual circuits using the NCP FRFH support.

The frame-relay BNN capability of ACF/NCP V7 R1 supports multiple stations per DLCI for 3745 adapters (not 3746-900 attached).

ACF/NCP Version 6 Release 2

NCP V6 R2 provided a general purpose frame-relay switching capability for multiprotocol, SNA and non-SNA, traffic. The switching capability is referred to as the Frame-Relay Frame Handling (FRFH) function.

This allows connection of FRTEs to a network of 3745s and provides end-to-end connections (PVCs) for FRTE pairs. Like the initial release, NCP V6 R2 runs on all models of the 3745 Communications Controller and on existing line adapters, including the High Speed Scanner (HSS). NCP frame relay allows attachment using leased lines at speeds from 600 bits per second up to 2 Mbps. FRFH and INN FRTE functions can be shared on a single frame-relay line.

Note: The FRFH function is often referred to as FR DCE (Data Communications Equipment) in analogy with X.25 terminology. In NCP publications the term Frame-Relay Switching Equipment (FRSE) is used as well.

In addition, LMI support was added in this release.

ACF/NCP Version 6 Release 1

NCP provided its first frame-relay support in NCP V6 R1.

NCP V6 R1 runs on all models of the 3745 Communications Controller family, providing a wide range of capacities and throughput. This frame-relay support is implemented strictly in the NCP software without requiring any new hardware. It runs on the existing 3745 hardware and line adapters, including the T1/E1 High Speed Scanner. No host application software changes are required to use NCP frame relay.

Functionally, NCP V6 R1 provides the ability to interconnect NCPs to each other through a frame-relay network, providing NCP-to-NCP subarea traffic support. NCP acts as a frame-relay end station, called Frame-Relay Terminal Equipment (FRTE). This is referred to as NCP INN FRTE function.

Note: A frame-relay end station is known as an FRTE but is sometimes referred to as an FR DTE (Data Terminal Equipment) as in X.25.

List of Abbreviations

AB	area border
ACF	advanced communications function
ACF/VTAM	advanced communications function for the virtual telecommunications access method
ANR	automatic network routing
APPN	advanced peer-to-peer networking
ARB	adaptive rate-based flow/congestion control
ARC	active remote connector
ARP	address resolution protocol
AS	autonomous system
ASB	autonomous system border
ASE	autonomous system external
ASCII	american national standard code for information interchange
AUTO	automatic
BAN	boundary access node
BECN	backward explicit congestion notification
BER	box event record
BGP	border gateway protocol
BOOTP	bootstrap protocol
bps	bits per second
BRS	bandwidth reservation system
BSC	binary synchronous communication
C&SM	communications and system management
CBSP	control bus and service processor
CCITT	comité consultative international télégraphique et téléphonique The international telegraph and telephone consultative committee
CCU	central control unit
CD	carrier detector
CDF-E	configuration data file - extended
CE	customer engineer
CF3745	3745 and 3746 configurator and performance model
CHPID	channel path id
CIDR	classless inter-domain routing
CIR	committed information rate
CLIST	command list
CLA	communication line adapter
CLP	communication line processor
CM	communications manager
CNN	composite network node
CNM	communication network management
COS	cost of service
CP	control point
CR	communications rate
CSU	customer service unit
DCAF	distributed console access facility
DCE	data circuit-terminating equipment
DDS	digital data service
DE	discard eligibility
DLC	data link control
DLCI	data link connection identifier
DLSw	data link switching
DLUR	dependent LU requester
DLUS	dependent LU server
DMUX	double multiplex circuit
DSU	data service unit
DTE	data terminal equipment
DX	duplex
EBCDIC	extended binary-coded decimal interchange code
EBN	extended border node
EC	engineering change
EMIF	ESCON multiple image facility
EN	end node
EP	emulation program
EPO	emergency power OFF
ESCA	ESCON channel adapter
ESCC	ESCON channel coupler
ESCD	ESCON Director
ESCON	Enterprise Systems CONnection
ESCP	ESCON processor
FC	feature code
FDX	full duplex
FECN	forward explicit congestion notification

FRAD	frame-relay access device
FRFH	frame-relay frame handler
FRSE	frame-relay switching equipment
FRTE	frame-relay terminating equipment
HCD	hardware configuration definition
HDX	half duplex
HI	high
HLA	host link address
HONE	hands-on network environment
HPR	high performance routing
HSS	high-speed scanner
ICMP	internet control message protocol
IML	initial microcode load
INN	intermediate network node or
	IBM information network
IOCP	Input/Output Configuration Program
IP	internet, or internetwork, protocol
IPL	initial program load
IPR	installation planning representative
ITU-T	international telecommunications union - telecommunications (ex-CCITT)
KB	kilobyte (processor storage) 1KB = 2^{10} bytes (1 024 bytes)
kbps	kilobits per second (speed or communication volume per second) 1 kbps = 1 000 (one thousand) bits per second
LAA	locally administered address
LAN	local area network
LCB	line connection box
LCBB	line connection box base
LCBE	line connection box expansion
LCP	link control protocol
LDM	limited distance modem
LED	light emitting diode
LIB n	line interface board type n
LIC n	line interface coupler type n
LSA	link state advertisement
LIU n	line interface coupler unit type n
LIV	link integrity verification
LMI	local management interface
LP	logical partition
LPDA®	link problem determination aid
LQ	line quality
LU	logical unit
LSS	low-speed scanner
MAC	medium access control
MAU	medium attachment unit
MB	megabyte (processor storage) 1MB = 2^{20} bytes (1 048 576 bytes)
Mbps	megabits per second (speed or communication volume per second) 1 Mbps = 1 000 000 (one million) bits per second
MCL	microcode change level
MES	miscellaneous equipment specification
MIB	management information base
MIH	missing interrupt handler
MLC	machine level control
MLTG	multi-link transmission group
MOSS-E	maintenance and operator subsystem - extended
MTP	multipoint
MUX	multiplex circuit
MVS	multiple virtual storage
NAU	network addressable unit
NMBA	nonbroadcast multiaccess
NCP	Network Control Program
NDRS	non-disruptive route switching
NGMF	netView graphic monitor facility
NN	network node
NNP	network node processor
NPM	netView performance monitor
NRZI	non-return-to-zero inverted
NVT	network virtual terminal
ODLC	outboard data link control
OSPF	open shortest path first
PBN	peripheral border node
PCI	Peripheral component interconnect
PEP	partitioned emulation program
PING	packet internet groper
PN	peripheral node
PPP	point-to-point protocol
PPPNCP	point-to-point network control protocol
PTP	point-to-point

PTT	post, telegraph, and telephone
PU	physical unit
PVC	permanent virtual circuit
QUAL	quality
RCV	receive clock
RETAIN®	remote technical assistance information network
RFS	ready for sending
RIP	routing information protocol
RNR	receive not ready
ROS	read-only storage
RR	receive ready
RSF	remote support facility
RTP	rapid transport protocol
RTS	request to send
SDLC	synchronous data link control
SMUX	single multiplex circuit
SNBU	switched network backup
SNI	SNA network interconnection
SNMP	simple network management protocol
SPAU	service processor access unit
SRC	service reference code
S/S	start-stop
SVC	switched virtual circuit
TC	test control
TCM	trellis code modulation
TCP	transmission control protocol
TG	transmission group
THRES	threshold
TICn	Token-ring interface coupler type n
TIM	time services
TOS	type of service
TPF	transaction processing facility
TRA	Token-ring adapter
TRP	Token-ring processor
TSS	transmission subsystem
UDP	user datagram protocol
UTP	unshielded twisted pair
VTAM	virtual telecommunications access method
XID	exchange station identification
XMIT	transmit

Glossary

This glossary defines new terms used in this manual.

adaptive rate-based flow and congestion control (ARB). A function of High Performance Routing (HPR) that regulates the flow of data over an RTP connection by adaptively changing the sender's rate based on feedback on the receiver's rate. It allows high link utilization and prevents congestion before it occurs, rather than recovering after congestion has occurred.

advanced communication function (ACF). A group of IBM licensed programs. principally VTAM programs. TCAM, NCP, and SSP, that use the concepts of Systems Network Architecture (SNA), including distribution of function and resource sharing.

advanced communications function for the virtual telecommunications access method (ACF/VTAM). An IBM licensed program that controls communication and the flow of data in an SNA network. It provides single-domain, multiple-domain, and interconnected network capability.

advanced peer-to-peer networking (APPN). Data communications support that routes data in a network between two or more advanced program-to-program communications (APPC) systems that do not need to be adjacent.

automatic network routing. A function of High Performance Routing (HPR) that is provides a low-level routing mechanism that requires no intermediate storage.

channel adapter (CA). A communication controller hardware unit used to attach the controller to a host processor.

communication controller. A device that directs the transmission of data over the data links of a network; its operation may be controlled by a program executed in a processor to which the controller is connected or it may be controlled by a program executed within the device. For example, the IBM 3745 and 3746 Network Nodes.

communications manager. A function of the OS/2 Extended Edition program that lets a workstation connect to a host computer and use the host resources as well as the resources of the other personal computers to which the workstation is attached, either directly or through a host system. The communications manager provides application programming interfaces (APIs) so that users and develop their own applications.

configuration data file - extended (CDF-E). A 3746 Network Node MOSS-E file that contains a description of all the hardware features (presence, type, address, and characteristics).

communications management configuration host node. The type 5 host processor in a communications management configuration that does all network-control functions in the network except for the control of devices channel-attached to a data host nodes. Synonymous with communications management host. See also data host node.

control panel. A panel that contains switches and indicators for the customer's operator and service personnel.

control program. A computer program designed to schedule and to supervise the execution of programs of the controller.

control subsystem. The part of the controller that stores and executes the control program, and monitors the data transfers over the channel and transmission interfaces.

customer engineer. See IBM service representative

data circuit-terminating equipment (DCE). The equipment installed at the user's premises that provides all the functions required to establish, maintain, and terminate a connection, and the signal conversion between the data terminal equipment (DTE) and the line. For example, a modem is a DCE.

Note: The DCE may be a stand-alone equipment or integrated in the 3745.

data terminal equipment (DTE). That part of a data station that serves as a data source, data link , or both, and provides for the data communication control function according to protocols. For example, the 3174 and PS/2s are DTEs.

data host node. In a communication management configuration, a type 5 host node that is dedicated to processing applications and does not control network resources, except for its channel adapter-attached or communication adapter-attached devices. Synonymous with data host. See also communications management configuration host node.

direct attachment. The attachment of a DTE to another DTE without a DCE.

ESCON channel. A channel having an Enterprise System Connection* channel-to-control-unit I/O interface that uses optical cables as a transmission medium.

ESCON channel adapter (ESCA). A communication controller hardware unit used to attach the controller to a host via ESCON fiber optics. An ESCA consists of an ESCON channel processor (ESCP) and an ESCON channel coupler (ESCC).

ESCON channel coupler (ESCC). A communication controller hardware unit which is the interface between the ESCON channel processor and the ESCON fiber optic cable.

ESCON channel processor (ESCP). A communication controller hardware unit which provides the channel data link control for the ESCON channel adapter.

distributed console access facility. (1) This program product provides a remote console function that allows a user at one programmable workstation (PS/2) to remotely control the keyboard input and monitor the display of output of another programmable workstation. The DCAF program does not affect the application programs that are running on the workstation that is being controlled. (2) An icon that represents the Distributed Console Access Facility.

enterprise systems chhnection (ESCON). A set of IBM products and services that provides a dynamically connected environment within an enterprise.

Host. See host processor

host processor. (1) A processor that controls all or part of a user application network. (2) In a network, the processing unit where the access method for the network resides. (3) In an SNA network, the processing unit that contains a system services control point (SSCP). (4) A processing unit that executes the access method for attached communication controllers.

High performance routing (HPR). An extension of APPN that provides faster traffic throughput, lower delays, and lower storage overheads.

IBM service representative. An individual in IBM who does maintenance services for IBM products or systems. Also called the IBM *Customer Engineer*.

initial microcode load (IML). The process of loading the microcode into an adapter, the MOSS, or the service processor.

internet. (1) A wide area network connecting disparate networks using the internetwork protocol (IP) (2) A public domain wide area network connecting thousands of disparate networks in industry, education, government and research. The Internet uses TCP/IP as the standard for transmitting information.

internet address. The numbering system used in IP internetwork communications to specify a particular network, or a particular host on that network with which to communicate.

internet control message protocol (ICMP). A protocol used by a gateway to communicate with a source host, for example, to report an error in a datagram. It is an integral part of the Internetwork Protocol (IP).

internetwork protocol. A protocol that routes data from its source to its destination in an internet environment. It is also called the *Internet Protocol*.

internetwork. Any wide area network connecting more than one network.

initial program load (IPL). The initialization procedure that causes the 3745 control program (NCP) to begin operation.

LAN-attached console. A PS/2 attached to the token-ring LAN that has the service processor attached. It is used to operate remotely the MOSS and MOSS-E functions.

IP router. A device that enables an Internetwork Protocol (IP) host to act as a gateway for routing data between separate networks.

line interface coupler (LIC). A circuit that attaches up to four transmission cables to the controller (from DTEs, DCEs or telecommunication lines).

locally administered address. In a local area network, an adapter address that the user can assign to override the universally administered address.

maintenance and operator subsystem - extended (MOSS-E). The licensed internal code loaded on the service processor hard disk to provide maintenance and operator facilities to the user and IBM service representative.

microcode. A program that is loaded in a processor (for example, the MOSS processor) to replace a hardware function. The microcode is not accessible to the customer.

modem (modulator-demodulator). See DCE.

multiple virtual storage (MVS). Multiple Virtual Storage, consisting of MVS/System Product Version 1 and the MVS/370 Data Facility Product operating on a System/370™ processor.

NetView. An IBM licensed program used to monitor a network, manage it, and diagnose its problems.

nonswitched line. A connection between systems or devices that does not have to be made by dialing. The connection can be point-to-point or multipoint. The line can be leased or private. Contrast with *switched line.*.

ping. A simple IP application that sends one or more messages to a specified destination host requesting a reply. Usually used to verify that the target host exists, or that its IP address is a valid address.

remote console. A PS/2 attached to the 3746 Network Node either by a switched line (with modems) or by one of the communication lines of the user network.

remote technical assistance information network (RETAIN).

service processor. The processor attached to a 3745, 3746-900, and 3746-950 via a token-ring LAN.

remote support facility (RSF). RSF provides IBM maintenance assistance when requested via the public switched network. It is connected to the IBM RETAIN database system.

service representative. See IBM service representative

services. A set of functions designed to simplify the maintenance of a device or system.

switched line. A transmission line with which the connections are established by dialing, only when data transmission is needed. The connection is point-to-point and uses a different transmission line each time it is established. Contrast with *nonswitched line*.

synchronous data link control (SDLC). A discipline for managing synchronous, code-transparent, serial-by-bit information transfer over a link connection. Transmission exchanges may be duplex or half-duplex over switched or nonswitched links. The configuration of the link connection may be point-to-point, multipoint, or loop. SDLC conforms to subsets of the Advanced Data Communication Control Procedures of the American National Standards Institute and High-Level Data Link Control (HDLC) of the International Standards Organization.

synchronous transmission. Data transmission in which the sending and receiving instruments are operating continuously at substantially the same frequency and are maintained, through correction, in a desired phase relationship.

Token-ring adapter (TRA) type 3. 3746-900 and 3746-950 line adapter for IBM Token-Ring Network, composed of one token-ring processor card (TRP2), and two Token-Ring interface couplers type 3 (TIC 3s).

Token-ring interface coupler type 2 (TIC2). A circuit that attaches an IBM Token-Ring network to the 3745.

Token-Ring Interface Coupler type 3 (TIC3). A circuit that attaches an IBM Token-Ring network to the 3746-900 or 3746-950.

user access area. A specific area in the controller where the customer can install, remove, change, or swap couplers and cables without IBM assistance.

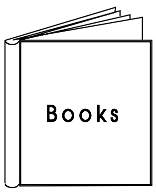
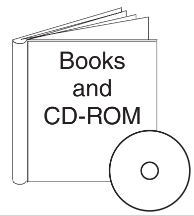
universally administered address. In a local area network, the address permanently encoded in an adapter at the time of manufacture. All universally administered addresses are unique.

user application network. A configuration of data processing products, such as processors, controllers, and terminals, for data processing and information exchange. This configuration may use circuit-switched, packet-switched, and leased-circuit services provided by carriers or PTT. Also called a *user network*.

V.24, V.35, and X.21. ITU-T (ex-CCITT) recommendations on transmission interfaces.

Bibliography

Customer Documentation for the 3745 (All Models), and 3746 (Model 900)

Table 27 (Page 1 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900		
This customer documentation has the following formats:		
 		
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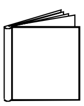
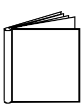
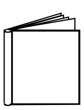
		3745 Models A and 3746 Books All of the books in the 3745 Models A and 3746 library are available on the CD-ROM that contains the Licensed Internal Code (LIC) for the machine.
Evaluating and Configuring		
	GA33-0092	***IBM 3745 Communication Controller Models 210, 310, 410, and 610*** ***Introduction*** Gives an introduction of the IBM Models 210 to 610 capabilities. For Models A, refer to the *Overview*, GA33-0180.
	GA33-0180	***IBM 3745 Communication Controller Models A and 170***[2] ***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Overview*** Gives an overview of connectivity capabilities within SNA, APPN, and IP networking.
	GA27-4234	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Planning Series: Overview, Installation, and Integration*** Provides information for: • Overall 3746 planning • Installation and upgrade scenarios • Controller and service processor network integration • Related MOSS-E and CCM worksheets for these tasks.

Table 27 (Page 2 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900

	GA27-4235	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Serial Line Adapters*** Provides information for: • Serial line adapter descriptions • Serial line adapter line weights and connectivity • Types of SDLC support • Configuring X.25 lines • Performance tuning for frame-relay, PPP, X.25, and NCP lines. • ISDN adapter description and configuration.
	GA27-4236	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Token Ring and Ethernet*** Provides information for: • Token-ring adapter description and configuration • Ethernet adapter desription and configuration.
	GA27-4237	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***ESCON Channels*** Provides information for: • ESCON adapter descriptions • ESCON configuration and tuning information • ESCON configuration examples.
	GA27-4238	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Physical Planning*** Provides information for: • 3746 and MAE physical planning details • 3746 and MAE cable information • Explanation of installation sheets • 3746 plugging sheets.

Table 27 (Page 3 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900		
	GA27-4239	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Management Planning*** Provides information for: • Overview for 3746 • 3746 APPN/HPR, IP router, and X.25 • NetView Performance Monitor (NPM), remote consoles, and RSF • MAE APPN/HPR management.
	GA27-4240	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Multiaccess Enclosure Planning*** Provides information for: • MAE adapters details • MAE ESCON planning and configuration • ATM and ISDN support.
	GA27-4241	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Protocols Description*** Provides information for: • Overview and details about APPN/HPR and IP.
	On-line information	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Controller Configuration and Management Worksheets*** Provides planning worksheets for ESCON, Multiaccess Enclosure, serial line, and token-ring definitions.
Preparing Your Site		
	GC22-7064	***IBM System/360™, System/370™, 4300 Processor*** ***Input/Output Equipment Installation Manual-Physical Planning*** (Including Technical News Letter GN22-5490) Provides information for physical installation for the 3745 Models 130 to 610. For 3745 Models A and 3746 Model 900, refer to the *Planning Guide*, GA33-0457.
	GA33-0127	***IBM 3745 Communication Controller*** ***Models 210, 310, 410, and 610*** ***Preparing for Connection*** Helps for preparing the 3745 Models 210 to 610 cable installation. For 3745 Models A refer to the *Connection and Integration Guide*, SA33-0129.

Table 27 (Page 4 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900

Preparing for Operation	
GA33-0400	***IBM 3745 Communication Controller All Models***[3] ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Safety Information***[1] Provides general safety guidelines.
SA33-0129	***IBM 3745 Communication Controller All Models***[3] ***IBM 3746 Nways Multiprotocol Controller Model 900*** ***Connection and Integration Guide***[1] Contains information for connecting hardware and integrating network of the 3745 and 3746-900 after installation.
SA33-0416	***Line Interface Coupler Type 5 and Type 6*** ***Portable Keypad Display*** ***Migration and Integration Guide*** Contains information for moving and testing LIC types 5 and 6.
SA33-0158	***IBM 3745 Communication Controller All Models***[3] ***IBM 3746 Nways Multiprotocol Controller Model 900*** ***Console Setup Guide***[1] Provides information for: • Installing local, alternate, or remote consoles for 3745 Models 130 to 610 • Configuring user workstations to remotely control the service processor for 3745 Models A and 3746 Model 900 using: – DCAF program – Telnet Client program – Java Console support.
Customizing Your Control Program	
SA33-0178	***Guide to Timed IPL and Rename Load Module*** Provides VTAM procedures for: • Scheduling an automatic reload of the 3745 • Getting 3745 load module changes transparent to the operations staff.
Operating and Testing	
SA33-0098	***IBM 3745 Communication Controller*** ***All Models***[4] ***Basic Operations Guide***[1] Provides instructions for daily routine operations on the 3745 Models 130 to 610.
SA33-0177	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller Model 900*** ***Basic Operations Guide***[1] Provides instructions for daily routine operations on the 3745 Models 17A to 61A, and 3746 Model 900 operating as an SNA node (using NCP), APPN/HPR Network Node, and IP Router.

Table 27 (Page 5 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900

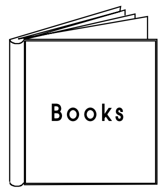
SA33-0097	***IBM 3745 Communication Controller All Models***[3] ***Advanced Operations Guide***[1] Provides instructions for advanced operations and testing, using the 3745 MOSS console.
On-line Information	***Controller Configuration and Management Application*** Provides a graphical user interface for configuring and managing a 3746 APPN/HPR Network Node and IP Router, and its resources. It is also available as a stand-alone application, using an OS/2 workstation. Defines and explains all the 3746 Network Node and IP Router configuration parameters through its online help.
SH11-3081	***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Controller Configuration and Management: User's Guide***[5] Explains how to use CCM and gives examples of the configuration process.
GA33-0479	***IBM 3745 Communication Controller Models A*** ***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***NetView Console APPN Command Reference Guide*** Explains how to use the RUN COMMAND from the NetView S/390 Program and gives examples.
Managing Problems	
SA33-0096	***IBM 3745 Communication Controller All Models***[3] ***Problem Determination Guide***[1] A guide to perform problem determination on the 3745 Models 130 to 61A.
On-line Information	***Problem Analysis Guide*** An online guide to analyze alarms, events, and control panel codes on: • IBM 3745 Communication Controller Models A[2] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.
SA33-0175	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Expansion Unit Model 900*** ***IBM 3746 Nways Multiprotocol Controller Model 950*** ***Alert Reference Guide*** Provides information about events or errors reported by alerts for: • IBM 3745 Communication Controller Models A[2] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.

Table 27 (Page 6 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900
[1] Documentation shipped with the 3745. [2] 3745 Models 17A to 61A. [3] 3745 Models 130 to 61A. [4] Except 3745 Models A. [5] Documentation shipped with the 3746-900.

Additional Customer Documentation for the 3745 Models 130, 150, 160, 170, and 17A

Table 28. Additional Customer Documentation for the 3745 Models 130 to 17A

This customer documentation has the following format:



Finding Information		
		3745 Models A and 3746 Books All of the books in the 3745 Models A and 3746 library are available on the CD-ROM that contains the Licensed Internal Code (LIC) for the machine.
Evaluating and Configuring		
	GA33-0138	***IBM 3745 Communication Controller Models 130, 150, 160, and 170*** ***Introduction*** Gives an introduction about the IBM Models 130 to 170 capabilities, including Model 160. For Model 17A refer to the *Overview*, GA33-0180.
Preparing Your Site		
	GA33-0140	***IBM 3745 Communication Controller Models 130, 150, 160, and 170*** ***Preparing for Connection*** Helps for preparing the 3745 Models 130 to 170 cable installation. For 3745 Model 17A refer to the *Connection and Integration Guide*, SA33-0129.

[1] Documentation shipped with the 3745.

Customer Documentation for the 3746 Model 950

Table 29 (Page 1 of 4). Customer Documentation for the 3746 Model 950		
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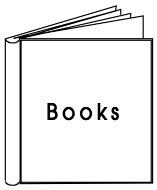		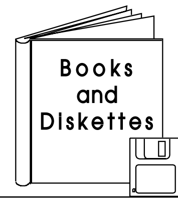
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		3745 Models A and 3746 Books All of the books in the 3745 Models A and 3746 library are available on the CD-ROM that contains the Licensed Internal Code (LIC) for the machine.
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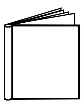
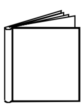
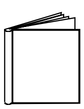
	GA33-0400	***IBM 3745 Communication Controller All Models***[1] ***IBM 3746 Expansion Unit Model 900*** ***IBM 3746 Nways Multiprotocol Controller Model 950*** ***Safety Information***[2] Provides general safety guidelines.
Evaluating and Configuring		
	GA33-0180	***IBM 3745 Communication Controller Models A and 170***[3] ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Overview*** Gives an overview of connectivity capabilities within SNA, APPN, and IP networking.
	GA27-4234	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Overview, Installation, and Integration*** Provides information for: • Overall 3746 planning • Installation and upgrade scenarios • Controller and service processor network integration • Related MOSS-E and CCM worksheets for these tasks.

Table 29 (Page 2 of 4). Customer Documentation for the 3746 Model 950

	GA27-4235	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Serial Line Adapters*** Provides information for: • Serial line adapter descriptions • Serial line adapter line weights and connectivity • Types of SDLC support • Configuring X.25 lines • Performance tuning for frame-relay, PPP, X.25, and NCP lines. • ISDN adapter description and configuration.
	GA27-4236	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Token Ring and Ethernet*** Provides information for: • Token-ring adapter description and configuration • Ethernet adapter description and configuration.
	GA27-4237	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***ESCON Channels*** Provides information for: • ESCON adapter descriptions • ESCON configuration and tuning information • ESCON configuration examples.
	GA27-4238	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Physical Planning*** Provides information for: • 3746 and MAE physical planning details • 3746 and MAE cable information • Explanation of installation sheets • 3746 plugging sheets.

Table 29 (Page 3 of 4). Customer Documentation for the 3746 Model 950

GA27-4239	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Management Planning*** Provides information for: • Overview for 3746 • 3746 APPN/HPR, IP router, and X.25 • NetView Performance Monitor (NPM), remote consoles, and RSF • MAE APPN/HPR management.
GA27-4240	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Multiaccess Enclosure Planning*** Provides information for: • MAE adapters details • MAE ESCON planning and configuration • ATM and ISDN support.
GA27-4241	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Protocols Description*** Provides information for: • Overview and details about APPN/HPR and IP.
On-line information	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Controller Configuration and Management Worksheets*** Provides planning worksheets for ESCON, Multiaccess Enclosure, serial line, and token-ring definitions.

Table 29 (Page 4 of 4). Customer Documentation for the 3746 Model 950

Operating and Testing	
SA33-0356	***IBM 3746 Nways Multiprotocol Controller Model 950*** ***User's Guide***[2] Explains how to: • Carry out daily routine operations on Nways controller • Install, test, and customize the Nways controller after installation • Configure user's workstations to remotely control the service processor using: – DCAF program – Telnet client program – Java Console support.
On-line information	***Controller Configuration and Management Application*** Provides a graphical user interface for configuring and managing a 3746 APPN/HPR network node and IP Router, and its resources. It is also available as a stand-alone application, using an OS/2 workstation. Defines and explains all the 3746 Network Node and IP Router configuration parameters through its on-line help.
SH11-3081	***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Controller Configuration and Management: User's Guide***[2] Explains how to use CCM and gives examples of the configuration process.
GA33-0479	***IBM 3745 Communication Controller Models A*** ***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***NetView Console APPN Command Reference Guide*** Explains how to use the RUN COMMAND from the NetView S/390 Program and gives examples.
Managing Problems	
On-line information	***Problem Analysis Guide*** An on-line guide to analyze alarms, events, and control panel codes on: • IBM 3745 Communication Controller Models A[3] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.
SA33-0175	***IBM 3745 Communication Controller Models A***[3] ***IBM 3746 Expansion Unit Model 900*** ***IBM 3746 Nways Multiprotocol Controller Model 950*** ***Alert Reference Guide*** Provides information about events or errors reported by alerts for: • IBM 3745 Communication Controller Models A[3] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.

[1] Models 130 to 61A.
[2] Documentation shipped with the 3746-950
[3] 3745 Models 17A to 61A.

Required Documentation

The following documents are indispensable for planning for your 3745/3746 controllers:

- *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180
- *3745 Communication Controller All Models, 3746 Nways Multiprotocol Controller Model 900: Console Setup Guide*, SA33-0158.

Be sure to use the latest editions of the above documents.

Related Documentation

The following documents are also helpful for **planning** for your 3745/3746 controllers:

- *Planning for Integrated Networks*, SC31-8062
- *Planning and Reference for NetView, NCP, and VTAM*, SC31-7122.
- *Virtual Telecommunications Access Method V3 R4: Resource Definition Reference*, SC31-6438

The following Enterprise Systems Connection (**ESCON**) documents may be helpful:

- *Introducing the Enterprise Systems Connection*, GA23-0383
- *Enterprise Systems Connection Migration*, GA23-0383
- *Planning for Enterprise Systems Connection Links*, GA23-0367
- *Introducing Enterprise Systems Connection Directors*, GA23-0363.

The following *IBM International Technical Support Centers* “redbooks” are generally very helpful:

- *Frame Relay Guide*, GG24-4463
- *3746-900 and NCP Version 7 Release 2*, GG24-4464.

The following Network Control Program (**NCP**) documents may be helpful:

- For NCP V6 R2:
  - *Network Control Program V6 R2: Migration Guide*, SC31-6216
  - *Network Control Program V6 R2, ACF/SSP V3 R8, EP R11: Resource Definition Guide*, SC31-6209-01
  - *Network Control Program V6 R2, ACF/SSP V3 R8, EP R11: Resource Definition Reference*, SC31-6210-01
  - *Network Control Program V6 R2: Planning and Implementation Guide*, GG24-4012
  - *Network Control Program V6 R2, ACF/SSP V3 R8, EP R11: Library Directory*, SC31-6215.
- For NCP V6 R3:
  - *Network Control Program V6 R3: Migration Guide*, SC31-6217
  - *Network Control Program V6 R3, ACF/SSP V3 R9, EP R11: Resource Definition Guide*, SC31-6209-02
  - *Network Control Program V6 R3, ACF/SSP V3 R9, EP R11: Resource Definition Reference*, SC31-6210-02 Guide,
  - *Network Control Program V6 R3, ACF/SSP V3 R9, EP R11: Library Directory*, SC31-6218.
- For NCP V7 R1:
  - *Network Control Program V7 R1: Migration Guide*, SC31-6219
  - *Network Control Program V7 R1, ACF/SSP V4 R1, EP R12: Resource Definition Guide*, SC31-6223-00
  - *Network Control Program V7 R1, ACF/SSP V4 R1, EP R12: Resource Definition Reference*, SC31-6224-00
  - *Network Control Program V7 R1, ACF/SSP V4 R1, EP R12: Library Directory*, SC31-6220.

- For NCP V7 R2:
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Generation and Loading Guide*, SC31-6221.
  - *Network Control Program V7 R2: Migration Guide*, SC31-6258-00
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Resource Definition Guide*, SC31-6223-01
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Resource Definition Reference*, SC31-6224-01
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Library Directory*, SC31-6259.
- For NCP V7 R3:
  - *Network Control Program V7 R3: Migration Guide*, SC31-6258-01
  - *Network Control Program V7 R3, ACF/SSP V4 R3, EP R12: Resource Definition Guide*, SC31-6223-02
  - *Network Control Program V7 R3, ACF/SSP V4 R3, EP R12: Resource Definition Reference*, SC31-6224-02
  - *Network Control Program V7 R3, ACF/SSP V4 R3, EP R12: Library Directory*, SC31-6262.
- For NCP V7 R4:
  - *Network Control Program V7 R4: Migration Guide*, SC30-3786
  - *Network Control Program V7 R4, ACF/SSP V4 R4, EP R12: Resource Definition Guide*, SC31-6223-03
  - *Network Control Program V7 R4, ACF/SSP V4 R4, EP R12: Resource Definition Reference*, SC31-6224-03
  - *Network Control Program V7 R4, ACF/SSP V4 R4, EP R12: Library Directory*, SC30-3785.
- For NCP V7 R5:
  - *Network Control Program V7 R5: Migration Guide*, SC30-3833
  - *Network Control Program V7 R5, ACF/SSP V4 R4, EP R12: Resource Definition Guide*, SC31-6223-04
  - *Network Control Program V7 R5, ACF/SSP V4 R4, EP R12: Resource Definition Reference*, SC31-6224-04
  - *Network Control Program V7 R5, ACF/SSP V4 R4, EP R12: Library Directory*, SC30-3832.
- For NCP V7 R6:
  - *Network Control Program V7 R6: Migration Guide*, SC30-3833-01
  - *Network Control Program V7 R6, ACF/SSP V4 R4, EP R14: Resource Definition Guide*, SC31-6223-06
  - *Network Control Program V7 R6, ACF/SSP V4 R4, EP R14: Resource Definition Reference*, SC31-6224-06
  - *Network Control Program V7 R6, ACF/SSP V4 R4, EP R14: Library Directory*, SC30-3785.
- For NCP V7 R7:
  - *Network Control Program V7 R7: Migration Guide*, SC30-3889
  - *Network Control Program V7 R7, ACF/SSP V4 R4, EP R14: Resource Definition Guide*, SC31-6223-07
  - *Network Control Program V7 R7, ACF/SSP V4 R4, EP R14: Resource Definition Reference*, SC31-6224-07
  - *Network Control Program V7 R7, ACF/SSP V4 R4, EP R14: Library Directory*, SC30-3971.

The following **OS/2** document may be of some help:

IBM Extended Services® for OS/2 Programming Services and Advanced Problem Determination for Communications, SO4G-1007.

For the Distributed Console Access Facility (**DCAF**) Version 1.3 the following documents are needed:

- *DCAF: Installation and Configuration Guide*, SH19-4068
- *DCAF: User's Guide*, SH19-4069
- *DCAF: Target User's Guide*, SH19-6839.

To learn more about the **APPN** architecture, including high-performance routing (HPR), adaptive rate based flow and congestion control (ARB), dependent LU requesters/servers (DLURs/DLUSs), and other subjects, refer to:

- *Inside APPN - The Essential Guide to the Next-Generation SNA*, SG24-3669.
- *APPN Architecture and Protocol Implementations Tutorial* SG24-3669.

The following Virtual Telecommunications Access Method (**VTAM**), may be helpful:

- *Virtual Telecommunications Access Method V4R3: Resource Definition Reference*, SC31-6438.

For help with **TCP/IP**, refer to:

- *TCP/IP for MVS: Performance Tuning Guide*, SC31-7188.

To learn about token-ring configurations and the **IEEE 802.2** standard, refer to:

- *Token-Ring Network Architecture Reference*, SC30-3374.

These latest NetView documents may be helpful:

- *TME 10 NetView for OS/390 Version 1: Planning Guide*, GC31-8226
- *TME 10 NetView for OS/390 Version 1: Tuning Guide*, SC31-8240.

The following NetView Performance Monitor (**NPM**) documents are available:

- *NetView Performance Monitor: Concepts and Planning V2R2*, GH19-6961-01
- *NetView Performance Monitor: Concepts and Planning V2R3*, GH19-6961-02
- *NetView Performance Monitor: Concepts and Planning V2R4*, GH19-6961-03
- *NetView Performance Monitor: Concepts and Planning V3R1*, GH19-4221-00.

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Tell Us What You Think!

3745 Communication Controller Model A
3746 Nways Multiprotocol Controller
Models 900 and 950
Planning Series:

Serial Line Adapters

Publication No. GA27-4235-01

We hope you find this publication useful, readable, and technically accurate, but only you can tell us! Your comments and suggestions will help us improve our technical publications. Please take a few minutes to let us know what you think by completing this form. If you are in the USA, you can mail this form postage free or fax it to us at 1-800-253-3520. Elsewhere, your local IBM branch office or representative will forward your comments or you may mail them directly to us.

Overall, how satisfied are you with the information in this book?	Satisfied	Dissatisfied
	☐	☐

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