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**MultiFRAD<sup>II</sup>**<sup>™</sup>  
Router/Two-Port Frame Relay Access Device

## **MultiFRAD 200-Series**

**Model FR2201**

**User Guide**

**MultiTech**<sup>®</sup>  
Systems 

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# User Guide

88311500 Revision A

MultiFRAD II (Model FR2201)

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## Chapter 1 - Introduction and Description



## Introduction

Welcome to Multi-Tech's new MultiFRAD II™, model FR2201, a Router/ Two-Port Frame Relay Access Device (FRAD) that encapsulates non-packetized data streams from serial and LAN devices into frame relay frames and frames that data with header and trailer information prior to sending it to the frame relay network. The MultiFRAD (Figure 1-1) enables non-frame relay devices to connect to a common carrier frame relay network service or private frame relay network. This unit has a trunk interface to a Frame Relay network, an Ethernet LAN connection for IP or IPX routing or bridging, and two data channels that can be connected to non-frame-relay devices. On receiving a communication over the frame relay network, the MultiFRAD strips away the frame relay control information so the target device receives the data packaged in its original form.

Since frame relay networks use shared resources, they typically are more reliable and less expensive per month than equivalent leased lines. Depending on the location and distances between points, simple point-to-point networks can cost less per month than leased lines. The cost savings are even greater when multiple leased lines are replaced with frame relay.

The trunk connection links to a synchronous Data Communications Equipment (DCE) device that accesses the Frame Relay network. The Ethernet LAN connection handles IP or IPX routing and Media Access Control (MAC) layer bridging for all other protocols on either a 10Base-T or AUI port connection. The two data ports are for asynchronous or HDLC synchronous Data Terminal Equipment (DTE) devices.



Figure 1-1. MultiFRAD II

## Preview of this Guide

This User Guide describes the MultiFRAD and details how to install and configure it. The information contained in each chapter is as follows:

### **Chapter 1 - Introduction and Description**

Chapter 1 describes the MultiFRAD and includes front panel descriptions, back panel connectors, and relevant technical specifications.

### **Chapter 2 - Installation**

This chapter provides information on unpacking and cabling your MultiFRAD. Safety Warnings are detailed, followed by the installation procedure in which each cable is connected to the MultiFRAD and the unit is powered on.

### **Chapter 3 - Software Loading and Configuration**

Chapter 3 details the software loading and configuration procedures. The MultiFRAD software is windows based; numerous configuration options are available and are described in this chapter.

### **Chapter 4 - MultiFRAD Software**

Chapter 4 describes the MultiFRAD software from an applications approach, and includes examples of possible uses.

### **Chapter 5 - Remote Configuration and Management**

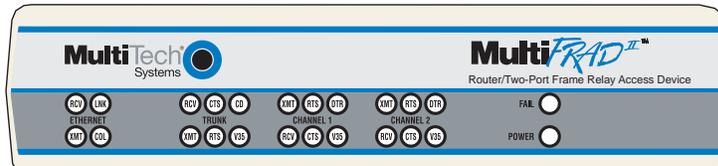
Chapter 5 provides procedures for changing the configuration of a remote MultiFRAD. Remote configuration enables you to change the configuration of a unit by simply connecting a PC with communications software to a remote MultiFRAD that has communications software and a modem connected to the command port. You can then configure the unit. Chapter 5 also describes a typical Telnet Client application and a Web browser application.

### **Chapter 6 - Warranty, Service and Tech Support**

Chapter 6 provides instructions on getting service for your MultiFRAD at the factory, a statement of the limited warranty, information about our user bulletin board service, and space for recording information about your MultiFRAD prior to calling Multi-Tech's Technical Support personnel.

## Front Panel Description

The front panel has three groups of LEDs that provide the status of the LAN connection, trunk and data channel activity, and general status of the MultiFRAD. The Ethernet LAN LEDs display LAN activity; i.e., they show whether the MultiFRAD is connected to the LAN, transmitting or receiving packets, and if a data collision is occurring. The trunk LEDs display the trunk status, whether a trunk is ready to transmit or receive serial data, and if an external communications device with a V.35 interface is connected to the MultiFRAD. The data channel 1 and data channel 2 LEDs display the status of the two data channels, including whether the data channel or the attached device is ready to transmit or receive data and if the data channel is configured for a V.35 serial interface. The last group of LEDs indicates whether the self test passed or failed and if the power On/Off switch on the back of the MultiFRAD is switched On.



**Figure 1-1. Front Panel**

### ETHERNET

- RCV** Receive indicator blinks when packets are being received from the local area network.
- LNK** Link indicator lights indicating that the MultiFRAD is connected to the local area network.
- XMT** Transmit indicator blinks when packets are being transmitted to the local area network.
- COL** Collision indicator lights when a collision is in progress, that is, when two nodes are transmitting packets at the same time.

### TRUNK

- RCV** Receive indicator blinks when the trunk is receiving data.
- CTS** Clear To Send indicator lights when the trunk is ready to transmit data.
- CD** Carrier Detect indicator lights when the MultiFRAD detects a carrier signal.
- XMT** Transmit indicator blinks when the trunk is transmitting data.
- RTS** Request to Send indicator lights then the trunk is ready to receive data.
- V35** The V35 indicator lights when the trunk is configured for a V.35 interface; i.e., the shunt for the trunk is in the V.35 position.

### DATA CHANNELS

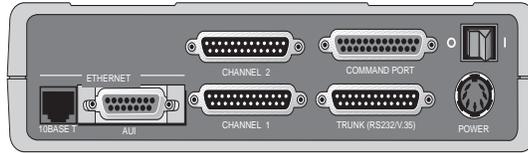
- XMT** Transmit indicator blinks when the channel is transmitting data.
- RTS** Request to Send indicator lights when the attached device is ready to receive data from the channel.
- DTR** Data Terminal Ready indicator lights when the attached device provides the DTR signal.
- RCV** Receive indicator blinks when the channel is receiving data.
- CTS** Clear To Send indicator lights when the channel is ready to transmit data.
- V35** The V35 indicator lights when the channel is configured for a V.35 interface; i.e., the channel shunt is in the V.35 position.

**FAIL** Fail indicator lights when a self test fails to complete as expected.

**POWER** The power indicator lights when the On/Off Switch is in the ON position.

## Back Panel Description

All the cable connections to the MultiFRAD are made at the back panel. Four categories of cables are used on the MultiFRAD: Ethernet, Channels, Command Port, and Trunk (RS232/V.35). The back panel connectors are shown in Figure 1-2 and described in the following groups.



**Figure 1-2. Back Panel**

### Ethernet 10Base-T Connector

The Ethernet 10Base-T connector is used to connect the MultiFRAD to a LAN using unshielded twisted cable. This connector is an RJ-45 jack.

### Ethernet AUI Connector

The Ethernet AUI (Attachment Unit Interface) connector is used to connect the MultiFRAD to a LAN using thickwire Ethernet cable. This connector is a 15-pin D-shell female connector.

### Channels 1 and 2 Connectors

The two Channel connectors are used to connect data devices to the MultiFRAD. A data device can be a synchronous device such as a multiplexer or an asynchronous device such as a PC. The data channels can be either RS232C or V.35. If a V.35 connection is desired, then the internal shunt for that channel must be physically moved from its default RS232 position to the V.35 position. Back-to-back cables are supplied with the MultiFRAD to connect the RS232C data devices to the back panel DB25 male channel connectors.

### Command Port Connector

The Command Port connector is used to configure the MultiFRAD using a PC with a serial port or terminal emulation. The Command Port connector has a DCE physical interface with a DB25 female connector.

### TRUNK (RS232/V.35) Connector

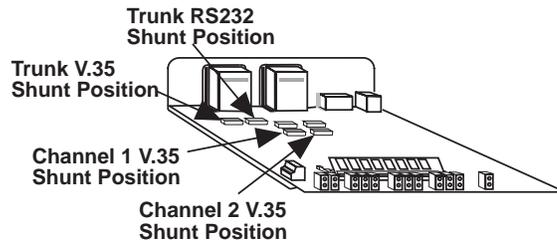
The RS232/V.35 trunk connector is used to connect the MultiFRAD to a Frame Relay Network. The trunk connection is to a synchronous communications device such as a modem, DSU, or ISDN. This connection can be either RS232C or V.35. If the connection is V.35, then the shunt for that link must be moved from the default RS232 position to the V.35 position. This connector is a DB25 male connector.

### Power Connector

The Power connector is used to connect the external power supply to the MultiFRAD. The Power connector is a 6-pin circular DIN connector. A separate power cord connects the power supply to a live AC grounded outlet.

# Shunts

There are three shunts (Figure 1-3) on the printed circuit board for the trunk and the data channels.



**Figure 1-3. Shunts**

The MultiFRAD has separate shunts for the trunk and both data channels. Both the default RS232 Shunt Position and the V.35 position for the Trunk are identified. The V.35 positions for the Channel shunts are also shown. To change the position of a shunt, refer to the V.35 Shunt procedure in Chapter 2.

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# Technical Specifications

The MultiFRAD conforms to the following specifications:

- Provides access to Frame Relay Networks for IP, IPX, bridged LAN traffic, Async and HDLC Sync devices
- Trunk and data ports can be configured as either EIA-232 or V.35
- Trunk speeds up to T1/E1, synchronous
- Command Port - 19.2 Kbps, asynchronous
- 4 MB DRAM
- 1MB of Flash memory

## Data Ports

Supports 2 data ports

- Data port speeds from 300 bps to 115.2 Kbps asynchronous and 4800 bps to 128 Kbps synchronous
- Asynchronous data format parameters: 5, 6, 7, 8 data bits; Even, Odd, None parity; 1, 1.5, 2 stop bits
- Async Data port options: local echo, hardware or software flow control, pacing, Xon pass-thru, ENQ/ACK spoofing
- Sync channel parameters: internal/external clocking, flag or mark idle, NRZ/NRZI encoding, interframe timer
- Special APSM mode to allow Data port and LAN traffic muxing over a single PVC

## Ethernet Port

- Routing Protocols - IP and IPX and bridging all others
- Ethernet Interface - 10Base-T (twisted pair) RJ-45 connector or 10Base5 (Thicknet) 15-pin D-shell female connector (AUI)
- Special APSM mode to allow LAN traffic and Data port muxing over a single PVC

## Command Port

- Single 19.2K bps asynchronous Command Port with DB25 female connector.

## Trunk Port

- T1/E1 (1.544M/2.048 Mbps) sync link using DB25 male connector. Optional ITU-T V.35 interface using a V.35 adapter cable.
- Supports over 900 concurrent PVCs. DLCI values from 16 to 1007
- ANSI Annex D, Annex A, or LMI link management protocols

## Electrical/Physical

- Power Supply Input: 100 to 250V AC ~ 50 to 60 HZ, 0.9A
- Power Supply Output: +5V DC @ 3.0A, +12V DC @ 0.5A, -12V DC @ 0.2A
- Power Consumption: 10 Watts
- Dimensions - 2.25" high x 9" wide x 12.875" deep
- Weight - 4.5 pounds (1.7 kg)

## Requirement

- PC with one serial COM port to connect to the Command Port of the MultiFRAD for configuration



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**MultiFRAD<sup>II</sup>**<sup>™</sup>  
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## Chapter 2 - Installation

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# Introduction

This chapter will guide you through the unpacking and installation of your MultiFRAD. The installation procedure, which is preceded by important safety warnings, provides step-by-step instructions on cabling and powering-on the MultiFRAD. Chapter 3 provides instructions on installing and configuring the MultiFRAD software.

## Unpacking your MultiFRAD

Remove all items from the box. Your shipping box should contain the MultiFRAD, a power supply, various cables, software and manual disks, and a MultiFRAD Model FR2201 Quick Start Guide. Inspect all items (Figure 2-1) before proceeding with the installation. If any item appears to be damaged, do not power up the unit; contact Multi-Tech's Technical Support personnel for advice (Refer to Chapter 6). If no damage is observed, configure the MultiFRAD using the information in the rest of this chapter.

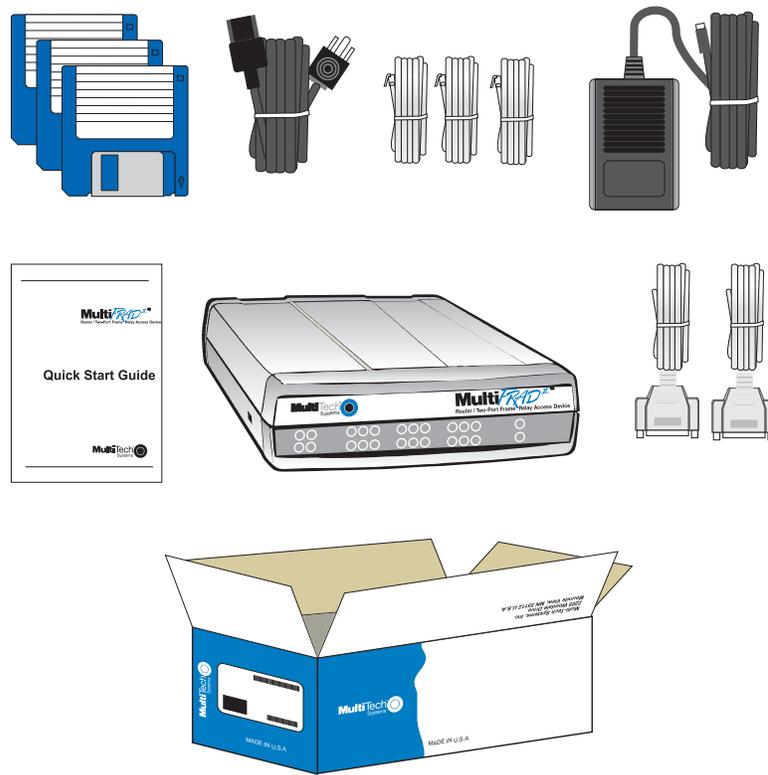


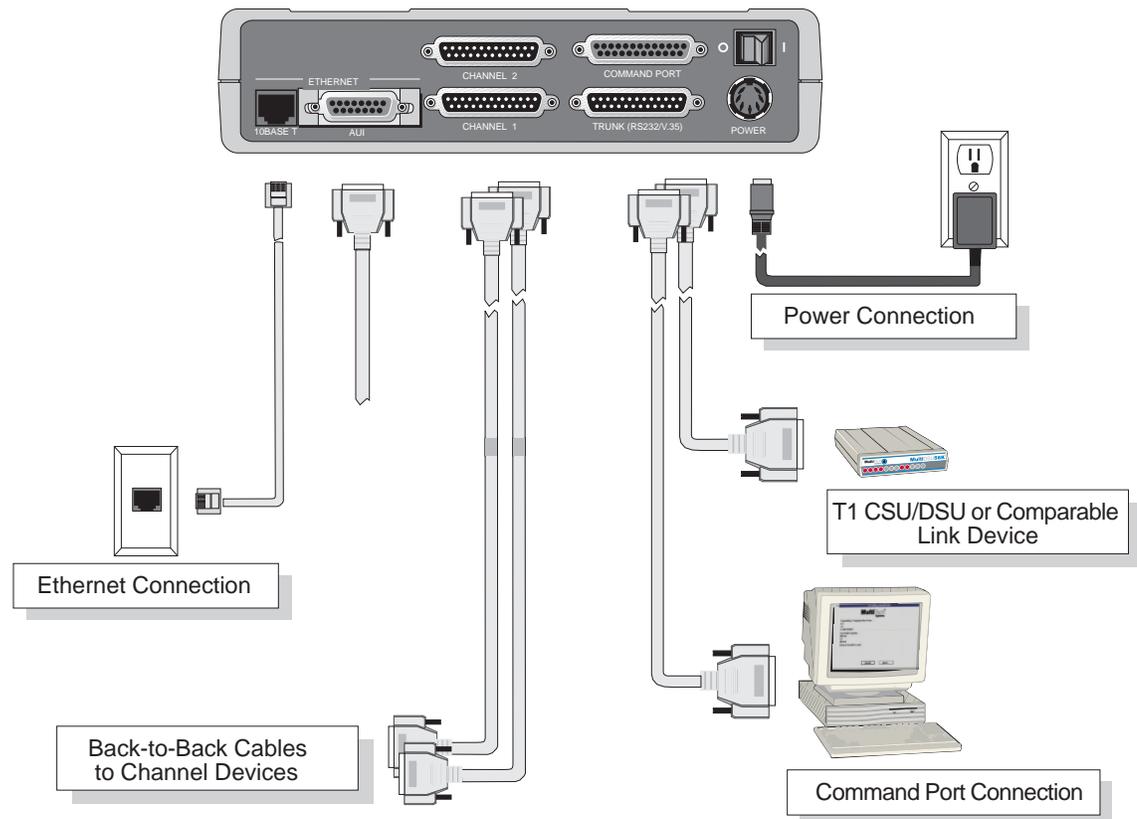
Figure 2-1. Unpacking

# Cabling your MultiFRAD

Cabling your MultiFRAD involves making the proper Power, Command Port, Ethernet, and Channel connections. Figure 2-2 shows the back panel connectors and the associated cable connections. Table 2-1 details the procedures for connecting the cables to your MultiFRAD.

**Table 2-1. Cabling Procedure**

- | Step | Procedure   |
|------|---|
| 1    | Connect one end of a (supplied) DB25 <u>back-to-back cable</u> to each of the data channel connectors on the back of your MultiFRAD (labeled CHANNEL 1-2). See Figure 2-2. Connect the other end of each cable to a channel device.<br><br>NOTE: Both channels support the RS232/V.35 protocols, and either asynchronous or HDLC synchronous RS232 data equipment such as multiplexers. |



**Figure 2-2. Cable Connections**

- Connect one end of an DB25 (female) cable to the Trunk connector (Figure 2-2). Connect the other cable end to your T1 CSU/DSU or compatible link device.
- To make the network connection, connect an RJ-45 (UTP) cable to the 10 BASE-T Ethernet connector or the male connector for a 10Base5 cable to the AUJ Ethernet connector (shown in Figure 2-2). Connect the other end of the cable to your LAN.
- Connect the MultiFRAD to your PC with a standard RS232 cable. Plug the male end of the cable into the Command Port (Figure 2-2) and the other end into the PC's serial port.
- Connect one end of the power supply to a live AC outlet, then connect the other end to the MultiFRAD as shown in Figure 2-2. The Power connector is a 7-pin circular DIN connector.
- Apply power to the MultiFRAD by setting the Power switch (Figure 2-2) to the "1" (on) position.

At this time your MultiFRAD is completely cabled. Proceed to the next section to install your software.





## Chapter 3 - Software Loading and Configuration



# Installing your Software

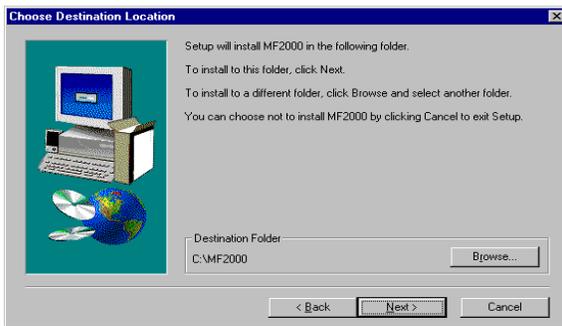
The following procedure does not provide every screen or option used in the process of installing the MultiFRAD software. The assumption is that a technical person with a thorough knowledge of Windows and the software loading process is doing the installation. Additional information on the MultiFRAD software is provided in the User Guide supplied with your MultiFRAD II.

1. Run Windows on the PC that is connected to the Command Port.
2. Insert the MultiFRAD II disk 1 into the disk drive on the PC that is connected to the Command Port.
3. **Win3.1 users** - access Run by clicking the File menu in Program Manager and then click Run. In the Run dialog box, type **a:\setup** or **b:\setup** (depending on the letter of your disk drive) in the Command Line field and then click **OK**.

**Win95/NT users** - click the Start box and then click Run. In the Run dialog box click the down arrow and choose **a:\setup.exe** or **b:\setup.exe** (depending on the letter of your disk drive) in the Command Line field and then click **OK**.

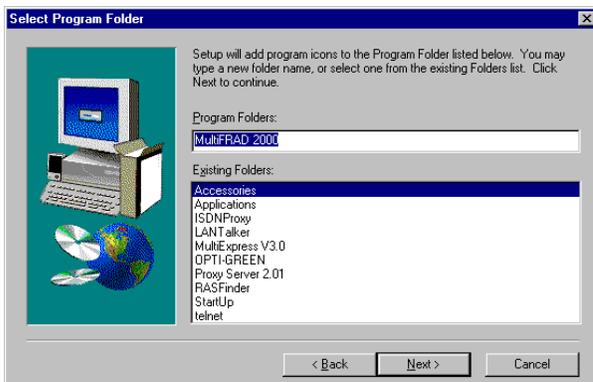


4. Click **Next>** to continue, then follow the on-screen instructions to install your MultiFRAD software.
5. The **Choose Destination Location** screen is displayed.

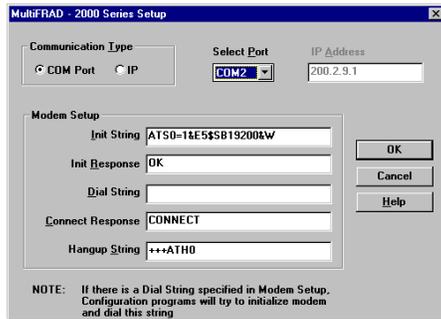


Accept the default (**MF2000**) by clicking **Next>** (or pressing the Enter key); otherwise, click **Browse** to select a different folder for your MultiFRAD software.

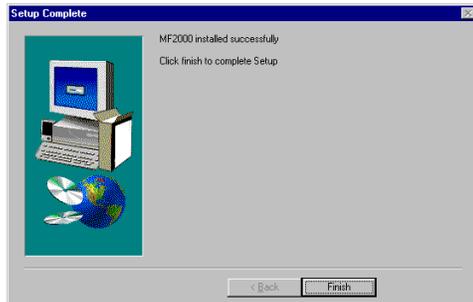
6. The **Select Program Folder** screen is displayed. Click **Next>** to continue.



After all the program files from both disks are loaded, the **Setup** dialog box is displayed, enabling you to designate the COM port of the PC that is connected to your MultiFRAD. On the **Select Port** field, click the down arrow and choose the COM port of your PC (COM1 -- COM4) that is connected to your MultiFRAD. Click **OK** to continue.



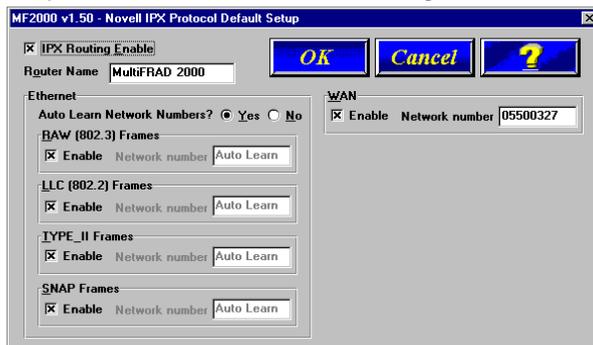
7. The **Setup Complete** screen is displayed.



8. Click **Finish** to continue configuring your MultiFRAD. The **Do you want to download default setup?** dialog box is displayed.



9. Click **Yes** to continue. A series of five Setup and Configuration dialog boxes will now be displayed. The On-Line Help system provides detailed explanations of each dialog box and option. To access Help, click the ? button on the dialog box for which you need additional information.



If your network protocol is **IPX**, continue with the following steps. If your network protocol is **IP**, click the **IPX Routing Enable** check box to clear it and disable IPX, then click **OK** and proceed to step 14.

10. **Router Name:** You can either use the default Router Name (MultiFRAD 2000) or assign a new Router Name in this field. The Router Name must be a printable ASCII string of a maximum of 47 characters. The MultiFRAD uses this name to advertise its service throughout the IPX internetwork.
11. **Ethernet:** You can enable or disable Auto Learn Ethernet Network Numbers by clicking Auto Learn Ethernet Network Numbers to check or uncheck the box.

If your network DOES NOT include a file server, we recommend disabling Auto Learn; the MultiFRAD or the network administrator can assign the network numbers.

If your network DOES include a file server, we recommend enabling Auto Learn and allowing the MultiFRAD to learn the IPX network numbers from the file server. **WARNING:** If the file server and MultiFRAD lose power, the MultiFRAD may reboot quicker than the server and assign the network numbers before the file server can; the MultiFRAD polls the server 20 times and if it receives no response it will assign the network numbers.

If you select **No** for Auto Learn, record the network numbers assigned by the network file server for each of the four frame types (Raw (802.3), LLC (802.2), EthernetII (Type II), SNAP) in the space provided below.

**RAW** (802.3) Frames Network Number \_\_\_\_\_  
**LCC** (802.2) Frames Network Number \_\_\_\_\_  
**TYPE\_II** Frames Network Number \_\_\_\_\_  
**SNAP** Frames Network Number \_\_\_\_\_  
**WAN** Network Number \_\_\_\_\_

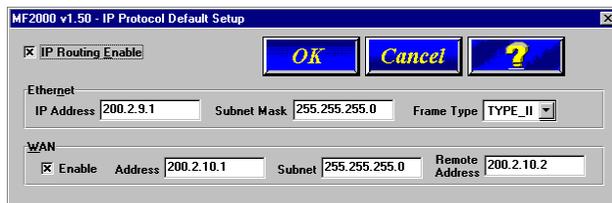
When you manually assign network numbers, you must make sure they match the network numbers assigned to your local file server (if any).

12. **WAN:** Enter the WAN network number for the Frame Relay WAN Port by clicking the Network Number box, backspacing through the default number, and entering your new WAN Number. Make sure the WAN network number is the same as the MultiFRAD on the other end of the link.

The WAN network number has to be assigned by the Network Administrator and must be unique throughout the entire internetwork.

**Note:** The WAN port does not have the capability of learning the network number, unlike the LAN port (i.e., the WAN port does not have a file server).

13. Click **OK** when you are satisfied with your selections.
14. If you clicked **OK** from the IPX Protocol Default Setup dialog box (step 9), the IP Protocol Default Setup dialog box is displayed.

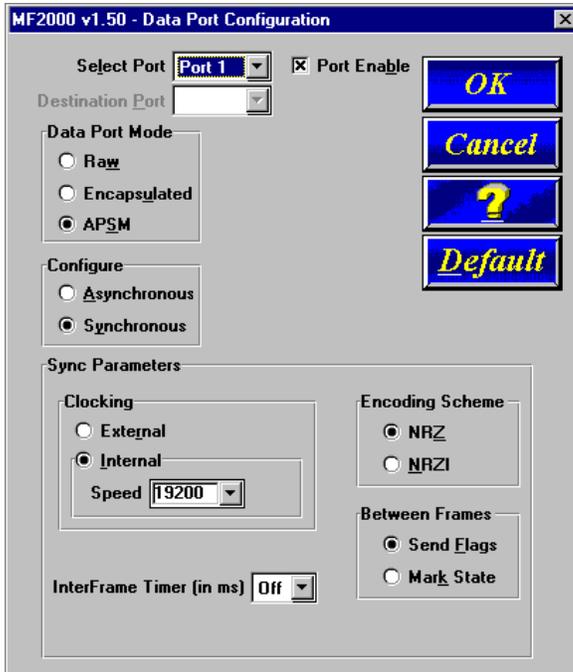


15. To change the IP parameters, proceed to the next step. Clicking **OK** advances to the WAN Ports Default Setup dialog box. The WAN Ports Default Setup starts at step 21.
16. The default Ethernet IP Address has to be changed to your unique LAN address. Enter an acceptable, unique **IP address** in the Ethernet port IP Address field.
17. Change the default **Subnet Mask** and **Frame Type** to the values you have assigned to your LAN port.
18. The default WAN Address has to be changed to your unique WAN address. Assign an acceptable unique **WAN Address** to the WAN port.
19. Change the default **Subnet Mask** and **Remote Address** for WAN to the values you have assigned to your WAN.
20. Click **OK** when you are satisfied with your selections.
21. The **WAN Ports Default Setup** dialog box is displayed. The WAN Port is enabled in this dialog box. Frame Relay is also enabled. If your WAN port is going to be used in Point-to-point protocol, click **Enable PPP**. When PPP is enabled, the Modem Command Setup field becomes active and either Asynchronous or Direct Connect needs to be checked (enabled).



The WAN port can be further configured (after the software installation is completed) by clicking the MultiFRAD Configuration icon and then clicking the WAN button.

22. Click **OK** on the WAN Ports Default Setup dialog box.
23. The **Data Port Configuration** dialog box enables you to individually configure the two data channels (Port 1 and Port 2).



If you are connecting a given port to a synchronous device, ensure that the Clocking type and Speed (for Internal clock only) settings are correct. Also, check that the Encoding Scheme, Between Frames, and InterFrame Timer settings are correct for your channel device. Refer to user documentation for the channel device parameters.

If you are connecting to an Asynchronous data device, select **Asynchronous**, then select the appropriate maximum **Speed** from the drop-down list. Refer to the user documentation for the parameters of the data device.

24. If your MultiFRAD is going to be connected in a Point-to-Point configuration, then **Data Port Mode** defaults to **APSM** and all other modes are inactive.

The **APSM** option is recommended when LAN traffic and both data channels are mapped to a single frame relay DLCI.

The **Encapsulated** option is recommended when a synchronous data channel and LAN traffic are combined on a single frame relay DLCI.

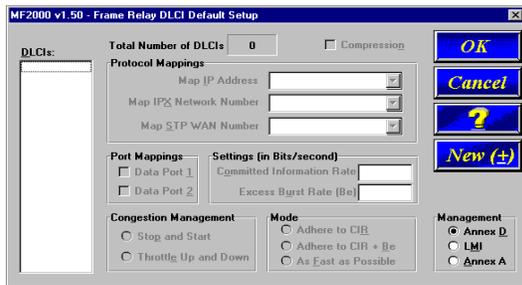
The **Raw** option can be used when there is no LAN traffic and each data channel is mapped to an individual DLCI. This option is also recommended for use when a 3rd party FRAD is interpreting data. In the Raw data mode, the MultiFRAD adds two bytes of header information before sending data from the data channel out on the frame relay network.

25. If your data device is an asynchronous device, click **Asynchronous** to enable it, then set the **Speed** (for Internal Clocking) in the drop-down list. Also select the Word Length, Parity, Stop Bits, etc. for your device. Refer to the user documentation for the parameters of the data device.

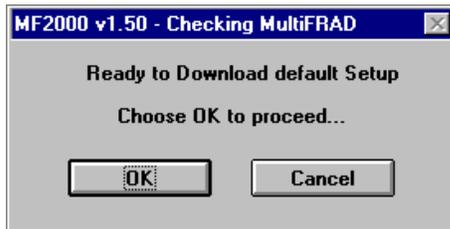
If your data device is a synchronous device, ensure that the clocking is correct, also the Speed if an internal clock is used. Also check that the Encoding Scheme, Between Frames, and InterFrame Timer settings are correct for your channel device, per user documentation.

26. Click **OK** when you are satisfied with the configurations for both data ports. If you enabled PPP in the WAN Ports Default Setup dialog box, proceed to step 28.
27. If you enabled Frame Relay in the WAN Ports Default Setup dialog box, the Frame Relay DLCI Default Setup dialog box is displayed with all the groups inactive. Click **OK** to continue.

When your MultiFRAD is connected to an active frame relay network service, it can detect DLCIs and the frame relay management type. However, at this point your MultiFRAD is not yet communicating with the frame relay network. We recommend that you finish loading the software and then access the frame relay dialog box from the main Setup dialog box.

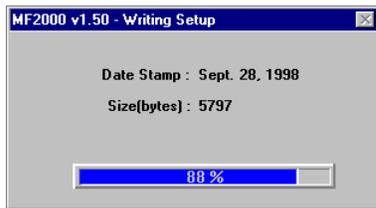


28. The Checking MultiFRAD dialog box is displayed.

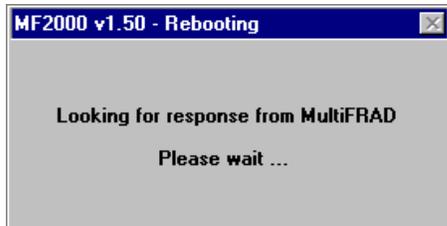


The Setup utility is "Ready to Download default setup Choose OK to proceed." Click **OK** to proceed.

29. Writing Setup dialog box is displayed as the setup configuration is written to the MultiFRAD.



30. After the setup is written to the MultiFRAD, the unit reboots.



31. During reboot, the **Fail** LED on the MultiFRAD is On. Wait for the **Fail** LED to go Off.

32. **Win3.1 users** - you are returned to your Program Manager where the MultiFRAD Program Group and Program Item (Windows icons) have been created.

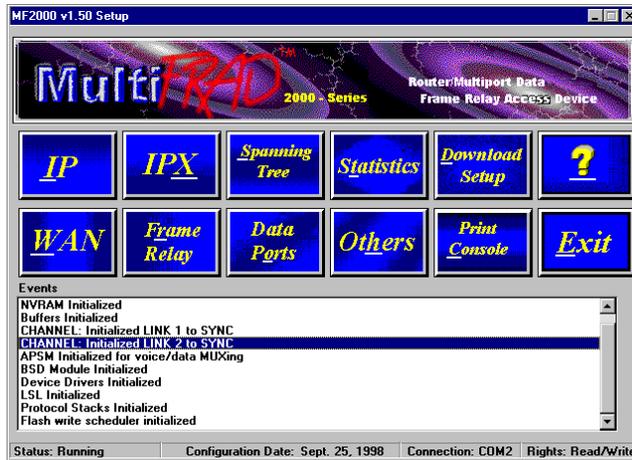
**Win95/NT users** - you are returned to your MultiFRAD 2000 folder which will be visible on your desktop.

Your MultiFRAD is operational at this time.

33. To map the detected DLCIs to your data ports and protocols, proceed with the following steps:

**Win3.1 users** - from the Program Manager, click the **MultiFRAD Configuration** icon in the MultiFRAD 2000 Program Group. The main Setup dialog box is displayed.

**Win95/NT users** - from your desktop, click Programs, MultiFRAD 2000, then **MultiFRAD Configuration**. The main Setup dialog box is displayed.



34. On the main Setup dialog box, click **Frame Relay**.

35. A Frame Relay dialog box stating “MultiFRAD has detected and added following DLCIs.” is displayed.

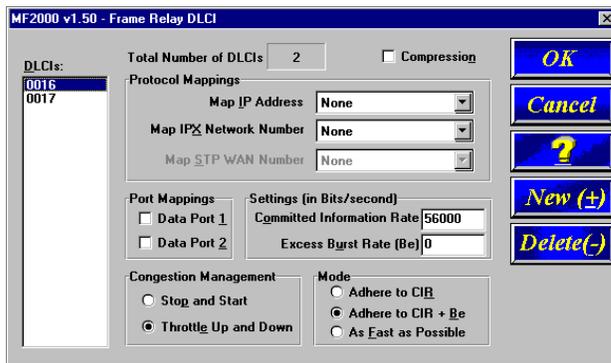


Click **OK**.

36. A second Frame Relay dialog box is displayed, stating “MultiFRAD has detected Management Type to be Annex D. Hence it has set Management type to Annex D from LMI”. The Management Types are Annex A, Annex D, or LMI. Any one of them could appear in this dialog box.



Click **OK** and the Frame Relay DLCI dialog box is displayed.

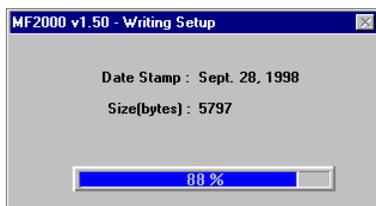


37. Click the DLCI you want to map. The Protocol Mappings, Port Mappings, and all the other groups become active.
38. To map this DLCI to one or more data ports, click (in the **Port Mappings** group) the desired **Data Port** number(s) (1 and/or 2) that you want to associate with this DLCI.
39. Ensure that **Throttle Up and Down** is selected in the **Congestion Management** group.
40. Ensure that **Adhere to CIR + Be** is selected in the **Mode** group. Multi-Tech recommends using this setting initially.
41. Double-click the **Committed Information Rate** text box in the **Settings (in Bits/second)** group and enter the CIR value your service provider supplied for this DLCI.
42. Double-click the **Excess Burst Rate (Be)** text box in the **Settings (in Bits/second)** group and enter the Be value your service provider supplied for this DLCI.

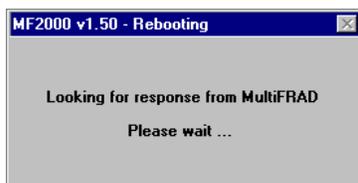
The **Compression** option may be useful at low link speeds; however, do not use this feature with a high speed link.

The **Management Type** is assigned by your frame relay service provider. Do not change this assignment for any detected DLCI.

43. Repeat steps 33 through 42 for each new DLCI.
44. Click **OK** when you are satisfied with all your selections.
45. The Writing Setup dialog box is displayed as the setup configuration is written to the MultiFRAD.



46. After the setup is written to the MultiFRAD, the unit reboots.



47. During reboot, the **Fail** LED on the MultiFRAD is On. Wait for the **Fail** LED to go Off.
48. **Win3.1 users** - you are returned to your Program Manager where the MultiFRAD 2000 Program Group and Program Item (Windows icons) have been created.

**Win95/NT users** - you are returned to your MultiFRAD 2000 folder which will be visible on your desktop.

Your MultiFRAD is operational at this time.

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**MultiFRAD<sup>II</sup>**<sup>™</sup>  
Router/Two-Port Frame Relay Access Device

## Chapter 4 - MultiFRAD Software

**MultiTech**<sup>®</sup>  
Systems 

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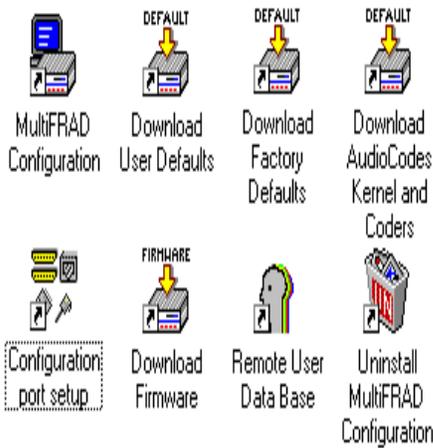
# Introduction

This chapter describes the MultiFRAD 2000 software from an applications approach in how the configuration can be changed with recommendations on the impact of that change. The major configuration parameters were set during your loading of the software and downloading of your configuration at the end of the software installation. The MultiFRAD 2000 software is designed for the Microsoft® Windows® environment.

Recommendations are provided in some case that if you change this parameter or that parameter, it may affect your unit in this way. The approach in this chapter is not to cover every dialog box and describe every option, your new Help menu system provides that information. The Help menus define each button, option, field, and recommend values where applicable. The Help menus are a dynamic help system in that information is presented corresponding to the active dialog box. You do not have to scan through unrelated information in order to find the Help menu you are looking for.

## Before You Begin

To view or change your MultiFRAD configuration in Windows 95/NT, click the Start button, point to Programs, then MultiFRAD 2000, and click MultiFRAD Configuration. You may also start the MultiFRAD Configuration from My Computer by selecting the **mf2000** folder and double-clicking on the Fradcon.exe file in the file list.



MultiFRAD Configuration is discussed in detail later in this chapter. A brief description of the other components is provided here:

### Download User Defaults



This feature allows you to download the user default settings, configured during installation, to the MultiFRAD. If you have made changes to the MultiFRAD configuration and wish to revert to the default setup, you can do so through the MultiFRAD 2000 program group.

### Download Factory Defaults



Choose **Download Factory Defaults** to download the factory default settings. If the MultiFRAD is running, you will be queried to reboot. Click **Yes** to continue with the download. You will then be presented with a dialog for **IP Setup**. These screens will contain the original setup information. Click **OK** on each to accept the default settings, or make any necessary changes and then click **OK**. When prompted, click **OK** again to proceed with the download. The default setup will be written to the MultiFRAD. This process may take a few minutes. When it is finished, you will be returned to Windows.



## Download Firmware

This utility allows you to download the firmware to the MultiFRAD. This may be necessary in the case of repair or upgrade. To download the firmware, choose **Download Firmware** from the MultiFRAD 2000 program group, and the **Open** dialog box is displayed (if the MultiFRAD is running, you will be queried to reboot to update firmware; click **OK** to proceed and the **Open** dialog will be displayed).

By default, the software will display the proper firmware from the MF2000 folder. Double-click this file in the **File Name** list.

The **Downloading Code** dialog is displayed, which includes a status bar to monitor the download. When the download is complete the MultiFRAD will reboot. This process will take several minutes. After rebooting, you will be returned to Windows.



## Configuration port setup

### Configuration Port Setup

The Configuration Port Setup utility allows you to set up and configure the command port on your MultiFRAD. This dialog is included in the initial installation process. Although parameters can be changed, be sure to note the current status of the software before making any alterations.

When you installed the MultiFRAD software, you selected to configure the port as either an IP or COM Port. When COM Port is selected, you can assign the proper COM Port and define the modem Init String, Dial String, and various responses. If IP is selected, you can assign a static IP address or select one from the drop-down list. For more information on each individual parameter, refer to the online Help provided with the software.



## Remote User Data Base

### Remote User Data Base

This utility enables you to prepare a database of information concerning your remote users. You can add and remove users from the database or edit information already in the database.



## Uninstall MultiFRAD Configuration

### Uninstall MultiFRAD Configuration

Selecting Uninstall MultiFRAD Configuration will allow you to completely remove all the components of the MultiFRAD program group. Upon selecting this option you will be queried for confirmation. Click **Yes** to continue with the uninstall, or click **No** to abort.

**Note:** You will not be able to use the MultiFRAD without MultiFRAD Configuration. If you remove the components, you will need to reinstall the software.

# MultiFRAD Configuration



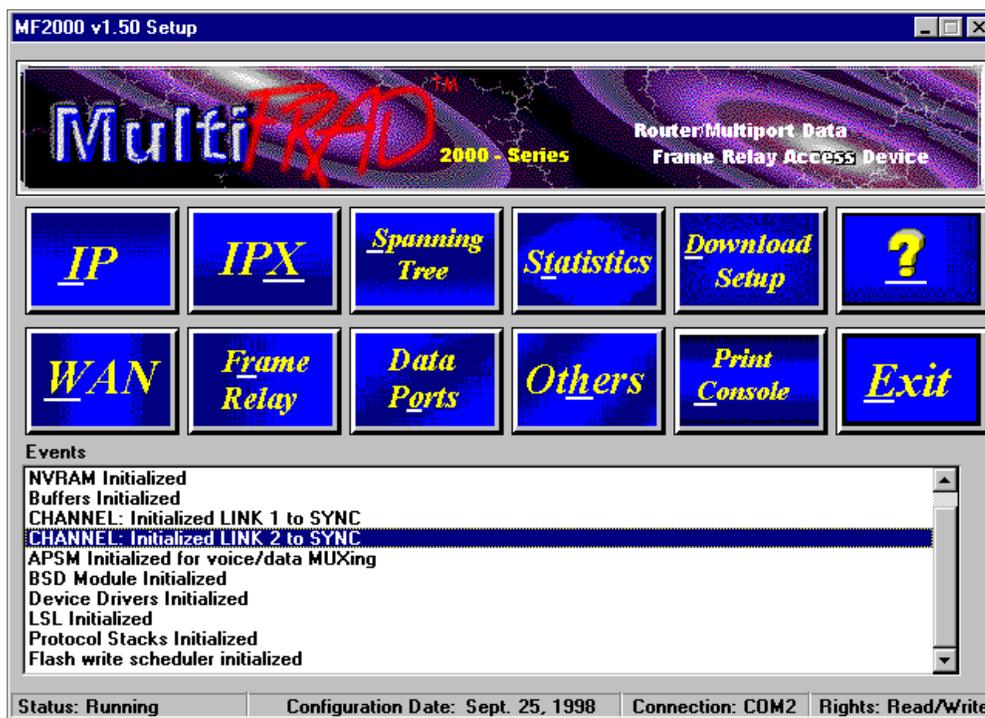
To view or change your MultiFRAD configuration in Windows 95/NT, click **Start | Programs | MultiFRAD 2000 | MultiFRAD Configuration**, or double-click the MultiFRAD Configuration icon in the MultiFRAD 2000 program group. After loading, the **MF2000 Setup** menu will appear.

## Setup Menu

The MultiFRAD 2000 Setup menu consists of 12 buttons in which you can point and click, an Events window, and a status bar. The 12 buttons enable you to display and change the protocol stacks, statistics, WAN port setup, Frame Relay parameters, data port configuration, enable applications such as SNMP Agent, Telnet Server, Web Server, and assign a MultiFRAD password.

The Events window is a reduced size version of the print console that can be a useful troubleshooting tool. Its purpose is to provide timely information about the boot process and ongoing information regarding the status of “events” such as the type of frame relay management selected and which PVCs are active.

The status bar, located at the bottom of the Setup menu, displays MultiFRAD status (e.g.; Running), the date that the unit was configured, the type of connection on the command port; e.g., if the PC connected to the command port is using its serial port to communicate with the MultiFRAD or if the PC is communicating with the MultiFRAD via an Ethernet connection. The last field on the status bar is the Rights field which displays either Read/Write or Read only rights. The first user to connect with the MultiFRAD has Read/Write rights and can change the configuration of the MultiFRAD. The second user has read-only rights and can only *display* the configuration of the MultiFRAD.

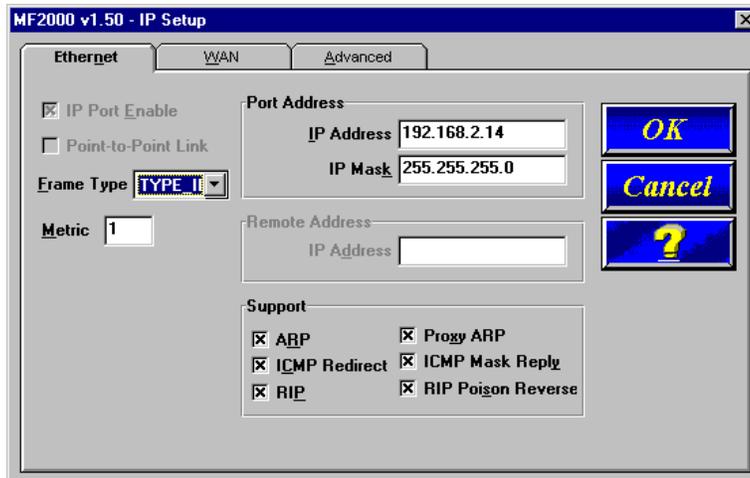


If your WAN port (connected to the DCE device) is configured for frame relay, the button immediately to the right of the WAN button is entitled, “Frame Relay.” However, if your WAN port is configured for Point-to-Point operation, the marking on the button switches from “Frame Relay” to “PPP.”

## IP Setup

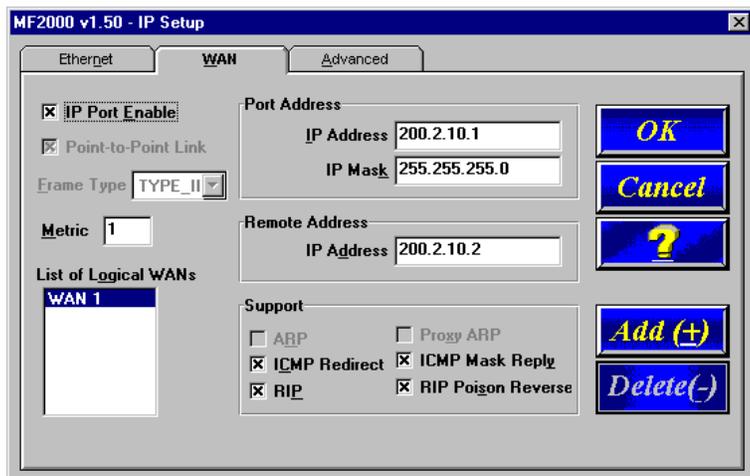
The IP Setup dialog box enables you change the IP routing capabilities, add or delete logical WANs, enable the DHCP relay agent, assign DNS server addresses, and define static routes and a default route. The initial routing capabilities were established during the software installation. You can change IP routing parameters by clicking on the Advanced tab and changing, for example, the RIP Response Time or RIP Route Aging Time. The WAN tab enables you to change the WAN port IP address, the remote address, and if logical WAN ports need to be added for frame relay, you can add them here by merely clicking the Add button.

The Ethernet IP Setup dialog box displays the parameters for your Ethernet port with the IP Address that was established during software installation.



From the Ethernet IP Setup dialog box you can switch to either the WAN IP Setup dialog box or the Advanced IP Setup dialog box by clicking the respective tab.

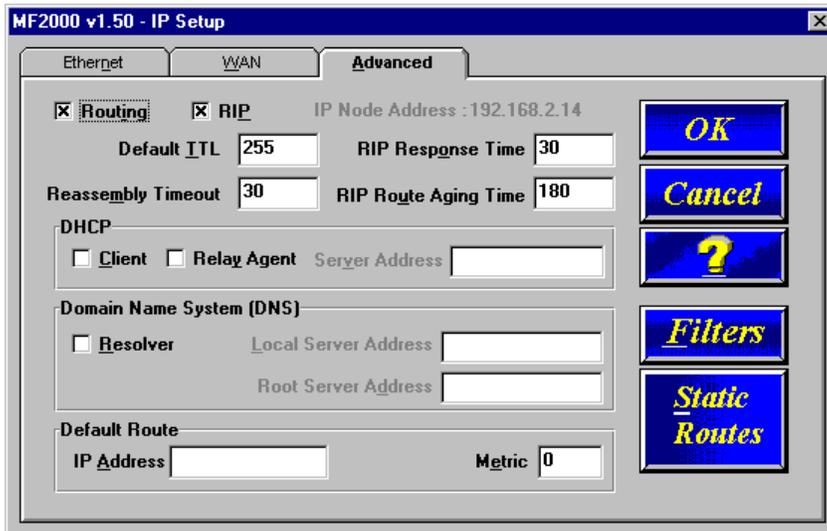
The WAN IP Setup dialog box enables you to disable or enable IP routing on the WAN port, change the port IP Address, mask, or remote IP address. If the WAN port is configured for frame relay, this dialog box enables you to add logical WANs. General setup for the logical IP WAN ports is configured on the WAN Port Setup dialog box that opens when you click the WAN button on the Setup menu.



To add logical WAN in a frame relay configuration, click the Add(+) button and the next WAN number is displayed in the List of Logical WANs window in the lower left corner of the WAN IP Setup dialog box. To delete the last logical WAN assigned, click the Delete (-) button.

The Advanced IP Setup dialog box controls the timers, Dynamic Host Configuration Protocol

(DHCP) and Domain Name System (DNS) options, the default route, filters, and Static Routes.



In most cases, you should not have to change the value of any timer (default TTL, reassembly timeout, RIP response time, or RIP route aging time). The DNS Resolver is supplied for remote Telnet clients when the router is configured for remote access and the terminal server application is enabled.

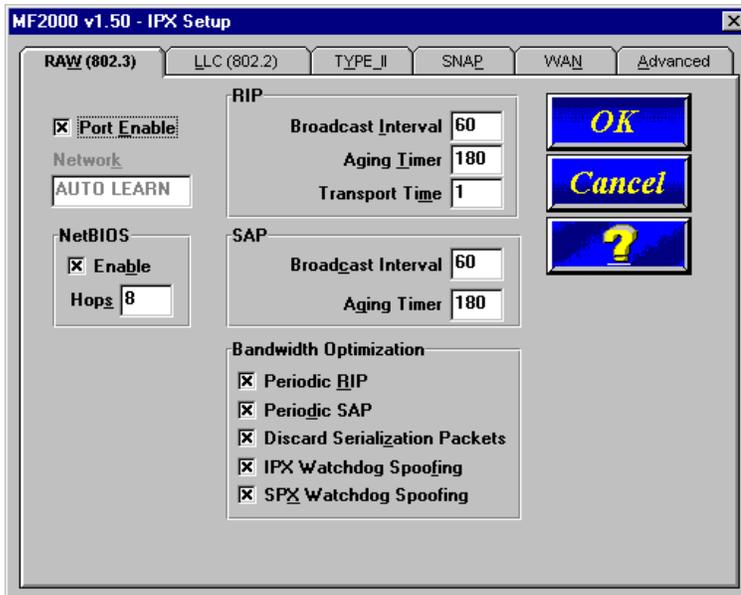
The MultiFRAD is capable of dynamically getting an IP address for a point-to-point client on one of its "client-only" WAN ports. Also, whether or not there is a DHCP server located on the LAN segment, DHCP Relay Agent should be enabled if there are DHCP clients on the LAN segment of the MultiFRAD. The IP address of either the DHCP server or the "next known" DHCP relay agent needs to be entered in the Server Address field.

The MultiFRAD supports DNS for the Terminal Server application; therefore, the dotted decimal IP address or domain name of the host must be specified. Enable DNS Resolver if you want the Terminal server to support Domain names; then enter the addresses of the local DNS Server and the DNS Root Server in the designated fields. The latter is used only if the local DNS server fails to respond.

If you are using Default Routing, disable RIP based routing, then enter the IP host address of the "next hop." The MultiFRAD will automatically resolve the host address to a port number via the IP route table.

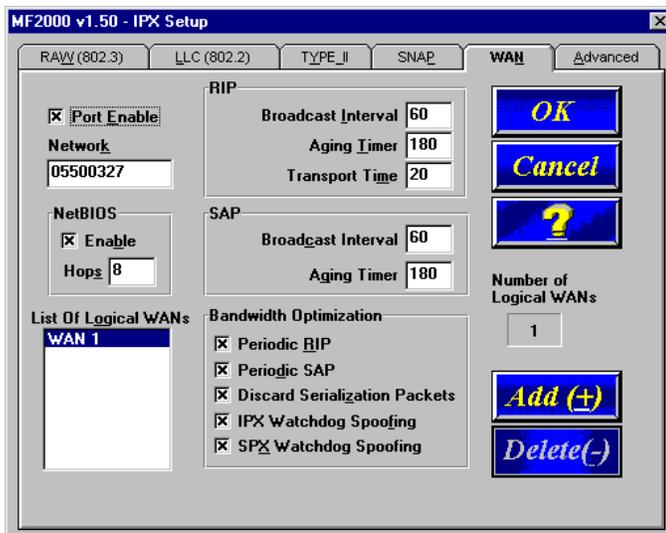
## IPX Setup

The IPX Setup dialog box controls the four frame types; the WAN ports setup; and the advanced tab enables IPX routing, enables auto learn of Ethernet network numbers, and specifies the distributed name of the MultiFRAD.



The RIP and SAP default timers should not have to be changed for most applications. Disabling IPX and SPX Watchdog Spoofing in the Bandwidth Optimization group has proven effective under certain circumstances with Citrix clients.

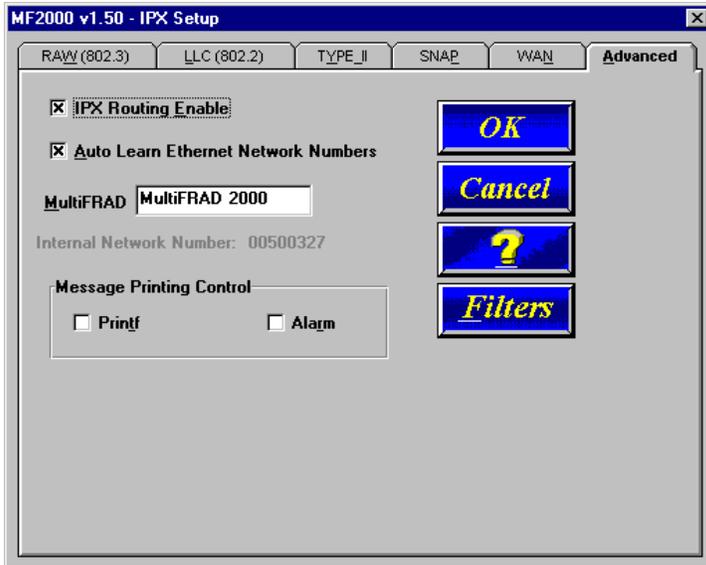
The IPX WAN Setup dialog box lets you to enable or disable IPX routing on the WAN port, change the network number for the WAN port, enable or disable NetBIOS, change the default RIP and SAP timers, and optimize the bandwidth. If the WAN port is configured for frame relay, this dialog box lets you to add logical WANs. How the logical IPX WAN ports are configured is controlled by the WAN Port Setup dialog box that you access by clicking the WAN button on the MultiFRAD Setup menu.



The IPX WAN network number has to be the same on both ends of the link and must be unique throughout the internetwork. If the WAN port is configured in a point-to-point operation, both WAN network numbers have to be the same and unique. If the WAN port is configured for frame relay,

both virtual WAN numbers have to be the same and unique. In a frame relay configuration, the logical WAN network number has to be the same and unique at both ends of the Permanent Virtual Circuit (PVC).

The Advanced IPX Setup dialog box controls the routing of the protocol, enables or disables auto learn of Ethernet network numbers, specifies the broadcast name of the MultiFRAD, and defines any IPX filtering by filter type, port number, and IPX address.

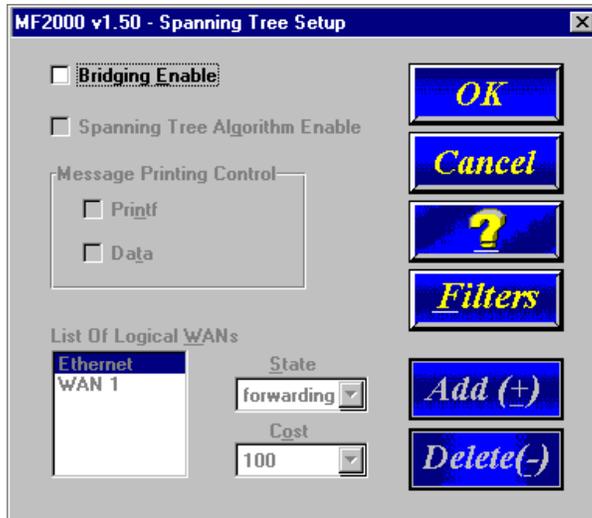


If bridging of IPX packets is desired, IPX routing must be disabled and frame type support for the frame type must be enabled.

If there is a server on the local segment, IPX network number auto learn should be enabled. If there is no server, or if for some reason the router comes up before the server, the router will default to some random network numbers after a short interval of time.

## Spanning Tree Setup

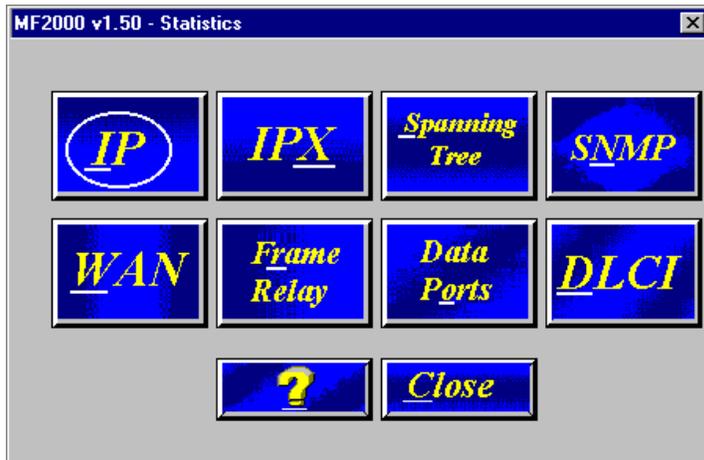
When the Bridging Enable option is enabled, the Spanning Tree Setup dialog box controls transparent bridging; however, if there are any loops or redundant links in the internetwork, the Spanning Tree Algorithm Enable option must also be enabled. Spanning Tree is a method of transparent bridging, as opposed to source route bridging which the MultiFRAD does not support.



The MultiFRAD defaults with one logical WAN port mapped to a DLCI. It is not necessary to map this port to a DLCI; however, care should be taken if an additional logical WAN is created. An additional WAN will default to a disabled state, and it must be mapped to a DLCI before it can be used. In most applications, the forwarding state should be enabled on the first logical WAN, and blocking should be set up on any additional WANs. While in operation, the MultiFRAD will automatically transition from blocking to forwarding, and vice versa, as necessary.

## Statistics

The Statistics dialog box enables you to view statistics on the major events of the MultiFRAD. The Statistics dialog box changes depending on the way the WAN port is configured. If the MultiFRAD is configured for point-to-point operation, the button to the right of the WAN button changes from "Frame Relay" to "PPP" and the DLCI button will no longer be active. If the WAN port is configured for frame relay, then the button to the right of the WAN reads "Frame Relay" and the DLCI button is active.



Statistics can be a useful troubleshooting tool. For example, the WAN Statistics show whether the MultiFRAD is sending or receiving on its composite link or WAN port. When the MultiFRAD is configured in a frame relay mode, it will transmit management frames approximately every ten seconds, trying to establish communication with the provider's switch. If the unit is sending frames but not receiving any, this may be an indication of a problem with the link device or the frame relay network. Statistics in the frame relay dialog box show the actual number of management frames sent and received, and can also indicate a link or frame relay network problem. (One way to determine if a problem is local would be to set your DSU to internal clocking and put it in loopback mode using an RJ-45 DSU loopback cable. If the MultiFRAD, cable, and DSU are all functioning properly, the WAN statistics will reflect that fact by showing the same number of bytes received as transmitted.)

Another useful screen is DLCI Statistics, which shows the status of the PVC; e.g., it indicates whether the selected DLCI is "active" or "inactive" and shows if the MultiFRAD is experiencing network congestion (reflected by FECNs or BECNs received).

## IP Statistics

IP is a connection-less network protocol that resides in the network layer of a conventional OSI layered model (for more information on this model, refer to Appendix C). Depending on what is going on at the application layer, IP will typically use one of two transport layer protocols. User Datagram Protocol (UDP), is a connection-less transport layer protocol used with TFTP or SNMP; and Transport Control Protocol (TCP) is a connection-oriented transport layer protocol used with FTP, Telnet, and SMTP.

Packets			
To Transmit	176	Could not be forwarded	0
Received	289	Discarded for Lack of Route	0
Forwarded	0	Received with Header Errors	0

UDP Packets			
Transmitted	176	Received with Errors	0
Received	175	with Unreachable Destination	32

TCP			
Packets		Number of	
Transmitted	0	Successful Connections	0
Retransmitted	0	Connection Attempt	0
Received	0	Packets	
		Received with Errors	0
		Transmitted with RST	0

UDP makes use of the port concept and has no measures for flow control, reliability, or error recovery. It is used when the full services of TCP are not required, and the reliability measures must be assumed by another layer.

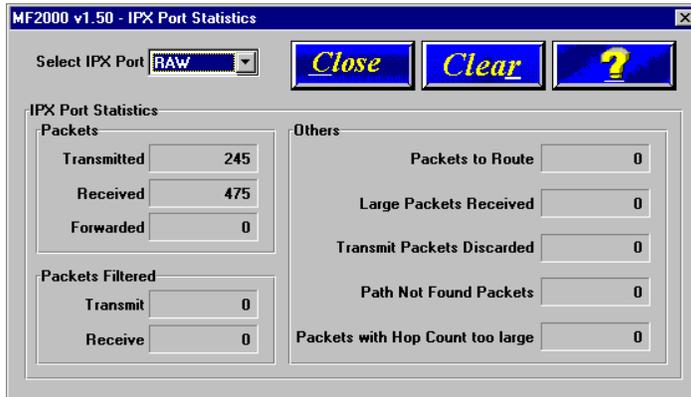
TCP works well in environments where the reliability measures are not assumed by other layers. It is connection-oriented and has a full range of services.

These statistics are primarily informational, and their use as a troubleshooting tool will be contingent on the applications running in the upper layers. For instance, if you were having problems connecting to MultiFRAD's Web server, you would look under the TCP section to make sure connections are being established. If not, perhaps the Web server is not enabled. Or, if you were having problems establishing a remote connection through TFTP, you could look in the UDP section to see if any packets are being received. If not, you may need to review your network addressing.

The Port Tab enables you to view generic IP statistics for a given Ethernet IP Port. The statistics for either the Ethernet (LAN) port or any logical IP WAN port can be viewed in this window. The practicality of statistical use in troubleshooting will depend on the application running in the upper layers.

## IPX Port Statistics

The IPX Port Statistics dialog box displays information pertaining to the IPX Port; for example, the frame type used or the number of packets transmitted/received.

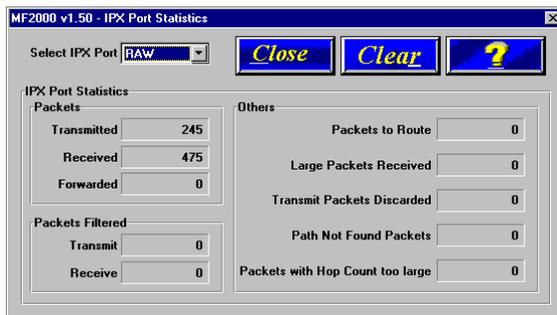


IPX is a network layer protocol usually associated with Novell Netware™ networks. It allows for encapsulation of four different frame types over a single physical LAN connection (provided each frame type has a unique network address): RAW (802.3), LLC (802.2), Ethernet II, and SNAP.

These statistics are mostly informational but could be useful for troubleshooting. For instance, if there was a question as to which frame type your workstation was using, you could view the statistics for each frame type and determine which one is being used by the amount of packets transmitted and received.

## STP (Spanning Tree) Port Statistics

The STP (Spanning Tree) Port Statistics dialog box displays information regarding the selected STP port, for example, the number of frames discarded or forwarded.



Spanning Tree transParent (STP) bridging is the method of bridging used by the MultiFRAD as specified in an IEEE 802.1D telecommunications standard. Enabling the spanning tree algorithm in addition to spanning tree bridging provides for a loop-free environment with redundant paths (if present) that will transition automatically from blocking to forwarding any time a root bridge failure occurs.

The STP Port statistics are mostly informational but can also be useful for troubleshooting. For example, you can check the number of forward transitions to ensure that the port has been active (in which case forward transitions will be greater than zero).

## SNMP Statistics

The SNMP Statistics dialog box provides statistical information on Simple Network Management Protocol (SNMP).

Packets Received with	
Set Request	0
Get Request	0
Get Next Request	0
Get Response Request	0
Bad Values	0
Bad Communities	0
Bad Community Uses	0
No Such Names Error	0

Packets	
Transmitted	0
Received	0

Asn Parse Errors	
Asn Parse Errors	0

Traps Received	
Traps Received	0

Others	
Transmit Variable too Big	0
Read Only Packets Received	0
Total Set Variable Packets Received	0
Total Request Variable Packets Received	0
Packets Sent with Get Response Request	0
Packets Received with Wrong Version	0

SNMP is an application layer protocol that facilitates the exchange of management information between network devices. There are three key components in SNMP: the devices that are to be managed, agents, and the network management systems. The managed device is the network device, such as a router. The agent is the network management software module residing in the managed device. The network management system runs the SNMP application that controls the managed devices and monitors their status. Four primary operations (Set, Get, Get Next, and Trap) are performed using SNMP and monitored for display on this screen of statistics.

You can use these statistics as a troubleshooting aid should you have a problem communicating with the MultiFRAD from your SNMP manager.

## WAN Statistics

The WAN Port Statistics dialog box provides statistical information regarding the MultiFRAD's WAN port, including the number of packets transmitted/received, and to transmit, and the number of bytes transmitted/received.

This dialog box monitors the traffic on the MultiFRAD's composite link (WAN) port. The Statistics that fall into the "Others" category relate to the physical layer between the MultiFRAD and the link device; i.e. the CSU/DSU. These statistics can be helpful in troubleshooting suspected problems in the physical layer; i.e., the WAN port itself, the link device (CSU/DSU), and any associated cabling.

## Frame Relay Statistics

The Frame Relay Management Statistics dialog box can be a useful tool for troubleshooting MultiFRAD installations and monitoring the performance of active links, and checking that the MultiFRAD is talking to the provider's switch.

The **Polling Details** section lists the various management frames sent and received. For every Status Enquiry Sent, a Status Response should be received from the network. Likewise, for every Full Status Enquiry Sent, there should be one Full Status Response received. The two status enquiry types are used by the FRAD to verify that the frame relay network is operational, and to determine which DLCIs are active. Under default settings a status enquiry is sent every ten seconds, and every sixth enquiry will be a Full Status Enquiry.

The Enquiries Sent and the Responses Received should increment together, and should be equal under normal circumstances. Any gap between them reflects a breakdown in communication with the provider's switch, and will be reflected as Missed Status Responses.

The **Status Errors** section lists the number of errors that have occurred. A Missed Status Response means the frame relay network did not respond to a status enquiry from the MultiFRAD before the next status enquiry was sent (by default there are 10 seconds between status enquiries).

A **Sequence Number Error** means the sequence numbers in a received status response did not match what the MultiFRAD expected based on its Status Enquiry. Basically, the Status Enquiry has two numbers (or counts), and one should be incremented by the network and then both numbers should be returned to the FRAD in the Status Response. Sequence Number Errors also reflect missing packets between the MultiFRAD and the switch, but are not a cause for alarm unless they are incrementing rapidly and steadily.

The **Link Details** section records the number of times the frame relay link between the MultiFRAD and the network has gone up (become active) or gone down (become inactive). The Link Details provide a more general picture of the status of communication between the MultiFRAD and the frame relay network.

## DLCI Statistics

The DLCI Statistics dialog box shows the individual DLCI status and statistics. This information can be helpful in determining if the DLCI is active, if it is going up and down, and if the MultiFRAD is experiencing frame relay network congestion (FECNs/BECNs). It also gives an indication of the momentary throughput on individual DLCIs.

When troubleshooting a frame relay circuit, once it has been established that management frames are being sent and received, the next step is to determine whether the DLCIs are becoming active. This dialog box will provide that information. A FRAD needs to be present at both ends for the DLCI to be active. Keep in mind that the frame relay network tells the FRAD the status of the PVC with one of its status responses. But the network will not say the PVC is active until it has established management communication at both ends of the PVC. If the FRADs at both ends of the PVC show that they are communicating with the frame relay network and the DLCI still shows active, and there is a communication problem over that PVC, there may be a problem with your service provider. If all

DLCIs show active at both (or all) locations and there is still an end-to-end communication problem, it is likely that it is in the configuration of the MultiFRAD. At that point, review your protocol stack/data port parameters and DLCI mappings.

## Data Port Statistics

The Data Port Statistics dialog box displays statistical information, such as bytes or blocks received/transmitted, for the two data ports.

This window shows the statistics for both data channels. If you highlight and double-click Port 1 or Port 2 on this screen, you will display another screen of channel statistics and various hardware signals (RTS, CTS, DSR, DCD, DTR) and Xon/Xoff status. This second screen also displays buffer utilization percentage and receive flow control time.

These statistics may indicate that either the data channels, or more likely the devices attached to them, are being driven harder than they should be. Excessive buffer utilization and/or receive flow control time can usually be reduced or eliminated by slowing the speed at which the channel is operating.

## WAN Port Setup

The WAN Port Setup dialog box controls how the port is configured (i.e., for frame relay or point-to-point operation). If the WAN port is configured for frame relay, then the mode of the port is set to Synchronous. If the port is configured for point-to-point, then the mode can be either synchronous or asynchronous. If the mode is asynchronous, then the connection method can be either answering or dialing. If the connection method is dialing, then a number to be dialed has to be entered in the dial number field and the modem type chosen in this field.

If the Frame Relay Device Driver is enabled, the MultiFRAD encapsulates data on its composite link for transmission over a frame relay network. Enabling this device driver requires additional frame relay configuration by clicking the Frame Relay button on the MultiFRAD Setup menu.

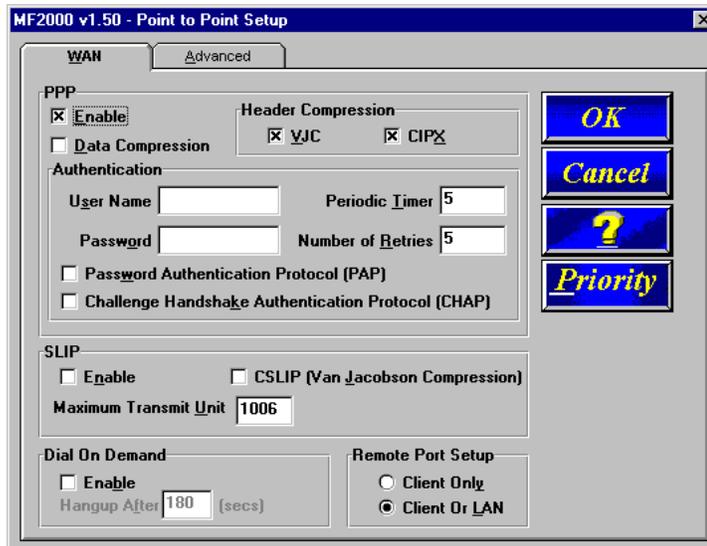


If the PPP/SLIP device driver is enabled, the MultiFRAD is configured for point-to-point operation for transferring packets between two end points. Devices at the end points can be either asynchronous or synchronous. If an asynchronous device is used, the MultiFRAD can be used as a single port remote access server. When the PPP/SLIP mode is used, further configuration is required using the PPP button on the MultiFRAD Setup menu.

## Point to Point Setup

The Point to Point Setup dialog box controls the WAN port protocol, dial on demand, and remote port setup. The WAN port protocol can be either Point to Point Protocol (PPP) or Serial Line Internet Protocol (SLIP). PPP is the more robust of the two protocols in that it enables the endpoints to negotiate use of the link and protocol parameters in a standardized way and also provides for standardized encapsulation of the packets. SLIP is an older protocol that requires manual authentication using a script.

To display the PPP dialog box, the WAN Port Setup dialog box has to be configured for PPP/SLIP.



PPP is the default protocol. If SLIP is being used, click on the PPP Enable option to disable PPP. Click on the SLIP Enable option. Determine if the TCP header is going to be compressed using VJC compression. If VJC compression is used, click the CSLIP (Van Jacobson Compression) option.

Two types of password authentication (PAP and CHAP) are supported for remote access clients and can be enabled here on the WAN tab. When either (or both) authentication protocols are enabled, the MultiFRAD expects the client at the other side of the link to be configured with a User Name and Password combination that is listed in its database. (Note: if there are no entries in the User database, any User Name and Password combination from a peer will be authenticated. For MultiFRAD-to-MultiFRAD connections, authentication normally is not used and the User Name and User Password fields are left empty.)

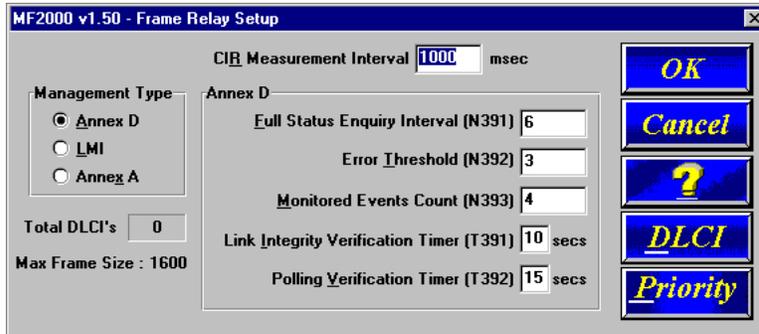
Enable SLIP if you are using this older protocol for communication on a dial-out WAN port. Either PPP or SLIP can be used on a dial-out port; however, on answering ports the MultiFRAD detects automatically the type of connection. If you enable CSLIP, the MultiFRAD will transmit and receive CSLIP packets. Packet size is limited by the Maximum Transmit Unit (MTU) value, for which the maximum setting (also the recommended setting) is 1006.

If you enable Dial On Demand, the MultiFRAD will bring down the connection on the WAN link when there is no real data traffic on the line and will automatically bring up the WAN link when there is a need to get data across. (This option is not applicable for a direct-connect link.) The 180-second setting for "Hangup After" sets the DTR signal low three minutes after hangup, bringing down the connection.

For Remote Port Setup, the default is Client Or LAN; i.e., the point-to-point peer can be either a dial-up client or another MultiFRAD. If the peer is a dial-up client, enabling the Client Only option lets you save on IP address since the client's IP address will belong to the LAN network; also, the IP address of the MultiFRAD's WAN port will be the same as the IP address of its LAN port.

## Frame Relay Setup

The Frame Relay dialog box displays the CIR Measurement Interval in milliseconds, the Management Type and details of that management type, and the number of DLCI's that are active. The MultiFRAD can detect DLCIs and the Management Type when you are connected to an active frame relay service. So it is important that if you change any frame relay parameters, that the new parameters agree with the way your frame relay service is provisioned.



In the Frame Relay Setup dialog box, you can change the Management Type by choosing one of the three options and then the detail parameters for that option are displayed to the right of the Management Type. For example, in the above dialog box, Annex D is the chosen management type with the Full Status Enquiry Interval [N391] set to 6 down thru Polling Verification Timer [T392] set to 15.

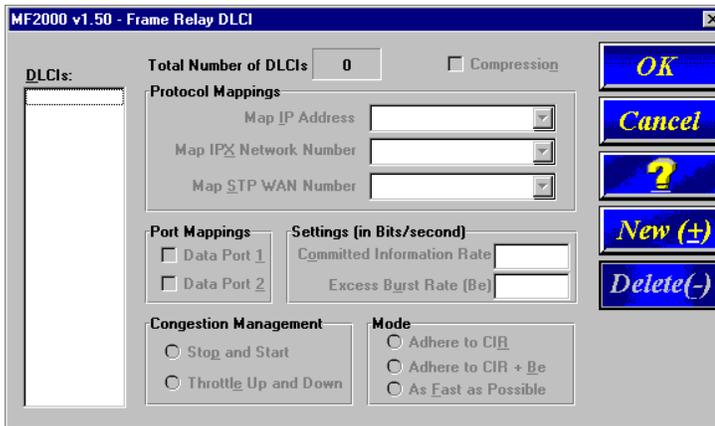
Usually, you will have no need to change the management type because the MultiFRAD will automatically detect the network's management type at power-up, or when the network becomes active. This auto-detection feature takes about 1 to 2 minutes to detect the management type and get a list of the DLCI's.

Occasionally the Management Type parameters can be changed to correct a problem. In these cases, making the following changes could alleviate the problem:

1. Change the **Link Integrity Verification Timer**. This feature sets how often the MultiFRAD verifies that the link is good. Reducing the setting from the default value of 10 seconds to a lower value; e.g., 5 seconds, will increase the frequency of those verifications.
2. Change the **Full Status Enquiry Interval** to affect how often DLCI Status is updated. This parameter defines how often the MultiFRAD will send a request for DLCI status information along with the Link Integrity Verification request. The default value is to include such a request every sixth time the link integrity is checked. A value less than every sixth request will enable faster detection of active/inactive DLCIs, but will also produce a slight increase in management overhead.
3. Change the **Monitored Events Count** and the **Error Threshold** to affect the MultiFRAD's sensitivity to errors on the link. Every management frame received by the MultiFRAD is considered an event, and if the link integrity sequence numbers are wrong, for example, it is considered an "errored" event. With the default settings, if **Error Threshold** is 3 and **Monitored Events Count** is 4, and 3 out of 4 events are "errored", then the link is considered to be bad, and the FRAD stops sending on all DLCIs and restarts the initial procedures to activate the link.
4. Change the **CIR Measurement Interval** to change the time frame in which the FRAD calculates throughput for each DLCI. By default, every 1000 milliseconds (1 second), the MultiFRAD calculates how much information has been sent on each DLCI, and depending on the congestion management option for a DLCI the MultiFRAD may stop sending on that DLCI because it has exceeded its CIR or CIR+Be rating. By changing the CIR Measurement interval, the throughput calculations can be made more or less often.

**Note:** performance could be compromised if the MultiFRAD is set to calculate throughput too often.

If you click the DLCI button on the right side of the dialog box, the Frame Relay DLCI dialog box is displayed.

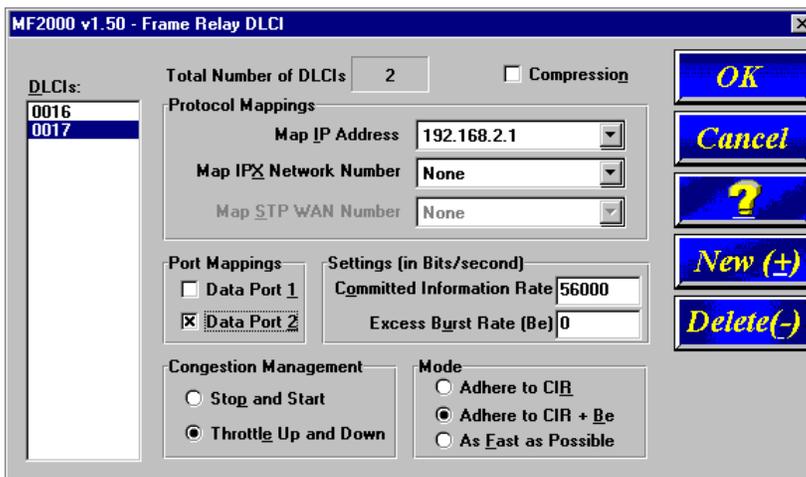


If you are connected to a frame relay service, this dialog box should display your current DLCI numbers automatically. It also shows the protocol mapping of the highlighted DLCI, which data port it is mapped to, and how you set up your Congestion Management, Mode, CIR, and Be values. To change the mapping of a DLCI, highlight the DLCI number in the DLCIs: window on the left side of the dialog box. The dialog box will then change to the mapping of that DLCI. To add a new DLCI that has not been auto detected, click the New (+) button and the Frame Relay New DLCI dialog box is displayed.

To add a new DLCI Number, enter the number in the Enter DLCI Number window. You do not have to enter the leading zeros.



When you click the OK button, the new DLCI appears in the DLCI's window in the Frame Relay DLCI dialog box.

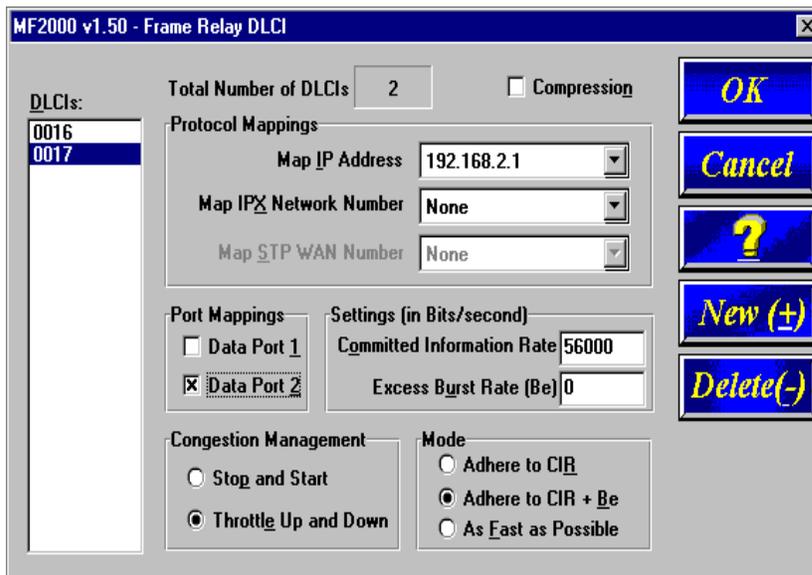


When a DLCI has just been detected, or if you have just created a new DLCI, it has not yet been mapped to a protocol address or a data port. The default Congestion Management, mode, CIR, and Be are displayed. You should verify these default settings with how your new DLCI is provisioned by your service provider.

Congestion Management, Mode, and CIR/Be settings are used to avoid congestion and possible loss of data. The Committed Information Rate (CIR) and Excess Burst rate (Be) settings are throughput amounts determined by the network and user when each DLCI is ordered. The CIR is the basic throughput which the network will try to set aside for that DLCI. It will always be equal to or less than the actual access rate of the physical line (i.e., if the frame relay physical link is a 56K DDS line, the sum of the CIRs of all DLCIs on that link should not exceed 56K bps). The Be is the excess burst throughput rate (added to CIR) that the network should accept for that DLCI before significant loss of data occurs due to the discarding of frames during times of congestion. Note, however, that in frame relay there is no absolute guarantee of a congestion-free link, regardless of CIR and Be settings. The CIR and Be settings on the MultiFRAD should match the settings that the network has provisioned.

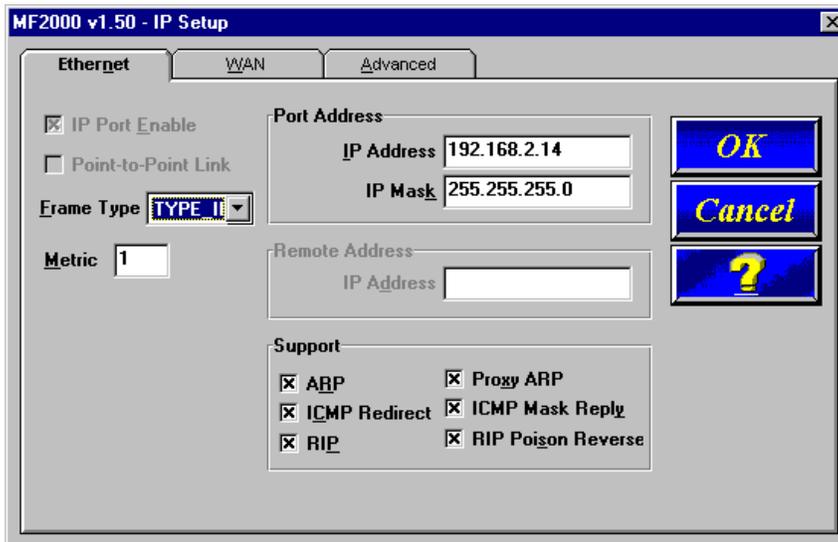
The Congestion Management and Mode settings determine how the MultiFRAD handles congestion. The Mode selects whether the MultiFRAD should use its own throughput calculations to avoid congestion, or simply send data to the network as fast as possible. The MultiFRAD calculates throughput after every CIR Measurement Interval, and can limit throughput to either the CIR (Adhere to CIR) or the CIR plus the Be (Adhere to CIR+Be). The Congestion Management setting selects whether the MultiFRAD should stop sending data when congestion is indicated (Stop and Start), or gradually reduce throughput during times of congestion (Throttle Up and Down).

Compression can be enabled on a per-DLCI basis by clicking on the Others-Compression box. If compression is required, it must be enabled on both the local and remote ends of the PVC.



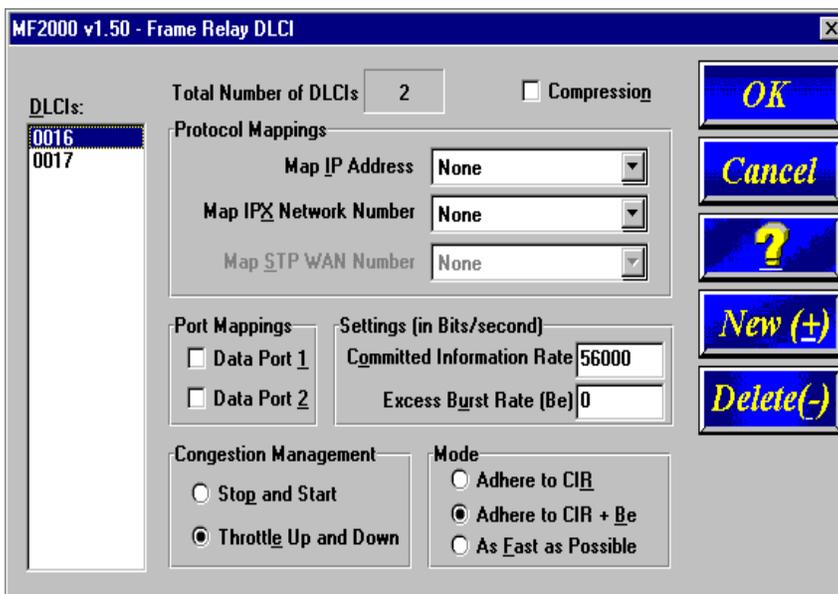
To map a new DLCI (e.g., 17) to a protocol, return to the MultiFRAD Setup menu and then click the protocol stack that you are using. In the lower left part of the protocol stack dialog box a list of Logical WANs is displayed. To add a new logical WAN, click the Add (+) button and the next logical WAN number will appear in the list on the left hand side of the dialog box.

For example let's map our new DLCI 17 to the IP protocol as a WAN 2 with an IP Port Address of 192.168.2.1, an IP Mask of 255.255.255.0, and a remote IP Address of 192.168.2.2. From the MultiFRAD Setup menu, click the IP button. The IP Setup dialog box is displayed. Click the WAN tab at the top of the dialog box. The WAN parameters are displayed. Click the Add (+) button and WAN 2 is added to the List of Logical WANs. Default IP addresses will be displayed for the Port Address and Remote Address and a default IP Mask will appear in its window. If either address or mask needs to be changed, click the appropriate window and change the numbers.



When you click the OK button in the IP WAN dialog box, you now have an IP address for a second logical WAN. Now we have to tie that IP address to a DLCI which in our example is DLCI 17. Now, return to the Frame Relay DLCI dialog box and highlight DLCI 17. Click the Protocol Mappings Map IP Address down arrow and the IP address 192.168.2.1 appears. Click this address and now IP address 192.168.2.1 is mapped to DLCI 17.

We now have WAN IP address 192.168.2.1 from the IP protocol stack mapped to DLCI 17. Let's say we also want to map a data channel to DLCI 17. The data ports that are already mapped to other DLCIs are grayed out. In our example, let's map data port 3 to DLCI 17. Simply click Port 3 in the Data Port Mappings group and an X appears in the box at the left of Port 3. Now we have both data port 3 and IP WAN address 200.2.11.1 mapped to DLCI 17. The MultiFRAD enables multiple sources of data to be mapped to the same DLCI because the MultiFRAD multiplexes all the data onto the DLCI. In other words, bandwidth for that DLCI is shared by all the data sources mapped to the DLCI. Of course this means that all the data sources must go to the same remote site, since the frame relay network will send all data on DLCI 17 to the same place.

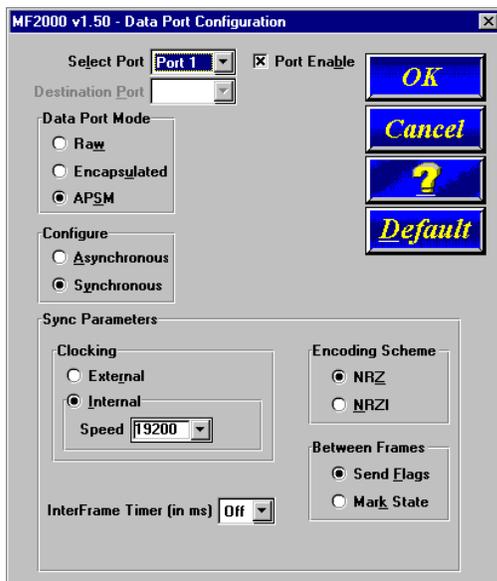


## Data Port Configuration

This dialog box lets you leave both data ports enabled for normal data transfer operations or disable a given port if you do not want to transmit or receive data over it. The Destination Port parameter will be active only if both data ports have been mapped to the same DLCI.

For point-to-point operation, only APSM mode will be enabled. For frame relay operation, APSM mode allows both data ports and any protocol stacks to be mapped to a single DLCI. Encapsulated mode allows data from only one port with any other protocol mapping through a given DLCI. Raw mode allows the data of only one port to be transmitted, and the other port will not be able to transfer data on that DLCI.

For an asynchronous device, select Configure Asynchronous and configure the MultiFRAD to match your device. For a synchronous device, select Configure Synchronous, then configure the MultiFRAD to match your synchronous device. The Data Port Configuration dialog box also enables you to configure both data channels independently.



For example, Port 1 could be connected to a Multi-Tech MultiMux MMH904 and configured with the following options:

- ' Data Port Mode set to **APSM** (Advanced Priority Statistical Multiplexer),
- ' **Synchronous** Configuration,
- ' **Internal** Clocking with Speed set to **19200**,
- ' Encoding Scheme set to **NRZ** for all Multi-Tech Muxes,
- ' Between Frames set to **Send Flags**, and
- ' InterFrame Timer (in ms) has to be **Off**.

The MMH904 would have to be configured for an external composite link device. This means that the 8-position DIP Switch on the MMH904 would have to be toggled to the closed position and an external composite link cable connected between the MMH904 and the MultiFRAD **Channel 1** connector.

In most applications, the encoding scheme, interframe timer, and between frames will be used at their default settings. If you are unsure of your device's configuration, start with the defaults or refer to your device's documentation.



## Chapter 5 - Remote Configuration and Management



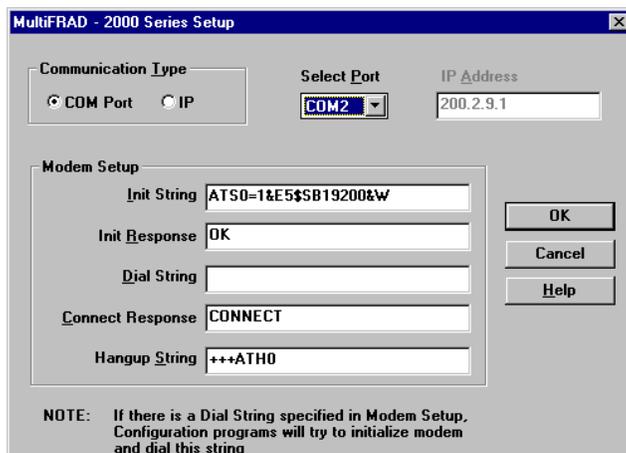
## Introduction

This chapter provides procedures for changing the configuration of a remote MultiFRAD unit. Remote configuration enables a PC at one site (local site) to dial a remote MultiFRAD and change the configuration of that remote unit. Remote configuration can be accomplished either directly through the LAN or remotely using modems. To remotely configure a MultiFRAD, a local PC needs to be connected to a dial-up line and the MultiFRAD software configured to call the remote MultiFRAD. The remote MultiFRAD needs to have a modem connected to a dial-up line and the Command Port. Once the connection to the remote unit is made, you can change the configuration as you see fit. Once the configuration is changed, you can download the new configuration to the remote MultiFRAD. Refer to the Modem-Based Remote Configuration Procedure in this chapter to remotely configure a MultiFRAD.

To configure the remote MultiFRAD through the LAN, change the communication type to the IP based Trivial File Transfer Protocol (known as TFTP) and change the configuration as you see fit. Refer to the LAN-Based Remote Configuration Procedure in this chapter to configure a remote MultiFRAD.

## Modem-Based Remote Configuration Procedure

- 1 At the remote site, remove the serial cable from the PC to the Command Port connector on the back panel of the MultiFRAD.
- 2 At the remote site, connect a special cable (Remote Configuration Cable) between the Command Port connector on the MultiFRAD and the RS232 connector on the modem. The special cable is a serial cable with male connectors on both ends. Refer to Appendix A for cable details.  
Connect the modem to your local telephone line.  
Provide your telephone number to the person verifying your configuration.  
Configure the remote modem for 19200 baud and turn on Force DTR.
- 3 At the main site, connect your local PC to a modem that is connected to a dial-up line.
- 4 Install the MultiFRAD software on the local PC and start the **Configuration Port Setup** program:  
*Windows 3.1x:* double-click the **Configuration Port Setup** icon in the MultiFRAD program group.  
*Windows 95/NT:* Click **Start | Programs | MultiFRAD 2000 | Configuration Port Setup**.
- 5 The MultiFRAD Setup dialog box is displayed.



Verify that the **Communication Type** field is set for **COM port** and the **Select Port** field is set for the COM port of your local PC.

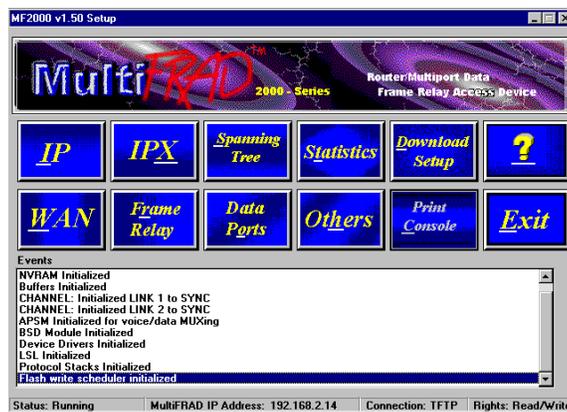
In the **Dial String** field, enter the AT command for dialing (ATDT) plus the phone number of the

remote MultiFRAD.

If your Modem Initialization String, Initialization Response, or Connect Response values are different than the defaults in the dialog box, refer to your modem user documentation and change the default values to match your modem.

Click **OK** when you are satisfied with all your selections.

- 6 You are returned to the Windows program. Start the MultiFRAD Configuration program.  
*Windows 3.1x:* Double-click the **MultiFRAD Configuration** icon in the Program Manager.  
*Windows 95/NT:* Click **Start | Programs | MultiFRAD 2000 | MultiFRAD Configuration**.
- 7 The Dialing Router Dialog Box is displayed while software is dialing the remote MultiFRAD.
- 8 The Reading Setup Dialog Box is displayed.
- 9 The MultiFRAD Setup dialog box is displayed. This is the dialog box of the remote MultiFRAD. Refer to Chapter 4 for a description of each dialog box. For a detailed description of each field within a dialog box, refer to the on-line helps provided within your MultiFRAD software.



- 10 After you have changed the configuration of the remote MultiFRAD, click the **Download Setup** button to update the configuration. The remote MultiFRAD will be brought down, the new configuration written to the unit, and the unit will reboot.
- 11 Click the **Exit** button when the downloading is complete.
- 12 The Hangup connection with Router? dialog box is displayed.  
 Click **Yes** to disconnect the phone connection to the remote site.
- 13 If the same telephone number is not going to be used again in the immediate future, you may want to remove it from the Port Setup dialog box.
- 14 At the remote site, reconnect the MultiFRAD to the serial port of the PC and from the Program Manager screen click the **MultiFRAD Configuration** Icon to verify that the MultiFRAD is running.

## LAN-Based Remote Configuration

### Windows Sockets Compliant TCP/IP Stack

The configuration program requires a Windows Sockets compliant TCP/IP stack. Microsoft provides a TCP/IP stack free for Windows for Workgroups 3.11. TCP/IP protocol software must be installed and functional before the configuration program can be used.

- 1 You must assign an Internet (IP) address for the PC and for each node that will be managed by the configuration program. Refer to the protocol software documentation for instructions on how to set the IP addresses.

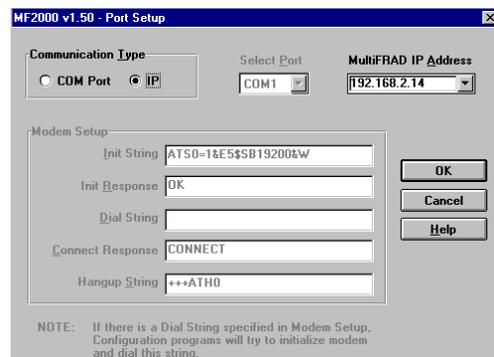
Once you have completed this step, you should be able to use the protocol Ping command for the PC host name. You should also test the network interface configuration by Pinging another TCP/IP device that is connected to the network.

- 2 Install the MultiFRAD software on the local PC and at the Windows Program Manager screen, and run the **Configuration Port Setup** program:

*Windows 3.1x:* Double-click the **Configuration Port Setup** Icon in the MultiFRAD program group.

*Windows 95/NT:* Click **Start | Programs | MultiFRAD 2000 | Configuration Port Setup**.

- 3 The MultiFRAD Setup dialog box is displayed.



Verify that the **Communication Type** field is set **IP**.

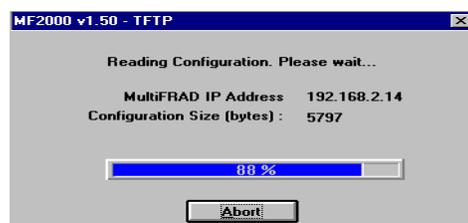
In the **Router IP Address** field, enter the IP Address of the remote MultiFRAD.

- 4 Click **OK** when you are satisfied with your selections.

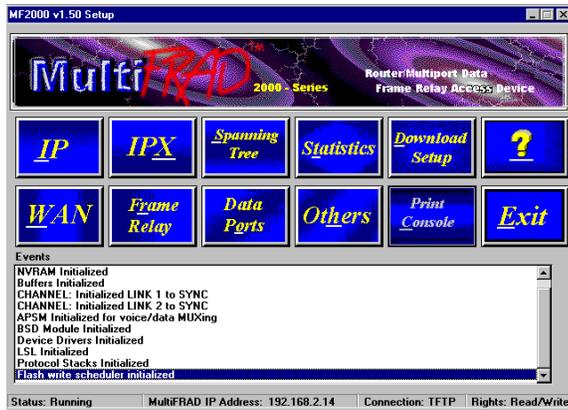
The Windows Program Manager menu is displayed.

- 5 Double-click the **MultiFRAD Configuration** icon.

The Reading Setup dialog box is displayed.



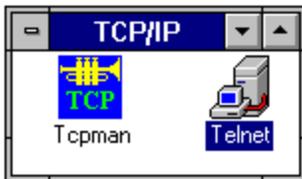
- 6 The MultiFRAD Setup dialog box is then displayed. This is the dialog box of the remote MultiFRAD. You can select any of the available buttons and change the configuration (or setup) and download the changes to the remote MultiFRAD. Refer Chapter 4 for a description of the MultiFRAD software. For definitions of each dialog box or fields within a dialog box, refer to the on-line help.



- 7 After you have changed the configuration of the remote MultiFRAD, click the **Download Setup** button to update the configuration. The remote MultiFRAD will be brought down, the new configuration written to the unit, and the unit will reboot.
- 8 Click the **Exit** button when the downloading is complete.
- 9 Click the **MultiFRAD Configuration** icon in the Program Manager screen to verify that the MultiFRAD is running.

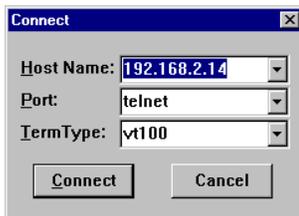
## Telnet

A typical Telnet client application, and typical Web-browser management of the MultiFRAD are described in the rest of this chapter. The MultiFRAD has a built-in Telnet Server for access through Telnet clients. A typical Telnet client is allowed to configure the MultiFRAD and its data ports. In addition, the MultiFRAD can be remotely accessed and configured from anywhere on the Internet through its Web interface.



The TCP/IP stack has to be loaded before the Telnet client can run and the Telnet Server option in the MultiFRAD software has to be enabled. To access the Telnet Client, double-click the Telnet icon. A blank Telnet screen is displayed. Click Connect and then Remote System.

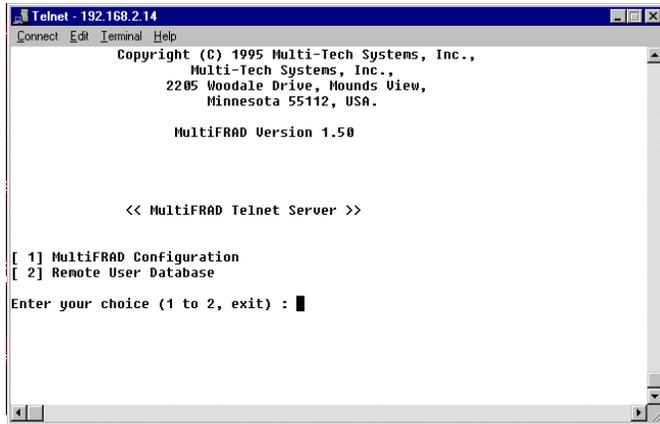
When the **Connect to remote host** dialog box is displayed, a Host Name has to be entered. In this example, the IP Host Name is 192.168.2.14.



Enter your MultiFRAD IP Address in the Host Name field. Click the Connect button and the MultiFRAD Telnet Server dialog box is displayed.

# MultiFRAD Management

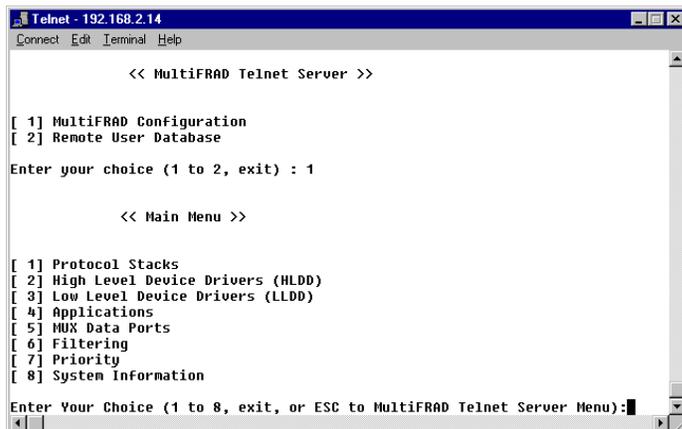
The MultiFRAD management menu provides two options; MultiFRAD Configuration and Remote User Database. The MultiFRAD Configuration options enable you to select the protocol stacks, high or low level device drivers, applications, Mux data ports, filtering, priority, or system information. The Remote User Database option enables you to build and maintain a user database for remote access.



When you enter a password in the Applications Setup dialog box in the MultiFRAD Software, once you choose an option from the MultiFRAD Telnet Server dialog box, you must enter your password before your choice is accepted.

## MultiFRAD Configuration

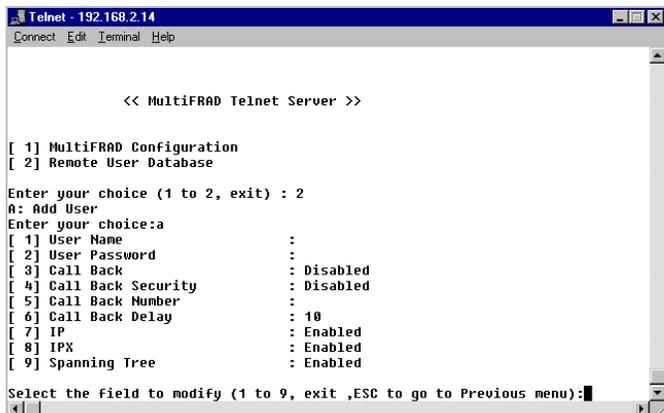
The MultiFRAD Configuration option enables you to view and change parameters on the protocol stacks, high and low level device drivers, enable or disable the supported servers, configure MUX data ports, set up filtering and priority, or view system information.



To select an option, enter the number of the option and hit the Enter key. For example, to select the Protocol Stacks option, type **1** <Enter>. For details on a given parameter, refer to the on-line helps.

## Remote User Database

The Remote User Database option from the MultiFRAD management menu enables you add and configure a list of users who will access the MultiFRAD remotely. After selecting Remote User Database (type **2** <Enter>) from the MultiFRAD Setup menu, type **A** <Enter> to add a new user to the database. The following list of options is displayed:



```
Telnet - 192.168.2.14
Connect Edit Terminal Help

      << MultiFRAD Telnet Server >>

[ 1] MultiFRAD Configuration
[ 2] Remote User Database

Enter your choice (1 to 2, exit) : 2
A: Add User
Enter your choice:a
[ 1] User Name           :
[ 2] User Password      :
[ 3] Call Back           : Disabled
[ 4] Call Back Security  : Disabled
[ 5] Call Back Number    :
[ 6] Call Back Delay     : 10
[ 7] IP                  : Enabled
[ 8] IPX                 : Enabled
[ 9] Spanning Tree       : Enabled

Select the field to modify (1 to 9, exit ,ESC to go to Previous menu):
```

By selecting and configuring the various options and entering the desired information, you can construct a database of remote users for the MultiFRAD. For a detailed description of each option, refer to the on-line help provided in your MultiFRAD software.

## Web Browser Management

The MultiFRAD can be accessed from anywhere on the connected Internet via the built-in WEB Browser interface. You must check this option in Other setup to enable the function. Depending on the rights of the user (read/write, or read only), it is possible to view the current parameters and statistics of the MultiFRAD as well as configure and download setup changes to the MultiFRAD.

You can access MultiFRAD configuration by typing the **IP Address** of the unit in the address line of your web browser. In this example, the IP address is 192.168.2.14.



Click the word **Login** to gain access to the MultiFRAD. The following screen appears:



Enter the **User Name** "supervisor" (no **Password** is required), then click **OK**. You are brought to the MF2000 Configuration menu.



**Note:** the first user to access the MultiFRAD will have *read/write* rights over the unit. All subsequent users will have *read only* rights, and some of the options in the Web interface will be inactive to them (i.e., will not be linked).

From the MF2000 Configuration menu, you can access current settings, view statistics, or configure and download a new setup to the MultiFRAD.

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**MultiFRAD<sup>II</sup>**<sup>™</sup>  
Router/Two-Port Frame Relay Access Device

## Chapter 6 - Warranty, Service and Tech Support

**MultiTech**<sup>®</sup>  
Systems 

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## Introduction

This chapter will provide you the resources for receiving service or support for your MultiFRAD. The chapter starts with a description of the warranty, and continues with instructions for contacting the Service department, Technical Support group, and various Multi-Tech Internet resources.

## Limited Warranty

Multi-Tech Systems, Inc. ("MTS") warrants that its products will be free from defects in material or workmanship for a period of two years from the date of purchase, or if proof of purchase is not provided, two years from date of shipment. MTS MAKES NO OTHER WARRANTY, EXPRESSED OR IMPLIED, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. This warranty does not apply to any products which have been damaged by lightning storms, water, or power surges or which have been neglected, altered, abused, used for a purpose other than the one for which they were manufactured, repaired by the customer or any party without MTS's written authorization, or used in any manner inconsistent with MTS's instructions.

MTS's entire obligation under this warranty shall be limited (at MTS's option) to repair or replacement of any products which prove to be defective within the warranty period, or, at MTS's option, issuance of a refund of the purchase price. Defective products must be returned by Customer to MTS's factory transportation prepaid.

MTS WILL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES AND UNDER NO CIRCUMSTANCES WILL ITS LIABILITY EXCEED THE PURCHASE PRICE FOR DEFECTIVE PRODUCTS.

## On-line Warranty Registration

If you would like to register your MultiFRAD electronically, you can do so at the following address:

<http://www.multitech.com/support/register.htm>

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## Tech Support

Multi-Tech has an excellent staff of technical support personnel available to help you get the most out of your Multi-Tech product. If you have any questions about the operation of this unit, call 1-800-972-2439. Please fill out the MultiFRAD information (below), and have it available when you call. If your MultiFRAD requires service, the tech support specialist will guide you on how to send in your equipment (refer to the next section).

### Recording MultiFRAD Information

Please fill in the following information on your MultiFRAD. This will help tech support in answering your questions. (The same information is requested on the Warranty Registration Card.)

Model No.: \_\_\_\_\_

Serial No.: \_\_\_\_\_

Software Version: \_\_\_\_\_

The model and serial numbers are on the bottom of your MultiFRAD.

Please note the type of external link device that is connected to your MultiFRAD before calling tech support. Also, note the status of your MultiFRAD including LED indicators, screen messages, diagnostic test results, DIP-Switch settings, problems with a specific application, etc. Use the space below to note the status:

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### Contacting Tech Support via E-mail

If you prefer to receive service on-line, via the Internet, you can contact Tech Support via e-mail at the following address:

[http://www.multitech.com/\\_forms/email\\_tech\\_support.htm](http://www.multitech.com/_forms/email_tech_support.htm)

## Service

If your tech support specialist decides that service is required, your MultiFRAD may be sent (freight prepaid) to our factory. Return shipping charges will be paid by Multi-Tech Systems.

Include the following with your MultiFRAD:

- a description of the problem.
- return billing and return shipping addresses.
- contact name and phone number.
- check or purchase order number for payment if the MultiFRAD is out of warranty. (Check with your technical support specialist for the standard repair charge for your MultiFRAD).
- if possible, note the name of the technical support specialist with whom you spoke.

If you need to inquire about the status of the returned product, be prepared to provide the **serial number** of the product sent.

Send your MultiFRAD to this address:

MULTI-TECH SYSTEMS, INC.  
2205 WOODALE DRIVE  
MOUNDS VIEW, MINNESOTA 55112  
ATTN: SERVICE OR REPAIRS

You should also check with the supplier of your MultiFRAD on the availability of local service and/or loaner units in your area.

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## The Multi-Tech BBS

For customers who do not have Internet access, Multi-Tech maintains a bulletin board system (BBS) that mirrors its FTP site. Information available from the BBS includes new product information, product upgrade files, and problem-solving tips. The phone number for the Multi-Tech BBS is (800) 392-2432 (USA and Canada) or (612) 785-3702 (international and local).

The BBS can be accessed by any asynchronous modem operating at 1200 bps to 33,600 bps at a setting of 8 bits, no parity, and 1 stop bit (8-N-1).

### To log on to the Multi-Tech BBS

1. Set your communications program to **8-N-1**.
2. Dial our BBS at (800) 392-2432 (USA and Canada) or (612) 785-3702 (international and local).
3. At the prompts, type your first name, last name, and password; then press ENTER. If you are a first time caller, the BBS asks if your name is spelled correctly. If you answer yes, a questionnaire appears. You must complete the questionnaire to use the BBS on your first call.
4. Press ENTER until the Main Menu appears. From the Main Menu you have access to two areas: the Files Menu and News. For help on menu commands, type **?**.

### To Download a file

#### If you know the file name

1. From the Main Menu, type **F** to access the Files Menu, then type **D**.
2. Enter the name of the file you wish to download from the BBS.
3. If a password is required, enter the password.
4. Answer **Y** or **N** to the automatic logoff question.
5. Select a file transfer protocol by typing the indicated letter, such as **Z** for Zmodem (the recommended protocol).
6. If you select Zmodem, the transfer will begin automatically. If you select another protocol, you may have to initiate the transfer yourself. (In most datacomm programs, the PAGE DOWN key initiates the download.)
7. When the download is complete, press ENTER to return to the File Menu.
8. To exit the BBS, type **G** and press ENTER.

#### If you don't know the file name

1. From the Main Menu, type **F** to access the Files Menu. For a list of file areas, type **L**, press ENTER, then type **L** and press ENTER again. (If you do not type the second **L**, you will list all of the files on the BBS.)
2. Mark each file area you would like to examine by typing its list number and pressing ENTER.
3. Enter **L** to list all the files in the selected file areas. Enter **C** to go forward in the file list and **P** to go back.
4. To mark one or more files for download, type **M**, press ENTER, type the list numbers of the files, and press ENTER again.
5. Enter **D**. You will see a list of the files you have marked. Enter **E** if you would like to edit the list; otherwise enter **D** again to start the download process.
6. Select a file transfer protocol by typing the indicated letter, such as **Z** for Zmodem (the recommended protocol).
7. If you select Zmodem, the file will transfer automatically. If you select another protocol, you may have to initiate the transfer yourself. (In most data communications programs, the PAGE DOWN key initiates the download.)

8. When the download is complete, press ENTER to return to the File Menu.
9. To exit the BBS, type **G** and press ENTER.

## About CompuServe

In addition to the BBS, Multi-Tech provides support through CompuServe's Modem Vendor Forum (GO MODEMVEN). Refer to your CompuServe documentation for special operating procedures.

## About the Internet

If you prefer to receive technical support via the Internet, you can contact Tech Support via e-mail at the following address:

[http://www.multitech.com/\\_forms/email\\_tech\\_support.htm](http://www.multitech.com/_forms/email_tech_support.htm)

Multi-Tech's presence includes a Web site at:

<http://www.multitech.com>

and an ftp site at:

<ftp://ftp.multitech.com>

The ftp server mirrors the Multi-Tech BBS.

## About the Multi-Tech Fax-Back Service

Multi-Tech's fax-back system provides 24-hour access to sales, marketing, and technical literature. Dial 612-717-5888, follow the voice prompts, and request document number 10 for a catalog of available documents. For convenience, have your fax number handy: \_\_\_\_\_ . From the catalog of available documents, you can order newsletters, white papers, press releases, etc. from the sales and marketing index (pages 1-4), or order basic modem operation and troubleshooting guides from the technical support and engineering index. Just enter the applicable FB Doc. # from the left column of the catalog.

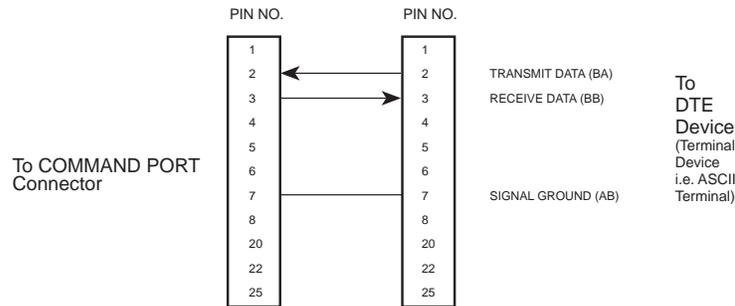
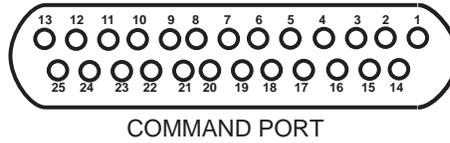
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**MultiFRAD<sup>II</sup>**<sup>™</sup>  
Router/Two-Port Frame Relay Access Device

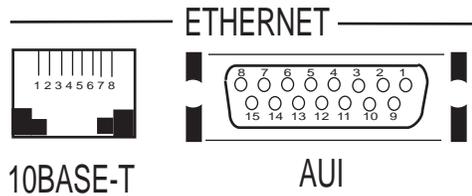
## Appendixes

# Appendix A - Cabling Diagrams

## Command Port Cable



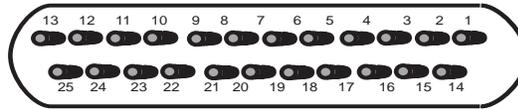
## LAN Cables



10Base-T (RJ-45)		
Pin	Circuit	Signal Name
1	TD+	Data Transmit Positive
2	TD-	Data Transmit Negative
3	RD+	Data Receive Positive
4	RD-	Data Receive Negative

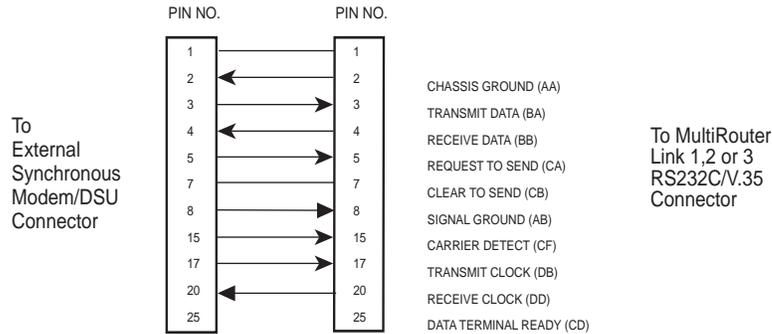
AU1 (DB-15)		
Pin	Circuit	Signal Name
1	CO-S	Control In Circuit Shield
2	CI+	Control In Positive
3	DO+	Data Out Positive
4	DIS	Data In Circuit Shield
5	DI+	Data In Circuit Positive
6	VC	Voltage common
7	CO+	Control Out Pos (optional)
8	COS	Control Out Shld (optional)
9	CI-	Control In Negative
10	DO-	Data Out Negative
11	DO-S	Data Out Circuit Shield
12	DI-	Data In Negative
13	VP	Voltage Plus
14	VS	Voltage Shield
15	CO-	Control Out Neg (optional)
Shell	PG	Protective Ground

# Trunk Cable

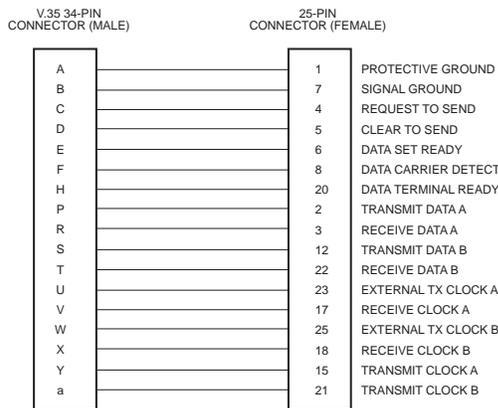
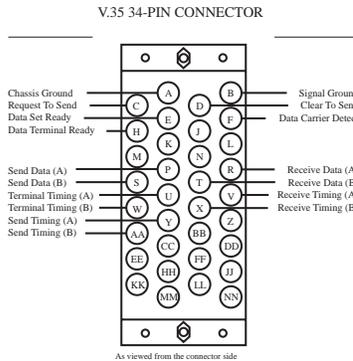


TRUNK (RS232C/V.35)

## RS232C/V.24 \* Link Cable



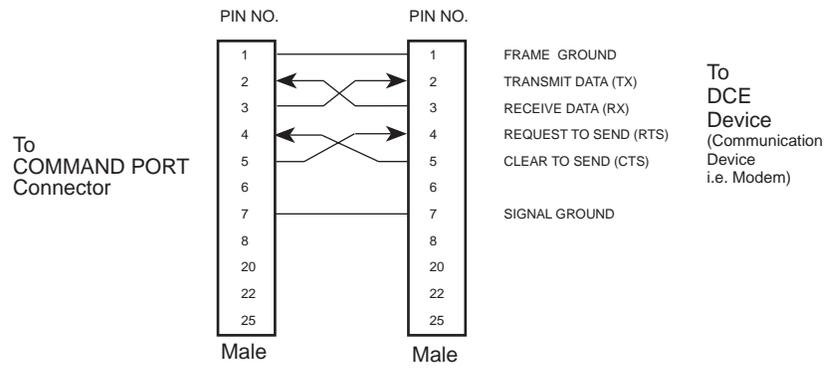
## V.35 Adapter Cable Configured on a RS232C/V.35\*\* Link Cable



\* The MultiFRAD RS232C interface circuits have been designed to meet the electrical specifications given in EIA (Electronic Industries Association) RS232C and CCITT (Consultative Committee International Telegraph and Telephone) V.24 Standards.

\*\* When configured for V.35 interface operation on the link, the V.35 adapter cable should be used. This cable uses a 25-pin female connector at one end and a 34-pin winchester male connector at the other end.

# Remote Configuration Cable



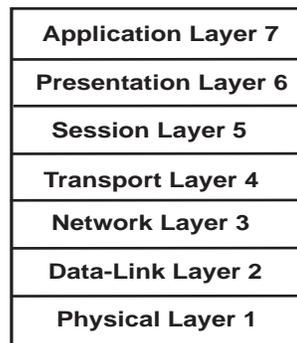
## Appendix B - Regulatory Information

**Note:** This equipment has been tested and found to comply with the limits for a **Class A** digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**Warning:** Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## Appendix C - Network Overview

Network architecture defines how computer equipment and other devices are linked together to form a communications system that enables users to share information and resources. There are proprietary network architectures and open architectures like the Open Systems Interconnection (OSI) model defined by the International Organization for Standardization (IOS). The OSI model defines a layered model for an open systems environment in which a process running in one computer communicates with a similar process on another computer if they implement the same OSI layer communications protocol. The OSI protocol stack shown in Figure B-1 is commonly used as a reference. During a communications session, processes running in each layer on each computer communicate with one another. The bottom layer defines the actual physical components such as connectors and cable and the electrical transmission of data bits between systems. The layers immediately above define data packaging and addressing methods. Still further up are methods for keeping communication sessions alive. Finally, the uppermost layers describe how applications use the underlying communication systems to interact with applications on other systems.



**Figure B-1. OSI Protocol Stack**

Protocols are loaded into a computer as software drivers. Each layer of the protocol stack defines a specific set of functions. An application at the uppermost layer interacts with the layer below when it needs to send information to another system on the network. The request is packaged in one layer and passed down to the next layer, which adds information related to functions handled at that layer, creating a new packet within a packet. This package is then passed down to the next layer and the process continues. Each layer adds information to the message packet and this information is read by the corresponding layer in the receiving system's protocol stack. In this way, each protocol layer communicates with its corresponding protocol layer to facilitate communication.

The physical layer defines the physical characteristics of the interface, such as mechanical components and connectors, electrical aspects such as voltage levels representing binary values, and functional aspects such as setting up, maintaining, and taking down the physical link. Well known physical layer interfaces for data communication include RS-232 and RS-449, the successor to RS-232.

The data-link layer defines the rules for sending and receiving information across the physical connection between two systems. This layer encodes and frames data for transmission, in addition to providing error detection and control. Because the data-link layer can provide error control, higher layers may not need to handle such services. However, when reliable media is used, there is a performance advantage by not handling error control in this layer, but in higher layers.

The Network layer defines protocols for opening and maintaining a path on the network between systems. It is concerned with data transmission and switching procedures, and hides such procedures from upper layers. The network layer can look at packet addresses to determine routing methods. If a packet is addressed to a workstation on the local network, it is sent directly there. If it's addressed to a network on another segment, the packet is sent to a routing device, which forwards it on the network. Some common protocols occupying the network layer are Internet Protocol (IP), X.25, Novell's Internetwork Packet Exchange (IPX), Banyan's VINES Internet Protocol (VIP).

The transport layer provides a high level of control for moving information between systems,

including more sophisticated error handling, prioritization, and security features. It provides quality service and accurate delivery by providing connection-oriented services between two end systems. The transport layer controls the sequence of packets, regulates traffic flow, and recognizes duplicate packets. It assigns packetized information which is a tracking number that is checked at the destination. If data is missing from the packet, the transport layer at the receiving end arranges with the transport layer of the sending system to have packets retransmitted. This layer ensures that all data is received and in the proper order.

The session layer coordinates the exchange of information between systems by using conversational techniques, or dialogues. Dialogues are not always required, but some applications may require a way of knowing where to restart the transmission of data if a connection is temporarily lost, or may require a periodic dialog to indicate the end of one data set and the start of a new one.

Presentation layer protocols are part of the operating system and the application the user runs on a workstation. Information is formatted for display or printing in this layer. Codes within the data, such as tabs or special graphics sequences, are interpreted. Data encryption and translation of other character sets are also handled in this layer.

Applications access the underlying network services using defined procedures in this layer. The application layer is used to define a range of applications that handle file transfers, terminal sessions, and message exchanges. Data starts at the application and presentation layers, where a user works with a network application, such as an electronic mail program. Requests for services are passed through the presentation layer to the session layer which begins the process of packetizing the information. A connection-oriented communication session may be opened between the two systems to provide reliable transmissions. Once the session is established, protocol layers begin exchanging information as appropriate.

## Packet

A packet is a package of data that is exchanged between devices over a data communications link. Data exchanged between devices may include messages and commands, control codes for managing the session, and data. Information is placed in packets by various communications subsystems of the transmitting system, then framed into a serial bit-stream and sent across the communications link. One of the main reasons for packetizing and framing information is that errors on the communication link only affect a small, discernible part of the transmission, which is easily retransmitted.

The process starts at the application layer. An application in one computer has some information to send to another computer. The information is sent down through the protocol stack, across the wire, and up through the protocol stack of the other computer. This information takes the form of a protocol data unit (PDU). As the PDU moves through the layers of the sending computer, each layer attaches specific information to the PDU that is relevant to the protocols in that layer. This attached information is destined for the peer layer in the receiving computer. For example, the transport layer in the sending computer adds a sequence number to the PDU. This sequence number is read by the transport layer in the receiving computer to resequence the packets.

The communication protocol defines the packet structure and the networking system in use and defines the frame structure for bit-stream transmission. Each protocol layer attaches information destined for its peer layer in the other computer. When the PDU reaches the physical layer, it is transmitted as a stream of bits. On copper wire, the bit-streams take the form of voltage level changes that represent binary ones and zeros. The data-link layer places the PDU in one or more frames and uses a media access method (such as CSMA/CD or token) to gain access to the transmission media. The PDU might be subdivided into a number of separately addressed frames. The frame format is defined by the network in use. For example, Ethernet defines frames that can hold up to 1,500 bytes of packet data.

In general, a packet is a collection of information that contains data (payload) and headers (pilot). Headers include the source and destination address as well as control information to handle errors and keep packets flowing properly. Each packet is a separate block of information that can have a

different destination address, and in some cases, different sizes. A typical packet holds 512 bytes of information, so it takes many packets to transfer a large file over a network.

As packets traverse a network, the addressing information contained in them is used by bridges and routers to direct packets to their destination, or keep them off of networks where they don't belong. Routers direct packets along a specific path that has been predetermined as the best route to the packets' destination. Routers use algorithms to determine efficient paths in conjunction with other routers on the network. Administrators can also manually configure routers, based on the cost or speed of routes. Information can be transmitted to another system using either connection-oriented or connection-less methods. A connection-less session is more efficient for short, bursty transmissions since a session setup is not required, but the end system may need to perform more work to resequence packets that arrive out of order and check for lost packets.

## Network Address

Every node on a network has an assigned address that other nodes use when communicating with it. For Ethernet and token ring network adapters, unique addresses are assigned at the factory. ARCNET networks have user-definable addresses. For example, the address of an Ethernet and token ring network adapter consists of a 6-byte address, half of which is a special number identifying the board's manufacturer. The last half of the address is a unique number for the board assigned at the factory. This strategy virtually guarantees that no two Ethernet or token ring network interface cards will ever have the same address and prevents conflicts.

When separate networks are connected into an internetwork, a new addressing scheme is required. On interconnected NetWare networks, each network segment has its own address, which is used for routing purposes and differentiate each segment from the others.

In TCP/IP networks such as the Internet, every node has a numeric address that identifies both a network and a local host or node on the network. This address is written as four numbers separated by dots, for example 148.1.9.1. The assignment of addresses is arbitrary within a company or organization, but if the company plans to connect with the Internet, it is important to obtain registered addresses from an outside agency to conform with international addressing standards. Applications running in computers also have addresses that other applications, either local or remote, use to communicate with the application. On TCP/IP networks, a socket is a combination of an Internet address plus an application address.

## Internet Protocol (IP)

Internet Protocol is a connection-less communication protocol that by itself provides a datagram service. Datagrams are self-contained packets of information that are forwarded by routers based on their address and the routing table information contained in the routers. Datagrams can be addressed to a single node or to multiple nodes. There is no flow control, acknowledgment of receipt, error checking, and sequencing. Datagrams may traverse different paths to the destination and thus arrive out of sequence. The receiving station is responsible for resequencing and determining if packets are lost. IP handles congestion by simple discarding packets. Resequencing and error handling are taken care of by upper layer protocols.

IP works on a number of local and wide area networks. When IP runs in the LAN environment on an Ethernet network, for example, the data field in the Ethernet frame holds the IP packet and a specific field in the frame indicates that IP information is enclosed. IP uses an addressing scheme that works independently of the network addressing scheme. For example, every Ethernet adapter has a factory-assigned address for each node.

## IP Addressing

Every node on an IP network requires a 4-byte numeric address that identifies both a network and a local host or node on the network. This address is written as four numbers separated by dots, for example, 148.1.9.1. In most cases, the network administrator sets up these addresses when installing a device.

The assignment of addresses is arbitrary within a company or organization, but if a company plans to connect with the Internet any time in the near future, a registered addresses should be obtained from the Defense Data Network (DDN) Network Information Center (NIC), which is managed by Network Solutions in Chantilly, Virginia. With the growing popularity of the Internet, it is recommended that all organizations obtain registered addresses to avoid address conflicts in the future.

There are three classes of Internet addresses; Class A, B and C. Class A networks use the first byte of the IP address for the network number and the remaining three bytes for the host number. The first byte may have any value from one to 127.

Class B networks use the first two bytes of the IP address for the network number and the last two bytes for the host number. The first byte must have a value from 128 to 191.

Class C networks use the first three bytes of the IP address for the network number and the last byte for the host number. This scheme provides for a very large number of different networks, each with up to 255 addressable devices. The first byte must have a value from 192 to 223.

The part of the IP address that refers to the network is called the network address. A network mask is the bit pattern which yields the network address in a Boolean AND operation with the IP address. For example, in Class C networks, network addresses take the form X.X.X.0. The network mask for Class C networks is 255.255.255.0. In all of the IP addresses on a given network, the network address will remain the same while the host portion will be different for each host or workstation.



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**MultiFRAD<sup>II</sup>**<sup>™</sup>  
Router/Two-Port Frame Relay Access Device

**Glossary**

### A

**Access:** The T1 line element made up of two pairs of wire that the telephone company brings to the customer premises. The Access portion ends with a connection at the local telco (LEC or RBOC).

**Accunet Spectrum of Digital Services (ASDS):** The AT&T 56K bps leased (private) line service. Similar to services of MCI and Sprint. ASDS is available in  $nx56/64K$  bps, where  $n=1, 2, 4, 6, 8, 12$ .

**ACK (ACKnowledgement code) (pronounced "ack"):** A communications code sent from a receiving modem to a transmitting modem to indicate that it is ready to accept data. It is also used to acknowledge the error-free receipt of transmitted data. Contrast with NAK.

**Adaptive Differential Pulse Code Modulation (ADPCM):** In multimedia applications, a technique in which pulse code modulation samples are compressed before they are stored on a disk. ADPCM, an extension of the PCM format, is a standard encoding format for storing audio information in a digital format. It reduced storage requirements by storing differences between successive digital samples rather than full values.

**Address:** A numbered location inside a computer. It's how the computer accesses its resources, like a video card, serial ports, memory, etc.

**AMI line coding:** One of two common methods of T1 line coding (with B8ZS). AMI line coding places restrictions on user data (B8ZS does not).

**Analog signal:** A waveform which has amplitude, frequency and phase, and which takes on a range of values between its maximum and minimum points.

**Analog Transmission:** One of two types of telecommunications which uses an analog signal as a carrier of voice, data, video, etc. An analog signal becomes a carrier when it is modulated by altering its phase, amplitude and frequency to correspond with the source signal. Compare with digital transmission.

**Application Program Interface (API):** A software module created to enable dissimilar, or incompatible applications programs to transfer information over a communications link. APIs may be simple or complex; they are commonly required to link PC applications with mainframe programs.

**ASCII (American Standard Code for Information Interchange) (pronounced "askey"):** A binary code for data that is used in communications and in many computers and terminals. The code is used to represent numbers, letters, punctuation and control characters. The basic ASCII code is a 7-bit character set which defines 128 possible characters. The extended ASCII file provides 255 characters.

**Asynchronous Transfer Mode (ATM):** A very high-speed method of transmission that uses fixed-size cells of 53 bytes to transfer information over fiber; also known as cell relay.

**AT Commands:** A standard set of commands used to configure various modem parameters, establish connections and disconnect. The "AT" is used to get the "attention" of the modem before the actual command is issued.

**Availability:** The measure of the time during which a circuit is ready for use; the complement of circuit "outage" (100% minus % outage = % available).

### B

**B7ZS (Bipolar 7 Zero Suppression) line coding:** One method of T1 line coding (see also "B8ZS" and "AMI"). B7ZS line coding does not place restrictions on user data (AMI does).

**B8ZS (Bipolar 8 Zero Suppression) line coding:** One of two common methods of T1 line coding (with AMI). B8ZS line coding does not place restrictions on user data (AMI does). A coding method used to produce 64K bps "clear" transmission. (See also "B7ZS" and "AMI" line coding)

**Backbone:** 1. A set of nodes and their interconnecting links providing the primary data path across a network. 2. In a local area network multiple-bridge ring configuration, a high-speed link to which the rings are connected by means of bridges. A backbone may be configured as a bus or as a ring. 3. In a wide area network, a high-speed link to which nodes or data switching exchanges (DSEs) are connected. 4. A common distribution core that provides all electrical power, gases, chemicals, and other services to the sectors of an automated wayer processing system.

**Background:** An activity that takes place in the PC while you are running another application. In other words, the active user interface does not correspond to the 'background' task.

**Bandwidth:** The transmission capacity of a computer channel, communications line or bus. It is expressed in cycles per second (hertz), the bandwidth being the difference between the lowest and highest frequencies transmitted. The range of usable frequencies that a transmission medium will pass without unacceptable attenuation or distortion. Bandwidth is a factor in determining the amount of information and the speed at which a medium can transmit data or other information.

**Backward Explicit Congestion Notification (BECN):** A bit that tells you that a certain frame on a particular logical connection has encountered heavy traffic. The bit provides notification that congestion-avoidance procedures should be initiated in the opposite direction of the received frame. See also FECN (Forward Explicit Congestion Notification).

**Basic Rate Interface (BRI):** An ISDN access interface type comprised of two B-channels each at 64K bps and one D-channel at 64K bps (2B+D).

**Bell Operating Companies (BOC):** The family of corporations created during the divestiture of AT&T. BOCs are independent companies which service a specific region of the US. Also called Regional Bell Operating Companies (RBOCs).

**Bell Pub 41450:** The Bell publication defining requirements for data format conversion, line conditioning, and termination for direct DDS connection.

**Bell Pub 62310:** The Bell publication defining requirements for data format conversion, line conditioning, and termination for direct DDS connection.

**Binary Synchronous Communication (BSC):** A form of telecommunication line control that uses a standard set of transmission control characters and control character sequences, for binary synchronous transmission of binary-coded data between stations.

**Bit (Binary digIT):** A bit is the basis of the binary number system. It can take the value of 1 or 0. Bits are generally recognized as the electrical charge generated or stored by a computer that represent some portion of usable information.

**Bit Error Rate Test (BERT):** A device or routine that measures the quality of data transmission. A known bit pattern is transmitted, and the errors received are counted and a BER (bit error rate) is calculated. The BER is the ratio of received bits in error relative to the total number of bits received, expressed in a power of 10.

**Bit robbing:** The use of the least significant bit per channel in every sixth frame for signaling. The line signal bits "robbed" from the speech path conveys sufficient pre-ISDN telephony signaling information with the remaining line signal bits providing sufficient line signaling bits for recreating the original sound. See "robbed bit signaling".

**Blue Alarm:** An error indication signal consisting of all 1s indicating disconnection or attached device failure. Contrast "Red Alarm" and "Yellow Alarm".

**Bps (bits per second):** A unit to measure the speed at which data bits can be transmitted or received. Bps differs from baud when more than one bit is represented by a single cycle of the carrier.

**Bridges:** 1. A functional unit that interconnects two local area networks that use the same logical link protocol but may use different medium access control protocols. 2. A functional unit that interconnects multiple LANs (locally or remotely) that use the same logical link control protocol but that can use different medium access control protocols. A bridge forwards a frame to another bridge based on the medium access control (MAC) address. 3. In the connection of local loops, channels, or rings, the equipment and techniques used to match circuits and to facilitate accurate data transmission.

**Buffer:** A temporary storage register or Random Access Memory (RAM) used in all aspects of data communications which prevents data from being lost due to differences in transmission speed. Keyboards, serial ports, muxes and printers are a few examples of the devices that contain buffers.

**Bus:** A common channel between hardware devices either internally between components in a computer, or externally between stations in a communications network.

**Byte:** The unit of information a computer can handle at one time. The most common understanding is that a byte consists of 8 binary digits (bits), because that's what computers can handle. A byte holds the equivalent of a single character (such as the letter A).

## C

**Call Setup Time:** The time to establish a circuit-switched call between two points. Includes dialing, wait time, and CO/long distance service movement time.

**Carrier Group Alarm (CGA):** A T1 service alarm generated by a channel bank when an OOF condition occurs for a predefined length of time (usually 300 mS to 2.5 seconds). The CGA causes the calls using a trunk to be dropped and for trunk conditioning to be applied.

**Carrier signal:** An analog signal with known frequency, amplitude and phase characteristics used as a transport facility for useful information. By knowing the original characteristics, a receiver can interpret any changes as modulations, and thereby recover the information.

**CCITT (Consultative Committee for International Telephone and Telegraph):** An advisory committee created and controlled by the United Nations and headquartered in Geneva whose purpose is to develop and to publish recommendations for worldwide standardization of telecommunications devices. CCITT has developed modem standards that are adapted primarily by PTT (post, telephone and telegraph) organizations that operate telephone networks of countries outside of the U.S. See also ITU.

**Central Office (CO):** The lowest, or most basic level of switching in the PSTN (public switched telephone network). A business PABX or any residential telephone connects to the PSTN at a central office.

**Centrex:** A multi-line service offered by operating telcos which provides, from the telco CO, functions and features comparable to those of a PBX for large business users. See also "Private Branch Exchange", "Exchange".

**Channel:** A data communications path between two computer devices. Can refer to a physical medium (e.g., UTP or coax), or to a specific carrier frequency.

**Channel bank:** A device that acts as a converter, taking the digital signal from the T1 line into a phone system and converting it to the analog signals used by the phone system. A channel bank acts as a multiplexer, placing many slow-speed voice or data transactions on a single high-speed link.

**Circuit-switched Network:** A technology used by the PSTN that allocates a pair of conductors for the exclusive use of one communication path. Circuit switching enables multiple conversations on one talk path only if the end-users multiplex the signals prior to transmission.

**Circuit switching:** The temporary connection of two or more communications channels using a fixed, non-shareable path through the network. Users have full use of the circuit until the connection is terminated.

**Clear Channel:** A transmission path where the full bandwidth is used (i.e., no bandwidth needed for signaling, carrier framing or control bits). A 64K bps digital circuit usually has 8K bps used for signaling. ISDN has two 64K bps circuits, and a 16K bps packet service of which part is used for signaling on the 64K channels.

**Client-Server:** In TCP/IP, the model of interaction in distributed data processing in which a program at one site sends a request to a program at another site and awaits a response. The requesting program is called a client; the answering program is called a server.

**Cluster Controller:** A device that can control the input/output operations of more than one device connected to it. A cluster controller may be controlled by a program stored and executed in the unit, or it may be entirely controlled by hardware.

**Committed Burst Size:** the maximum number of bits that the frame relay network agrees to transfer during any measurement interval

**Committed Information Rate (CIR):** An agreement a customer makes to use a certain minimum data transmission rate (in bps). The CIR is part of the frame relay service monthly billing, along with actual usage, that users pay to their frame relay service provider.

**Compression:** 1. The process of eliminating gaps, empty fields, redundancies, and unnecessary data to shorten the length of records or blocks. 2. In SNA, the replacement of a string of up to 64 repeated characters by an encoded control byte to reduce the length of the data stream to the LU-LU session partner. The encoded control byte is followed by the character that was repeated (unless that character is the prime compression character). 3. In Data Facility Hierarchical Storage Manager, the process of moving data instead of allocated space during migration and recall in order to release unused space. 4. Contrast with decompression.

**COMx Port:** A serial communications port on a PC.

**Congestion:** A network condition where there is too much data traffic. The ITU I.233 standard defines congestion management in terms of speed and burstiness.

**Congestion notification:** The function in frame relay that ensures that user data transmitted at a rate higher than the CIR are allowed to slow down to the rate of the available network bandwidth.

**Consecutive Severely Errored Seconds (CSES):** An error condition that occurs when from 3 to 9 SES (Severely Errored Seconds) are logged consecutively.

**Customer Premises Equipment (CPE):** The generic term for data comm and/or terminal equipment that resides at the user site and is owned by the user with the following exclusions: Over-voltage protection equipment, inside wiring, coin-operated or pay telephones, "company-official" equipment, mobile telephone equipment, "911" equipment, equipment necessary for the provision of communications for national defense, or multiplexing equipment used to deliver multiple channels to the customer.

## D

**D4:** the T1 4th generation channel bank.

**D4 channelization:** Refers to the compliance with AT&T TR 62411 for DS1 frame layout.

**D4 framing:** The T1 format for framing in AT&T D-Series channel banks, in which there are 12 separate 193-bit frames in a super-frame. A D4 framing bit is used to identify the channel and the signaling frame. Signalling for voice channels is carried in-band for every channel, along with the encoded voice. See "robbed-bit signaling".

**Data Communications Equipment (DCE):** Any device which serves as the portal of entry from the user equipment to a telecommunications facility. A modem is a DCE for the telephone network (PSTN) that is commonly on site at the user's premises. Packet Switched Networks have another level of DCE which is most often located at a central office.

**Data Link Connection Identifier (DLCI):** One of the six components of a frame relay frame. Its purpose is to distinguish separate virtual circuits across each access connection. Data coming into a frame relay node is thus allowed to be sent across the interface to the specified "address". The DLCI is confirmed and relayed to its destination, or if the specification is in error, the frame is discarded.

**Dataphone Digital Service (DDS):** A private line digital service that offers 2400, 4800, 9600 and 56K bps data rates on an inter-LATA basis by AT&T and on an intra-LATA basis by the BOCs.

**Data Service Unit (DSU):** A device that provides a digital data service interface directly to the data terminal equipment. The DSU provides loop equalization, remote and local testing capabilities, and a standard EIA/CCITT interface.

**Dedicated Line:** A communication line that is not switched. The term leased line is more common.

**Default:** This is a preset value or option in software packages, or in hardware configuration, that is used unless you specify otherwise.

**Device driver:** Software that controls how a computer communicates with a device, such as a printer or mouse.

**Digital Cross-connect System (DCS):** The CO device which splits and redistributes the T1 bandwidth. The DCS takes time slots from various T1 lines and alters them to provide the needed connectivity. DCS connections are made with software at an administrator's workstation.

**Digital Data:** Information represented by discrete values or conditions (contrast "Analog Data").

**Digital Loopback:** A technique used for testing the circuitry of a communications device. Can be initiated locally, or remotely (via a telecommunications device). The tested device decodes and encodes a received test message, then echoes the message back. The results are compared with the original message to determine if corruption occurred en route.

**Digital PBX:** A Private Branch Exchange that operates internally on digital signals. See also "Exchange".

**Digital Service, level 0 (DS0):** The worldwide standard speed (64K bps) for digital voice conversation using PCM (pulse coded modulation).

**Digital Service, level 1 (DS1):** The 1.544M bps voice standard (derived from an older Bell System standard) for digitized voice transmission in North America. The 1.544M bps consists of 24 digitally-encoded 64K bps voice channels (north America) and 2.048M bps (30 channels) elsewhere.

**Digital Signal:** A discrete or discontinuous signal (e.g., a sequence of voltage pulses). Digital devices, such as terminals and computers, transmit data as a series of electrical pulses which have discrete jumps rather than gradual changes.

**Digital Signaling Rates (DSn):** A hierarchical system for transmission rates, where "DS0" is 64K bps (equivalent to ISDN B channel), and DS1 is 1.5 Mbps (equivalent to ISDN PRI).

**Digital Transmission:** A method of electronic information transmission common between computers and other digital devices. Analog signals are waveforms: a combination of many possible voltages. A computer's digital signal may be only "high" or "low" at any given time. Therefore, digital signals may be "cleaned up" (noise and distortion removed) and amplified during transmission.

**Digitize:** To convert an analog signal to a digital signal.

**DIP switch (pronounced "dip switch"):** A set of tiny toggle switches, built into a DIP (dual in-line package), used for setting configurable parameters on a PCB (printed circuit board).

**Driver:** A software module that interfaces between the Operating System and a specific hardware device (i.e. color monitors, printers, hard disks, etc.). Also known as a device driver.

**Drop and Insert:** The process where a portion of information carried in a transmission system is demodulated ("Dropped") at an intermediate point and different information is included ("Inserted") for subsequent transmission.

**DTE (Data Terminating Equipment):** A term used to include any device in a network which generates, stores or displays user information. DTE is a telecommunications term which usually refers to PCs, terminals, printers, etc.

**DTMF (Dual-Tone MultiFrequency):** A generic push-button concept made popular by AT&T TouchTone.

## E

**E&M:** A telephony trunking system used for either switch-to-switch, or switch-to-network, or computer/telephone system-to-switch connection.

**EIA:** The Electronics Industries Association is a trade organization in Washington, DC that sets standard for use of its member companies. (See RS-232, RS-422, RS530.)

**Encapsulation:** A technique used by network-layer protocols in which a layer adds header information to the protocol data unit from the preceding layer. Also used in "enveloping" one protocol inside another for transmission. For example, IP inside IPX.

**Errored Seconds (ES):** Any second of operation that all 1.544M bits are not received exactly as transmitted. Contrast "Error Free Seconds".

**Error Free Seconds (EFS):** Any second of operation that all 1.544M bits are received exactly as transmitted. Contrast "Errored Seconds".

**ESF Error Event:** A T1 error condition that is logged when a CRC-6 error or an OOF error occurs.

**Ethernet:** A 10-megabit baseband local area network that enables multiple stations to access the transmission medium at will without prior coordination, avoids contention by using carrier sense and deference, and resolves contention by using collision detection and transmission. Ethernet uses carrier sense multiple access with collision detection (CSMA/CD).

**Excess Zeros:** A T1 error condition that is logged when more than 15 consecutive 0s or less than one 1 bit in 16 bits occurs.

**Exchange:** A unit (public or private) that can consist of one or more central offices established to serve a specified area. An exchange typically has a single rate of charges (tariffs) that has previously been approved by a regulatory group.

**Exchange Area:** A geographical area with a single uniform set of charges (tariffs), approved by a regulatory group, for telephone services. Calls between any two points within an exchange area are local calls. See also "Digital PBX", "PBX".

**Exchange Termination (ET):** The carrier's local exchange switch. Contrast with "Loop Termination - LT".

**Explicit Congestion Management:** The method used in frame relay to notify the terminal equipment that the network is overly busy. The use of FECN and BECN is called explicit congestion management. Some end-to-end protocols use FECN or BECN, but usually not both options together. With this method, a congestion condition is identified and fixed before it becomes critical. Contrast with "implicit congestion".

**Extended Super Frame (ESF):** One of two popular formats for framing bits on a T1 line. ESF framing has a 24-frame super-frame, where robbed bit signaling is inserted in the LSB (bit 8 of the DS-0 byte) of frames 6, 12, 18 and 24. ESF has more T1 error measurement capabilities than D4 framing. ESF and B8ZS are typically both offered to provide clear channel service.

## F

**Failed Seconds:** A test parameter where the circuit is unavailable for one full second.

**Failed Signal:** A T1 test parameter logged when there are more than 9 SES (Severely Errored Seconds).

**Fax (facsimile):** Refers to the bit-mapped rendition of a graphics-oriented document (fax) or to the electronic transmission of the image over telephone lines (faxing). Fax transmission differs from data transmission in that the former is a bit-mapped approximation of a graphical document and, therefore, cannot be accurately interpreted according to any character code.

**Firmware:** A category of memory chips that hold their content without electrical power, they include ROM, PROM, EPROM and EEPROM technologies. Firmware becomes "hard software" when holding program code.

**Foreground:** The application program currently running on and in control of the PC screen and keyboard. The area of the screen that occupies the active window. Compare with "background".

**Fractional T1 (FT1):** A digital data transmission rate between 56 Kbps (DS0 rate) and 1.544 Mbps (the full T1 rate - in North America). FT1 is typically provided on 4-wire (two copper pairs) UTP. Often used for video conferencing, imaging and LAN interconnection due to its low cost and relatively high speed. FT1 rates are offered in 64 Kbps multiples, usually up to 768 Kbps.

**Frequency:** A characteristic of an electrical or electronic signal which describes the periodic recurrence of cycles. Frequency is inversely proportional to the wavelength or pulse width of the signal (i.e., long wavelength signals have low frequencies and short wavelength signals yield high frequencies).

**Foreign Exchange (FX):** A CO trunk with access to a distant CO, enabling ease of access and flat-rate calls anywhere in the foreign exchange area.

**Foreign Exchange Office (FXO):** provides local telephone service from a CO outside of ("foreign" to) the subscriber's exchange area. In simple form, a user can pick up the phone in one city and receive a tone in the foreign city.

Connecting a POTS telephone to a computer telephony system via a T1 link requires a channel bank configured for the FX connection. To generate a call from the POTS set to the computer telephony system, a FXO connection must be configured.

**Foreign Exchange Station (FXS):** See FX, FXO. To generate a call from the computer telephony system to the POTS set, a FXS connection must be configured.

**Forward Explicit Congestion Notification (FECN):** A bit that tells you that a certain frame on a particular logical connection has encountered heavy traffic. The bit provides notification that congestion-avoidance procedures should be initiated in the same direction of the received frame. See also BECN (Backward Explicit Congestion Notification).

**Frame:** A group of data bits in a specific format to help network equipment recognize what the bits mean and how to process them. The bits are sent serially, with a flag at each end signifying the start and end of the frame.

**Frame Relay:** A form of packet switching that uses small packets and that requires less error checking than other forms of packet switching. Frame relay is effective for sending "bursty" data at high speeds (56/64K, 256K, and 1024 Kbps) over wide area networks. Frame Relay specifications are defined by ANSI documents ANSI T1.602, T1.606, T1S1/90-175, T1S1/90-213, and T1S1/90-214. In using frame relay, blocks of information (frames) are passed across a digital network interface using a "connection number" that is applied to each frame to distinguish between individual frames.

**Frame Relay Forum:** A nonprofit organization of 300+ vendors and service providers, based in Foster City, CA, that are developing and deploying frame relay equipment.

**Frame Relay Implementors Forum:** A group of companies supporting a common specification for frame relay connection to link customer premises equipment to telco network equipment. Their specification supports ANSI frame relay specs and defines extensions such as local management.

**Frame Relay Access Device (FRAD):** A piece of equipment that acts as a concentrator or frame assembler/dissassembler that can support multiple protocols and provide basic "routing" functions.

## G

**Gateway:** 1. A functional unit that interconnects two computer networks with different network architectures. A gateway connects networks or systems of different architectures. A bridge interconnects networks or systems with the same or similar architectures. 2. A network that connects hosts.

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**Graphical User Interface (GUI):** A type of computer interface consisting of a visual metaphor of a real-world scene, often of a desktop. Within that scene are icons, representing actual objects, that the user can access and manipulate with a pointing device.

## H

**Handshaking:** A process that two modems go through at the time of call setup to establish synchronization over the data communications link. It is a synchronization and negotiation process accomplished by the exchange of predefined, mutually recognized control codes.

**High-level Data Link Control (HDLC):** An ISO standard, bit-oriented data communications protocol that provides nearly error-free data transfers.

## I

**Hexadecimal:** A base 16 numbering system used to represent binary values. Hex uses the numbers 0-9 and the letters A-F: usually notated by an "h" (e.g., "4CF h", read "four charley fox, hex"). The result is that one hex digit represents a 4-bit value.

**Implicit congestion management:** A method of informing the terminal that the network is busy. This method relies on the end-system protocol to detect and fix the congestion problem. (TCP/IP is an example of a protocol using only implicit congestion management.) See also "explicit congestion management".

**In-band:** Refers to the type of signalling over the conversion path on an ISDN call. Contrast "out-of-band".

**Insufficient Ones:** A T1 error condition that is logged when less than one 1 in 16 0s or less than 12.5 % average 1s density is received.

**Inter Exchange Carrier (IEC):** The long distance company (LE) who's central office provides the point of reference for T1 access. Any common carrier authorized by the FCC to carry customer transmissions between LATAs.

**Internet:** Refers to the computer network of many millions of university, government and private users around the world. Each user has a unique Internet Address.

**Internet Address (IP Address):** A unique 32-bit address for a specific TCP/IP host on a network. Normally printed in dotted decimal format (e.g., 129.128.44.227).

**Internet Protocol (IP):** A protocol used to route data from its source to its destination in an Internet environment. The Internet Protocol was designed to connect to local area networks. Although there are many protocols that do this, IP refers to the global system of interconnecting computers. It is a highly distributed protocol (each machine only worries about sending data to the next step in the route).

**Internetwork Packet Exchange (IPX):** A NetWare communications protocol used to route messages from one node to another. IPX packets include network addresses and can be routed from one network to another. An IPX packet can occasionally get lost when crossing networks, thus IPX does not guarantee delivery of a complete message. Either the application has to provide that control, or NetWare's SPX protocol must be used.

**Interoperable:** Devices from different vendors that can exchange information using a standard's base protocol.

**I/O Addresses:** Locations within the I/O address space of your computer used by a device, such as an expansion card, a serial port, or an internal modem. The address is used for communication between software and a device.

**IRQ Level (Interrupt Request Level):** The notification a processor receives when another portion of the computer's hardware requires its attention. IRQs are numbered so that the device issuing the IRQ can be identified, and so IRQs can be prioritized.

**ISA (Industry Standards Architecture) (pronounced "ice a"):** The classic 8 or 16-bit architecture introduced with IBM's PC-AT computer.

**ISDN (Integrated Services Digital Network):** An International telecommunications standard for transmitting voice, video and data over a digital communications line. ISDN is a world-wide telecommunications service that uses digital transmission and switching technology to support voice and digital data communications. Frame relay was partially based on ISDN's data link layer protocol (LAPD). Frame relay can be used to transmit across ISDN services offering circuit-switched connection at 64K bps and higher speeds. Contrast Public Switched Telephone Network (PSTN).

**ITU-TSS (formerly CCITT):** International Telecommunications Union-Telecommunications Sector; the United Nations organization that prepares standards ("Recommendations") for resolving communications issues and problems.

## K

**Key Telephone System (KTS):** Phone devices with multiple buttons that let you select incoming or outgoing CO phone lines directly. Similar in operation to a PBX, except a KTS you don't have to dial a "9" for a call outside the building.

**Key Service Unit (KSU):** A small device containing the switching electronics for a business key telephone system (KTS).

**Key Set:** A telephone set with several buttons for call holding, line pickup, intercom, autodialing, etc. Also called a touch tone phone (Ericsson) and a KTS (Key Telephone Set).

## L

**LAPB:** Link Access Procedure Balanced; based on the X.25 Layer 2 specification. A full-duplex point-to-point bit-synchronous protocol commonly used as a data link control protocol to interface X.25 DTEs. LAPB is the link initialization procedure that establishes and maintains communications between the DTE and the DCE.

**LAPD:** Link Access Protocol for the D-Channel; based on the ISDN Q.921 specification. A full-duplex point-to-point bit-synchronous link-level protocol for ISDN connections; different from LAPB in its framing sequence. Transmission is in units called "frames", and a frame may contain one or more X.25 packets.

**Line Coding:** The representation of 1s and 0s on a T1 line. The two methods of line coding commonly used, B8ZS and AMI, differ in the restrictions placed on user data. T1 line coding ensures that sufficient timing information is sent with the digital signal to ensure recovery of all the bits at the far end. Timing information on the T1 line is included in the form of 1s in the data stream; a long string of 0s in the data stream could cause problems recovering the data.

**Line Termination (LT):** The electronics at the ISDN network side of the user/network interface that complements the NT1 at the user side. The LT and the NT1 together provide the high-speed digital line signals required for BRI access.

**Listed Directory Number (LDN):** The main number assigned by the telco; the number listed in the telephone directory and also provided by Directory Assistance. Some devices can have more than one LDN, such as ISDN devices that have one LDN for voice and another LDN for data.

**Local Area Network (LAN):** 1. A computer network located on a user's premises within a limited geographical area. Communication within a local area network is not subject to external regulations; however, communication across the LAN boundary may be subject to some form of regulation. 2. A LAN does not use store and forward techniques. 3. A network in which a set of devices are connected to one another for a communication and that can be connected to a larger network.

**Local Access and Transport Area (LATA):** A post-divestiture geographical area generally equivalent to a Standard Metropolitan Statistical Area. At divestiture, the territory served by the Bell system was divided into approximately 161 LATAs. The Bell Operating Companies (BOCs) provide Intra-LATA services.

**Local Exchange Carrier (LEC):** The local phone company which provides local (i.e., not long distance) transmission services. aka "telco". LECs provide T1 or FT1 access to LDCs (unless the T1 circuit is completely intra-LATA). Inter-LATA T1 circuits are made up of a combination of Access and Long Haul facilities.

**Local Management Interface (LMI):** A specification for frame relay equipment that defines status information exchange.

**Local Loop:** A transmission path, typically twisted-pair wire, between an individual subscriber and the nearest public telecommunications network switching center. The wires provide ISDN service, but require an NT1 at the user end and an LT at the network end. (aka, "loop" or "subscriber loop".)

**Logical Link Control (LLC2):** In a local area network, the protocol that governs the exchange of transmission frames between data stations independently of how the transmission medium is shared. The LLC2 protocol was developed by the IEEE 802 committee and is common to all LAN standards.

**Logical Unit (LU):** A type of network accessible unit that enables end users to gain access to network resources and communicate with each other.

**Long Haul:** The T1 element that connects to the Access portion of the long distance company's (LDC's) central office. The LDC is commonly called the point of presence (POP). Each LDC has a number of POPs, located throughout the country. The LDC is also called an IEC (Inter Exchange Carrier).

**Long Haul Communications:** The type of phone call reaching outside of a local exchange (LE).

## M

**Management Information Base (MIB):** A database of network management information used by the Common Management Information Protocol (CMIP) and the Simple Network Management Protocol (SNMP).

**Megacom:** An AT&T service with a normal WATS line (typically T1) between the customer premise and the AT&T serving class 4 CO are the customer's responsibility.

**MegaLink:** BellSouth's leased T1 service.

**Message:** Associated with such terms as packet, frame, and segment. 1. In information theory, an ordered series of characters intended to convey information. 2. An assembly of characters and sometimes control codes that is transferred as an entry from an originator to one or more recipients.

**Modem:** A communications device that enables a computer to transmit information over a telephone line. It converts the computer's digital signals into analog signals to send over a telephone line and converts them back to digital signals at the receiving end. Modems can be internal and fit into an expansion slot, or external and connect to a serial port.

**Multiplexer (Mux):** 1. A device that takes several input signals and combines them into a single output signal in such a manner that each of the input signals can be recovered. 2. A device capable of interleaving the events of two or more activities or capable of distributing the events of an interleaved sequence to the respective activities. 3. Putting multiple signals on a single channel.

**Multiprotocol:** A device that can interoperate with devices utilizing different network protocols.

**Multithreading:** The ability of a software system to be able to handle more than one transaction concurrently. This is contrasted to the case where a single transaction is accepted and completely processed before the next transaction processing is started.

## N

**Nailed Connection:** A permanent or dedicated circuit of a previously switched circuit or circuits.

**Nailed-up Circuit:** A semipermanent circuit established through a circuit-switching facility for point-to-point connectivity.

**NAK (Negative Acknowledgment):** Communications code used to indicate that a message was not properly received, or that a terminal does not wish to transmit. Contrast with ACK.

**Network:** A group of computers connected by cables or other means and using software that enables them to share equipment, such as printers and disk drives to exchange information.

**Node:** Any point within a network which has been assigned an address.

## O

**Object-Orientated:** A method for structuring programs as hierarchically organized classes describing the data and operations of objects that may interact with other objects.

**Office Channel Unit - Data Port (OCU-DP):** The CO channel bank used as the interface between the customer's DSU and the channel bank.

**Off-hook:** The condition of a device which has accessed a phone line (with or without using the line). In modem use, this is equivalent to a telephone handset being picked up. Dialing and transmission are allowed, but incoming calls are not answered. Contrast "on-hook".

**Off Premise Extension (OPX):** An extension or phone that terminates in a location other than that of the PBX. Commonly used to provide a corporate member with an extension of the PBX at home.

**Ones Density:** the measure of the number of logical 1s on a T1 line compared to a given total number of bits on that line; used for timing information in data recovery in AMI and B8ZS.

**On-Hook:** The condition of a device which has not accessed a phone line. In modem use, this is equivalent to a telephone handset that has not been picked up. In other words, it can receive an incoming call. Contrast "off-hook".

**Open Shortest Path First (OSPF):** A hierarchical Interior Gateway Protocol (IGP) routing algorithm for IP that is a proposed standard for Internet. OSPF incorporates least-cost routing, equal-cost routing, and load balancing.

**Outage:** The measure of the time during which a circuit is not available for use due to service interrupt. Outage is the complement of circuit "availability" (100% minus % available = % outage).

**Out-of-band:** Signaling that is separated from the channel carrying the information (i.e., the voice/data/video signal is separate from the carrier signal). Dialing and various other "supervisory" signals are included in the signaling element. Contrast "In-band" signaling.

**Out of Frame (OOF):** A T1 alarm condition that is logged on the loss of 2, 3 or 4 of 5 consecutive FT framing bits.

## P

**Packet:** 1. In data communication, a sequence of binary digits, including data and control signals, that is transmitted and switched as a composite whole. The data, control signals and, possibly, error control information are arranged in a specific format. 2. Synonymous with data frame. 3. In TCP/IP, the unit of data passed across the interface between the Internet layer and the link layer. A packet includes an IP header and data. A packet can be a complete IP datagram or a fragment of an IP diagram. 4. In X.25, a data transmission information unit. A group of data and control characters, transferred as a unit, determined by the process of transmission. Commonly used data field lengths in packets are 128 or 256 bytes. 5. The field structure and format defined in the CCITT X.25 recommendation.

**Packet Assembler/Disassembler (PAD):** Used by devices to communicate over X.25 networks by building or stripping X.25 information on or from a packet.

**Packet Data:** The information format ("packetized") used for packet-mode calls.

**Packet Mode:** Refers to the switching of chunks of information for different users using statistical multiplexing to send them over the same transmission facility.

**Parity bit:** An extra bit attached to each byte of synchronous data used to detect errors in transmission.

**Permanent Virtual Circuit (PVC):** A connection between two endpoints dedicated to a single user. IN ISDN, PVCs are established by network administration and are held for as long as the user subscribes to the service.

**Physical Unit (PU):** The component that manages and monitors the resources (such as attached links and adjacent link stations) associated with a node, as requested by an SSCP via an SSCP-PU session. An SSCP activates a session with the physical unit in order to indirectly manage, through the PU, resources of the node such as attached links. This term applies to type 2.0, type 4, and type 5 nodes only.

**Point of Presence (POP):** The central office's end points of the long distance carriers.

**Point to Point Protocol (PPP):** A protocol that lets a PC user access TCP/IP (Internet member) using an ISDN terminal adapter or a high-speed modem over a standard telephone line.

**Port:** A location for input or output data exchange. Computers, muxes, etc. have ports for various purposes.

**Primary Rate Interface (PRI):** Used on ISDN. In North America, and Japan, PRI is one 64 Kbps D channel and 23 B channels. Elsewhere, it is one D channel and 30 B channels.

**Primitive:** An abstract representation of interaction across the access points indicating that information is being passed between the service user and the service provider. The OSI Reference Model defines four types of primitives: Request, Indication, Response and Confirm.

**Private Branch Exchange (PBX):** A telephone exchange located on the customer's premises. The PBX provides a circuit switching facility for telephone extension lines within the building, and access to the public telephone network. See also "Exchange".

**PROM (Programmable Read Only Memory - pronounced "prom"):** A permanent memory chip that can be programmed or filled by the customer after by the manufacturer has set initial values. Contrast with ROM.

**Protocol:** 1. A set of semantic and syntactic rules that determines the behavior of functional units in achieving communication. 2. In Open Systems Interconnection architecture, a set of semantic and syntactic rules that determine the behavior of entities in the same layer in performing communication functions. 3. In SNA, the meanings of and the sequencing rules for requests and responses used for managing the network, transferring data, and synchronizing the states of network components. 4. Synonymous with line control discipline.

**PSTN (Public Switched Telephone Network):** A worldwide public voice telephone network that is used as a telecommunications medium for the transmission of voice, data and other information.

**Public Data Network (PDN):** A packet-switched network that is available to the public for individual ("subscriber") use. Typically, controlled by a government or a national monopoly.

**Public Switched Telephone Network (PSTN):** The group of circuit-switching voice carriers, which are commonly used as analog data communications services.

**Pulse Code Modulation (PCM):** 1. In data communication, variation of a digital signal to represent information; for example, by means of pulse amplitude modulation (PAM), pulse duration modulation (PDM), or pulse position modulation (PPM). 2. Transmissions of analog information in digital form through sampling and encoding the samples with a fixed number of bits.

**Pulse dialing:** One of two methods of dialing a telephone, usually associated with rotary-dial phones. Compare with "tone dialing".

## Q

**Quantizing:** The process of analog-to- digital conversion by assigning a range, from the contiguous analog values, to a discrete number.

## R

**Random Access Memory (RAM):** A computer's primary workspace. All data must be stored in RAM (even for a short while), before software can use the processor to manipulate the data. Before a PC can do anything useful it must move programs from disk to RAM. When you turn it off, all information in RAM is lost.

**Rate Enforcement:** The concept in frame relay where frames sent faster than the CIR are to be carried only if the bandwidth is available, otherwise they are to be discarded. (The frame relay network assumes that anything exceeding the CIR is of low priority.) Rate enforcement makes sure that the network will not get so congested that it isn't able to meet the agreed on CIR

**Recognized Private Operating Agency (RPOA):** A corporation, private or government-controlled, that provides telecommunications services. RPOAs, such as AT&T, participate as non-voting members in the CCITT.

**Red Alarm:** A T1 error condition generated when a local failure (e.g., loss of synchronization) exists for 2.5 seconds, causing a Carrier Group Alarm (CGA). See also "Blue Alarm" and "Yellow Alarm".

**Request for Comment (RFC):** A set of papers in which Internet standards (published and proposed), along with generally-accepted ideas, proposals, research results, etc. are published.

**Ring Down Box:** A device that emulates a CO by generating POTS calls for testing and product demos.

**Ring Down Circuit:** A tie line connecting phones where picking up one phone automatically rings another phone. A feature used for emergencies to alert the person at the other phone of the incoming call.

**RJ-11:** An industry standard interface used for connecting a telephone to a modular wall outlet; comes in 4- and 6-wire packages.

**RJ-45:** An 8-wire modular connector for voice and data circuits.

**Robbed Bit Signaling:** The popular T1 signaling mechanism where the A and B bits are sent by each side of the T1 termination and are "buried" in the voice data of each voice channel in the T1 circuit. Since the bits are "robbed" infrequently, voice quality is remains relatively uncompromised. See "bit robbing".

The robbed-bit signaling technique is used in D4 channel banks to convey signaling information. The eighth (least significant) bit of each of the 24 8-bit time slots is "robbed" every sixth frame to convey voice-related signaling information such as on-hook, off-hook, etc., for each channel.

**Router:** A device that connects two networks using the same networking protocol. It operates at the Network Layer (Layer 3) of the OSI model for forwarding decisions.

**Routing Information Protocol (RIP):** A distance vector-based protocol that provides a measure of distance, or hops, from a transmitting workstation to a receiving workstation.

**RS232-C:** An EIA standard for a serial interface between computers and peripheral devices (modem, mouse, etc.). It uses a 25-pin DB-25, or a 9-pin DB-9 connector. The RS-232 standard defines the purposes, electrical characteristics and timing of the signals for each of the 25 lines.

**RS-422:** The EIA standard for a balanced interface with no accompanying physical connector. RS-422 products can use screw terminals, DB-9, various DB-25, and DB-37 connectors.

**RS-530:** The EIA standard for the mechanical/electrical interface between DCEs and DTEs transmitting synchronous or asynchronous serial binary data. RS-530 provides for high data rates with the same connector used for RS-232; however, it is incompatible with RS-232.

## S

**Serial Port:** The connector on a PC used to attach serial devices (those that need to receive data one bit after another), such as a mouse, a printer or a modem. This consists of a 9- or 25-pin connector that sends data in sequence (bit by bit). Serial ports are referred to as "COMx" ports, where x is 1 to 4 (i.e., COM1 through COM4). A serial port contains a conversion chip called a "UART" which translates between internal parallel and external serial formats.

**Service:** The requirements offered by an RPOA to its customers to satisfy specific telecommunications needs.

**Severely Errored Seconds (SES):** Refers to a typical T1 error event where an error burst occurs (a short term, high bit-error rate that is self-clearing). Per the ITU-T (CCITT) G.821: any second in which the BER is less than  $1 \times 10^{-3}$ .

**Signaling:** The process of establishing, maintaining, accounting for, and terminating a connection between two endpoints (e.g., the user premises and the telco CO). Central office signals to the user premises can include ringing, dial tone, speech signals, etc. Signals from the user's telephone can include off-hook, dialing, speech to far-end party, and on-hook signals.

In-band signaling techniques include pulse and tone dialing. With common channel signaling, information is carried out-of-band.

**Simple Network Management Protocol (SNMP):** TCP/IP protocol that allows network management.

**Simultaneous Voice Data (SVD):** A technology for letting a user send data via a modem, and use a handset to talk to another user at the same time over the same connection. The alternative, making a second call, can be expensive or even impossible. The uses for SVD are telecommuting, videoconferencing, distant learning, tech support, etc.

**Stop Bit:** One of the variables used for timing in asynchronous data transmission. Depending on the devices, each character may be trailed by 1, 1.5, or 2 stop bits.

**Superframe (D4):** A T1 transmission format that consists of 12 DS1 frames, or 2316 bits. A DS1 frame consists of 193 bit positions. A frame overhead bit is in the first position, and it is used for frame and signaling phase alignment only.

**Subscriber Loop:** See "Local loop".

**Switched 56:** A circuit-switched (full duplex digital synchronous data transmission) service that lets you dial a number and transmit data to it at 56K bps. It is a relatively low cost service, widely used in North America for telecommuting, videoconferencing and high speed data transfers. Many phone companies are (or will be) phasing out Switched 56 in favor of ISDN service.

**Switched Virtual Circuit (SVC):** A type of data transmission where the connection is maintained only until the call is cleared.

**Switched Line:** In communications, a physical channel established by dynamically connecting one or more discreet segments. This connection lasts for the duration of the call after which each segment may be used as part of a different channel. Contrast with leased line.

**Switched Network:** A network in which a temporary connection is established from one point via one or more segments.

**Synchronous Data Link Control (SDLC):** A discipline conforming to subsets of the Advanced Data Communications Control Procedures (ADCCP) of the American National Standards Institute (ANSI) and High-level Data Link Control (HDLC) of the International Organization for Standardization, 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 non-switched links. The configuration of the link connection may be point-to-point, multipoint, or loop.

**Synchronous Transmission:** The transmission of data which involves sending a group of characters in a packet. This is a common method of transmission between computers on a network or between modems. One or more synchronous characters are transmitted to confirm clocking before each packet of data is transmitted. Compare to Asynchronous Transmission.

**Systems Network Architecture (SNA):** The description of the logical structure, formats, protocols, and operational sequences for transmitting information units through, and controlling the configuration and operation of networks.

## T

**Tariff:** The rate/availability schedule for telephone and ISDN services from a regulated service provider.

**TCP/IP:** A set of communication protocols that support peer-to-peer connectivity functions for both local and wide area networks.

**T Carrier:** The generic name for a digitally multiplexed carrier system. In the North American digital hierarchy, a T is used to designate a DS (digital signal) level hierarchy. Examples: T1 (DS1) is a 1.544 M bps 24-channel designation. In Europe, T1 is called E1. The T Carrier system was originally designed for transmitting digitized voice signals, but has since been adapted for digital data applications.

**T1:** A digital transmission link capable of 1.544M bps. T1 uses two pairs of normal UTP, and can handle 24 voice conversations, each digitized at 64K bps. T1 is a standard for digital transmission in the U.S., Canada, Japan and Hong Kong. T1 is the access method for high-speed services such as ATM, frame relay, and SMDS. See also T Carrier, T1 line and FT1.

**T1 Channel Tests:** A set of diagnostics that vary by carrier, used to verify a T1 channel operation. Can include Tone, Noise Level, Impulse Noise Level, Echo Cancellors, Gain, and Crosstalk testing.

**T1 Framing:** To digitize and encode analog voice signals requires 8000 samples per second (twice the highest voice frequency of 4000 Hz). Encoding in an 8-bit word provides the basic T1 block of 64K bps for voice transmission. This "Level 0 Signal, as its called, is represented by "DS-0", or Digital Signal at Level 0. 24 of these voice channels are combined into a serial bit stream (using TDM), on a frame-by-frame basis. A frame is a sample of all 24 channels; so adding in a framing bit gives a block of 193 bits (24x8+1=193). Frames are transmitted at 8000 per second (the required sample rate), creating a 1.544M (8000x193=1.544M) transmission rate.

**T1 Line:** A digital communications facility that functions as a 24-channel pathway for data or voice. A T1 line is composed of two separate elements: the Access element and the Long Haul element.

**T1 Mux:** A device used to carry many sources of data on a T1 line. The T1 mux assigns each data source to distinct DS0 time slots within the T1 signal. Wide bandwidth signals take more than one time slot. Normal voice traffic or 56/64K bps data channels take one time slot. The T1 mux may use an internal or external T1 DSU; a "channel bank" device typically uses an external T1 CSU.

**Transmission Control Protocol / Internet Program (TCP/IP):** A multilayer set of protocols developed by the US Department of Defense to link dissimilar computers across dissimilar and unreliable LANs.

**Terminal:** The screen and keyboard device used in a mainframe environment for interactive data entry. Terminals have no "box", which is to say they have no file storage or processing capabilities.

**Terminal Adapter (TA):** An ISDN DTE device for connecting a non-ISDN terminal device to the ISDN network. Similar to a protocol converter or an interface converter, a TA connects a non-ISDN device between the R and S interfaces. Typically a PC card.

**Tie line:** A dedicated circuit linking two points without having to dial a phone number (i.e., the line may be accessed by lifting the telephone handset or by pushing a button).

**Time-Division Multiplexing (TDM):** Division of a transmission facility into two or more channels by allotting the common channel to several different information channels, one at a time.

**Time Slot:** One of 24 channels within a T1 line. Each channel has a 64K bps maximum bandwidth. "Time slot" implies the time division multiplexing organization of the T1 signal.

**Toll Call:** A call to a location outside of your local service area (i.e., a long distance call).

**Tone dialing:** One of two methods of dialing a telephone, usually associated with Touch Tone® (push button) phones. Compare with pulse dialing.

**Topology:** Physical layout of network components (cables, stations, gateways, and hubs). Three basic interconnection topologies are star, ring, and bus networks.

**Transmission Control Protocol (TCP):** A communications protocol used in Internet and in any network that follows the US Department of Defense standards for internetwork protocol. TCP provides a reliable host-to-host protocol between hosts in packet-switched communications networks and in interconnected systems of such networks. It assumes that the Internet protocol is the underlying protocol.

**Transport Layer:** Layer 4 of the Open Systems Interconnection (OSI) model; provides reliable, end-to-end delivery of data, and detects transmission sequential errors.

**Transport Protocol Data Unit (TPDU):** A transport header, which is added to every message, contains destination and source addressing information that enables the end-to-end routing of messages in multi-layer NAC networks of high complexity. They are automatically added to messages as they enter the network and can be stripped off before being passed to the host or another device that does not support TPDU's.

**Trunk:** Transmission links that interconnect switching offices.

**TSR (terminate and stay resident):** A software program that remains active and in memory after its user interface is closed. Similar to a daemon in UNIX environments.

**Tunneling:** Encapsulation data in an IP packet for transport across the Internet.

**Twisted pair wiring:** A type of cabling with one or more pairs of insulated wires wrapped around each other. An inexpensive wiring method used for LAN and telephone applications, also called UTP wiring.

## U

**UART (Universal Asynchronous Receiver/Transmitter) (pronounced "you art"):** A chip that transmits and receives data on the serial port. It converts bytes into serial bits for transmission, and vice versa, and generates and strips the start and stop bits appended to each character.

**UNIX:** An operating system developed by Bell Laboratories that features multiprogramming in a multi-user environment.

**Unshielded Twisted Pair (UTP):** Telephone-type wiring. Transmission media for 10Base-T.

## V

**V.25bis:** An ITU-T standard for synchronous communications between a mainframe or host and a modem using HDLC or other character-oriented protocol.

**V.54:** The ITU-T standard for local and remote loopback tests in modems, DCEs and DTEs. The four basic tests are:

- local digital loopback (tests DTE send and receive circuits),
- local analog loopback (tests local modem operation),
- remote analog loopback (tests comm link to the remote modem), and
- remote digital loopback (tests remote modem operation).

**Virtual Circuit:** A logical connection. Used in packet switching wherein a logical connection is established between two devices at the start of transmission. All information packets follow the same route and arrive in sequence (but do not necessarily carry a complete address).

## W

**Wide Area Network (WAN):** 1. A network that provides communication services to a geographic area larger than that served by a local area network or a metropolitan area network, and that may use or provide public communication facilities. 2. A data communications network designed to serve an area of hundreds or thousands of miles; for example, public and private packet-switching networks, and national telephone networks. Contrast with local area network (LAN).

**Wide Area Telecommunications Service (WATS):** A low-cost toll service offered by most long distance and local phone companies. Incoming (800 call service, or IN-WATS) and outgoing WATS are subscribed to separately, but over the same line.

## X

**X.25:** ITU-T's definition of a three-level packet-switching protocol to be used between packet-mode DTEs and network DCEs. X.25 corresponds with layer 3 of the 7-layer OSI model.

## Y

**Yellow Alarm:** An error indication sent by the T1 device when it has not gotten a receive signal, or cannot synchronize on the receive signal received. Contrast "Red Alarm" and "Blue Alarm".

## Z

**Zero Byte Time Slot Interchange (ZBTSI):** A method for enabling 64K bps unrestricted user data (enabling all 0s in the user data). An alternative to (but not as popular as) 8BZS.

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