TDMoIP Driven®

RAD data communications

Installation and Operation Manual

IPmux-11

TDM Pseudowire Access Gateway

Version 2.00

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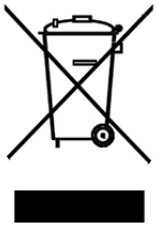
Product Disposal



To facilitate the reuse, recycling and other forms of recovery of waste equipment in protecting the environment, the owner of this RAD product is required to refrain from disposing of this product as unsorted municipal waste at the end of its life cycle. Upon termination of the unit's use, customers should provide for its collection for reuse, recycling or other form of environmentally conscientious disposal.

General Safety Instructions

The following instructions serve as a general guide for the safe installation and operation of telecommunications products. Additional instructions, if applicable, are included inside the manual.

Safety Symbols

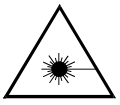
Warning

This symbol may appear on the equipment or in the text. It indicates potential safety hazards regarding product operation or maintenance to operator or service personnel.

Danger of electric shock! Avoid any contact with the marked surface while the product is energized or connected to outdoor telecommunication lines.

.

Protective earth: the marked lug or terminal should be connected to the building protective earth bus.



Warning

Some products may be equipped with a laser diode. In such cases, a label with the laser class and other warnings as applicable will be attached near the optical transmitter. The laser warning symbol may be also attached. Please observe the following precautions:

- **Before turning on the equipment, make sure that the fiber optic cable is intact and is connected to the transmitter.**
- **Do not attempt to adjust the laser drive current.**
- **Do not use broken or unterminated fiber-optic cables/connectors or look straight at the laser beam.**
- **The use of optical devices with the equipment will increase eye hazard.**
- **Use of controls, adjustments or performing procedures other than those specified herein, may result in hazardous radiation exposure.**

ATTENTION: The laser beam may be invisible!

In some cases, the users may insert their own SFP laser transceivers into the product. Users are alerted that RAD cannot be held responsible for any damage that may result if non-compliant transceivers are used. In particular, users are warned to use only agency approved products that comply with the local laser safety regulations for Class 1 laser products.

Always observe standard safety precautions during installation, operation and maintenance of this product. Only qualified and authorized service personnel should carry out adjustment, maintenance or repairs to this product. No installation, adjustment, maintenance or repairs should be performed by either the operator or the user.

Handling Energized Products

General Safety Practices

Do not touch or tamper with the power supply when the power cord is connected. Line voltages may be present inside certain products even when the power switch (if installed) is in the OFF position or a fuse is blown. For DC-powered products, although the voltages levels are usually not hazardous, energy hazards may still exist.

Before working on equipment connected to power lines or telecommunication lines, remove jewelry or any other metallic object that may come into contact with energized parts.

Unless otherwise specified, all products are intended to be grounded during normal use. Grounding is provided by connecting the mains plug to a wall socket with a protective earth terminal. If an earth lug is provided on the product, it should be connected to the protective earth at all times, by a wire with a diameter of 18 AWG or wider. Rack-mounted equipment should be mounted only in earthed racks and cabinets.

Always make the ground connection first and disconnect it last. Do not connect telecommunication cables to ungrounded equipment. Make sure that all other cables are disconnected before disconnecting the ground.

Connection of AC Mains

Make sure that the electrical installation complies with local codes.

Always connect the AC plug to a wall socket with a protective ground.

The maximum permissible current capability of the branch distribution circuit that supplies power to the product is 16A. The circuit breaker in the building installation should have high breaking capacity and must operate at short-circuit current exceeding 35A.

Always connect the power cord first to the equipment and then to the wall socket. If a power switch is provided in the equipment, set it to the OFF position. If the power cord cannot be readily disconnected in case of emergency, make sure that a readily accessible circuit breaker or emergency switch is installed in the building installation.

In cases when the power distribution system is IT type, the switch must disconnect both poles simultaneously.

Connection of DC Mains

Unless otherwise specified in the manual, the DC input to the equipment is floating in reference to the ground. Any single pole can be externally grounded.

Due to the high current capability of DC mains systems, care should be taken when connecting the DC supply to avoid short-circuits and fire hazards.

DC units should be installed in a restricted access area, i.e. an area where access is authorized only to qualified service and maintenance personnel.

Make sure that the DC supply is electrically isolated from any AC source and that the installation complies with the local codes.

The maximum permissible current capability of the branch distribution circuit that supplies power to the product is 16A. The circuit breaker in the building installation should have high breaking capacity and must operate at short-circuit current exceeding 35A.

Before connecting the DC supply wires, ensure that power is removed from the DC circuit. Locate the circuit breaker of the panel board that services the equipment and switch it to the OFF position. When connecting the DC supply wires, first connect the ground wire to the corresponding terminal, then the positive pole and last the negative pole. Switch the circuit breaker back to the ON position.

A readily accessible disconnect device that is suitably rated and approved should be incorporated in the building installation.

If the DC mains are floating, the switch must disconnect both poles simultaneously.

Connection of Data and Telecommunications Cables

Data and telecommunication interfaces are classified according to their safety status.

The following table lists the status of several standard interfaces. If the status of a given port differs from the standard one, a notice will be given in the manual.

Ports	**Safety Status**	
V.11, V.28, V.35, V.36, RS-530, X.21, 10 BaseT, 100 BaseT, Unbalanced E1, E2, E3, STM, DS-2, DS-3, S-Interface ISDN, Analog voice E&M	SELV	Safety Extra Low Voltage: Ports which do not present a safety hazard. Usually up to 30 VAC or 60 VDC.
xDSL (without feeding voltage), Balanced E1, T1, Sub E1/T1	TNV-1	Telecommunication Network Voltage-1: Ports whose normal operating voltage is within the limits of SELV, on which overvoltages from telecommunications networks are possible.
FXS (Foreign Exchange Subscriber)	TNV-2	Telecommunication Network Voltage-2: Ports whose normal operating voltage exceeds the limits of SELV (usually up to 120 VDC or telephone ringing voltages), on which overvoltages from telecommunication networks are not possible. These ports are not permitted to be directly connected to external telephone and data lines.
FXO (Foreign Exchange Office), xDSL (with feeding voltage), U-Interface ISDN	TNV-3	Telecommunication Network Voltage-3: Ports whose normal operating voltage exceeds the limits of SELV (usually up to 120 VDC or telephone ringing voltages), on which overvoltages from telecommunication networks are possible.

Always connect a given port to a port of the same safety status. If in doubt, seek the assistance of a qualified safety engineer.

Always make sure that the equipment is grounded before connecting telecommunication cables. Do not disconnect the ground connection before disconnecting all telecommunications cables.

Some SELV and non-SELV circuits use the same connectors. Use caution when connecting cables. Extra caution should be exercised during thunderstorms.

When using shielded or coaxial cables, verify that there is a good ground connection at both ends. The earthing and bonding of the ground connections should comply with the local codes.

The telecommunication wiring in the building may be damaged or present a fire hazard in case of contact between exposed external wires and the AC power lines. In order to reduce the risk, there are restrictions on the diameter of wires in the telecom cables, between the equipment and the mating connectors.

Caution To reduce the risk of fire, use only No. 26 AWG or larger telecommunication line cords.

Attention Pour réduire les risques s'incendie, utiliser seulement des conducteurs de télécommunications 26 AWG ou de section supérieure.

Some ports are suitable for connection to intra-building or non-exposed wiring or cabling only. In such cases, a notice will be given in the installation instructions.

Do not attempt to tamper with any carrier-provided equipment or connection hardware.

Electromagnetic Compatibility (EMC)

The equipment is designed and approved to comply with the electromagnetic regulations of major regulatory bodies. The following instructions may enhance the performance of the equipment and will provide better protection against excessive emission and better immunity against disturbances.

A good earth connection is essential. When installing the equipment in a rack, make sure to remove all traces of paint from the mounting points. Use suitable lock-washers and torque. If an external grounding lug is provided, connect it to the earth bus using braided wire as short as possible.

The equipment is designed to comply with EMC requirements when connecting it with unshielded twisted pair (UTP) cables. However, the use of shielded wires is always recommended, especially for high-rate data. In some cases, when unshielded wires are used, ferrite cores should be installed on certain cables. In such cases, special instructions are provided in the manual.

Disconnect all wires which are not in permanent use, such as cables used for one-time configuration.

The compliance of the equipment with the regulations for conducted emission on the data lines is dependent on the cable quality. The emission is tested for UTP with 80 dB longitudinal conversion loss (LCL).

Unless otherwise specified or described in the manual, TNV-1 and TNV-3 ports provide secondary protection against surges on the data lines. Primary protectors should be provided in the building installation.

The equipment is designed to provide adequate protection against electro-static discharge (ESD). However, it is good working practice to use caution when connecting cables terminated with plastic connectors (without a grounded metal hood, such as flat cables) to sensitive data lines. Before connecting such cables, discharge yourself by touching earth ground or wear an ESD preventive wrist strap.

FCC-15 User Information

This equipment has been tested and found to comply with the limits of the 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 environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the Installation and Operation manual, may cause harmful interference to the 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.

Canadian Emission Requirements

This Class A digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulation.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Warning per EN 55022 (CISPR-22)

Warning	This is a class A product. In a domestic environment, this product may cause radio interference, in which case the user will be required to take adequate measures.
Avertissement	Cet appareil est un appareil de Classe A. Dans un environnement résidentiel, cet appareil peut provoquer des brouillages radioélectriques. Dans ces cas, il peut être demandé à l'utilisateur de prendre les mesures appropriées.
Achtung	Dieses ist ein Gerät der Funkstörgrenzwertklasse A. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkströrungen auftreten, in welchen Fällen der Benutzer für entsprechende Gegenmaßnahmen verantwortlich ist.

Declaration of Conformity

Manufacturer's Name:	RAD Data Communications Ltd.
Manufacturer's Address:	24 Raoul Wallenberg St. Tel Aviv 69719 Israel

declares that the product:

Product Name: IPmux-11

conforms to the following standard(s) or other normative document(s):

EMC:	EN 55022: 1998	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.
	EN 50024: 1998	Information technology equipment – Immunity characteristics – Limits and methods of measurement.
Safety:	EN 60950: 2000	Safety of information technology equipment.

Supplementary Information:

The product herewith complies with the requirements of the EMC Directive 89/336/EEC, the Low Voltage Directive 73/23/EEC and the R&TTE Directive 99/5/EC for wired equipment. The product was tested in a typical configuration.

Tel Aviv, September 22, 2004

Haim Karshen
VP Quality

European Contact: RAD Data Communications GmbH, Otto-Hahn-Str. 28-30,
85521 Ottobrunn-Riemerling, Germany

Quick Start Guide

Installation of IPmux-11 should be carried out only by an experienced technician. If you are familiar with IPmux-11, use this guide to prepare the unit for operation.

1. Installing IPmux-11

Connecting the Interfaces

1. Connect the network to the RJ-45 connector designated ETH 1.
2. Connect the user LAN(s) to the RJ-45 connector(s) designated ETH 2 or ETH 3.
3. Connect the E1 or T1 line to the RJ-45 connector designated E1 or T1.

Caution When connecting balanced E1 or T1 equipment, make sure to use only 4-wire RJ-45 connectors with the following pins used for receiving and transmitting data: 1, 2, 4, 5. Do not use 8-pin RJ-45 connectors.

4. Connect the control terminal to the rear panel CONTROL connector.

   or

   Connect a Telnet host, or a PC running a Web browsing application to one of the user LAN ports.

Connecting the Power

- Connect the power cable to the power connector on the IPmux-11 rear panel.

  The unit has no power switch. Operation starts when the power is applied to the rear panel power connector.

2. Configuring IPmux-11

Configure IPmux-11 to the desired operation mode via an ASCII terminal connected to the rear panel CONTROL port. Alternatively, you can manage IPmux-11 over Telnet, or via a PC running a Web browsing application connected to one of the user LAN ports.

Starting a Terminal Session for the First Time

➤ **To start a terminal session:**

1. Connect a terminal to the CONTROL connector of IPmux-11.
2. Turn on the control terminal PC and set its port parameters to 115,200 baud, 8 bits/character, 1 stop bit, no parity. Set the terminal emulator to ANSI VT100 emulation (for optimal view of system menus).
3. Power IPmux-11 up and proceed with management session.

Configuring the IP Management Parameters

The host IP address, subnet mask and default gateway IP address must be configured via an ASCII terminal.

➤ **To configure the IP management parameters:**

- From the Host IP menu (**Main** > **Configuration** > **System** > **Host IP**), select an IP address of the IPmux-11 host.

Configuring E1 and T1 at the Physical Level

E1 and T1 interface must be configured at the physical level first.

➤ **To configure E1 and T1 at the physical level:**

- From the TDM Configuration menu (**Configuration** > **Physical layer** > **TDM configuration**), configure the necessary parameters of the E1 or T1 services.

Configuring Bundle Connections

The E1/T1 timeslots must be assigned to a bundle. The bundle must be sent to the remote IP address and be connected to one of the destination bundles.

➤ **To assign timeslots to a bundle:**

- From the DS0 Bundle Configuration menu (**Main** > **Configuration** > **Connection** > **DS0 bundle configuration**), assign desired timeslots to a bundle by setting them to **1**.

➤ **To connect a bundle:**

- From the Bundle Connection Configuration menu (**Main** > **Configuration** > **Connection** > **Bundle connection configuration**), set the following:
  - Destination IP address
  - Destination bundle.

Configuring the Internal Bridge

➤ **To configure the Ethernet policy for the internal bridge ports:**

- From the ETH Policy Configuration menu (**Main** > **Configuration** > **Bridge** > **Bridge policy configuration**), do the following:
  - Specify bridge port operation mode
  - Set default VLAN ID
  - Set default VLAN priority
  - Select rate limit for each port.

➤ **To configure VLANs for the internal bridge ports:**

- From the VLAN Table Configuration menu (**Main** > **Configuration** > **Bridge** > **VLAN table configuration**), assign VLANs for each bridge port, if necessary.

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Chapter 1
Introduction

1.1 Overview

IPmux-11 offers a solution for extending traditional E1/T1 transparently over packet switched networks (PSNs) such as IP, Ethernet, and MPLS networks. The device converts the data stream coming from its TDM ports into configurable-sized packets that are extended over the Fast Ethernet network port, and vice versa. IPmux-11 offers end-to-end synchronization for voice/leased line applications. IPmux-11 also features two Fast Ethernet user ports for data (Ethernet) connectivity to the IP/Ethernet network. Management is performed locally by a terminal, or remotely via Web, Telnet, or SNMP.

Versions

IPmux-11 is available with different hardware configurations. The following versions are available:

- TDM interface options:
  - E1 for balanced E1 interface
  - E1CX for unbalanced E1 interface (via supplied adapter cable)
  - T1 for T1 interface
- Network Ethernet interface options:
  - UTP for 10/100BaseT interface, RJ-45 connector
  - MM13LC for multimode 1310 nm - 100BaseFx interface, LC connector
  - SM13LC for single mode 1310 nm - 100BaseFx interface, LC connector
- User Ethernet interface options:
  - UTP for 10/100BaseT user interface, RJ-45 connector

Application

Figure 1-1 illustrates a typical IPmux-11 multiplexing voice and Ethernet traffic over an IP link.

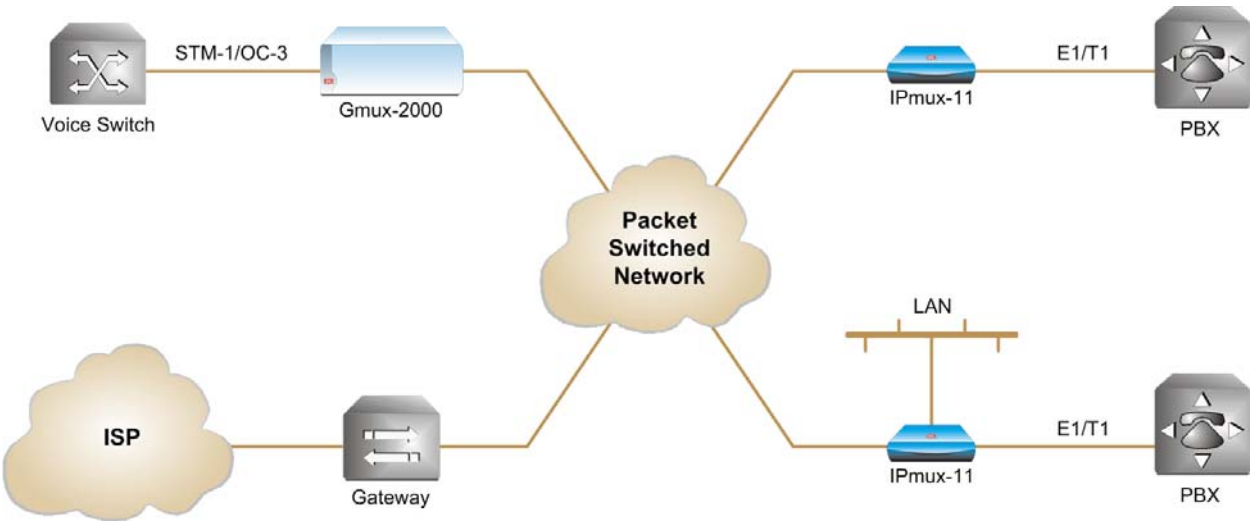

Figure 1-1. Multiplexing Voice and Ethernet over a Packet-Switched Network

Features

E1 Interface

The E1 port complies with G.703, G.704, and G.823 standards. The E1 port supports unframed, framed and multiframed operation with or without CRC-4. The E1 port supports long haul and short haul input signals and can be monitored for alarms and error statistics.

T1 Interface

The T1 port complies with ANSI T1.403, G.703, and G.704 standards. T1 jitter performance is according to G.824 and TR-62411. The T1 port supports unframed, SF, ESF and Robbed Bit signaling. The T1 port supports long haul and short haul input/output signals and can be monitored for alarms and error statistics. FDL and transmit performance monitoring for T1/ESF are also supported.

Ethernet Interface

IPmux-11 is available with three Ethernet ports (two user and one network port). The Ethernet ports work in the following switch modes:

- Transparent
- Tagged
- Untagged
- Double Tagged.

Note

Half-duplex operation in the IPmux-11 network port is not recommended when transmitting small-size packets, because collisions and backoffs cause large delay variation and may exceed the delay variation buffer tolerance at the receiving end, resulting in buffer underflows and errors.

IP

The data stream coming from the E1 or T1 port is converted into IP packets that are transported over the Fast Ethernet ports, and vice versa.

TDM bytes are encapsulated in a UDP frame that runs over IP and over Ethernet.

The number of TDM bytes in an IP frame is configurable for throughput/delay tradeoff.

Each device has a single IP address (host IP). A configurable destination IP address is assigned to the IP packets. IP ToS field support can be configured for IP level priority.

The Ethernet ports can be either UTP or fiber.

- **Fiber option** – standard 100BaseFx full-duplex port (see *Table 1-1*).
- **UTP option** – A standard 10/100BaseT half/full duplex port with autonegotiation and automatic crossover support. If autonegotiation is disabled, Ethernet mode should be configured.

Table 1-1. Fiber Optic Interface Options

Wavelength [nm]	Fiber Type [µm]	Transmitter Type	Power [dBm]		Receiver Sensitivity [dBm]	Loss [dB/km]		Budget [dBm]
			Min	Max		Min	Max	
1310	62.5/125 multimode	LED	-19	-14	-32	1	4	10*
1310	9/125 single mode	Laser	-15	-7	-34	0.5	0.8	16*

* Permitted fiber optic cable length differs according to fiber characteristics, splices, and connectors.

➤ **To calculate optical budget:**

Optical Budget [dB] =
|Receive Sensitivity| – |Optical Power| –3 (Aging) – Connectors/Patch Panels Loss

➤ **To calculate distance:**

Distance = Optical Budget/Maximum Loss

MPLS

IPmux-11 encapsulates TDM data with MPLS labels for transporting it over MPLS networks (TDMoMPLS). Saving up to 24 bytes of overhead in comparison to the standard TDMoIP encapsulation, TDMoMPLS is ideal for bandwidth-sensitive networks.

TDMoIP Operation Modes

E1/T1 operation modes are:

- Unframed E1/T1 over UDP over IP over Ethernet
- Fractional E1/T1 over UDP over IP over Ethernet
- Fractional E1/T1 with CAS over UDP over IP over Ethernet.

QoS

QoS supports:

- Labeling IP level priority (ToS/Diffserv) for TDMoIP packets
- VLAN tagging and priority labeling according to IEEE 802.1p&Q for TDMoIP packets
- QoS marking of the TDMoIP traffic in MPLS networks.

The user can configure the ToS (Type of Service) of the outgoing TDMoIP packets. This allows an en-route Layer 3 router or switch, which supports ToS, to give higher priority to IPmux-11 TDMoIP traffic for delay-sensitive and secure applications. IPmux-11 allows you to configure the **WHOLE** ToS byte field, since different vendors may use different bits to tag packets for traffic prioritization. This also enables operation according to various RFC definitions (for example RFC 2474, RFC 791). The user can also configure VLAN priority bits for Level 2 Priority.

Management

IPmux-11 can be managed locally by connecting an ASCII terminal to the RS-232 port on the rear panel, or via an HTTP connection (Web-based management tool, ConfiguRAD), Telnet or SNMP. The SNMP management capability enables fully graphical, user-friendly management using the RADview Service Center TDMoIP network management stations offered by RAD, as well as management by other SNMP-based management systems.

ConfiguRAD

ConfiguRAD is user-friendly, Web-based terminal management system for remote device configuration and maintenance. It is embedded into IPmux-11 and provided at no extra cost. ConfiguRAD can be run from any standard Web browser.

Timing

IPmux-11 maintains synchronization between TDM devices by deploying advanced clock distribution mechanisms.

Available timing modes are:

- Loopback
- Adaptive
- Internal clock
- External clock.

System clock ensures clock resilience by using master and fallback timing sources for clock redundancy.

IPmux-11 also provides system clock output via external clock connector.

1.2 Physical Description

IPmux-11 is a compact easy-to-install standalone unit. *Figure 1-2* shows a 3-dimensional view of IPmux-11.

Figure 1-2. IPmux-11 3D View

The front panel includes the IPmux-11 LEDs. For the detailed LED description, see *Chapter 3*.

User, network, external clock and management ports, and power supply connector are located on the rear panel of unit. For further details, see *Chapter 2*.

1.3 Functional Description

IPmux-11 provides TDM connectivity across the IP/Ethernet network. A single bundle (group of timeslots) can be transmitted to a predefined far-end bundle. IPmux-11 supports ICMP (ping), and generates ARP in case of unknown next hop MAC addresses, answers ARP requests, and supports the 802.3 VLAN Ethernet format.

IPmux-11 includes E1 or T1 port. Traffic is transmitted over the network as E1/T1 or fractional E1/T1, using the TDMoIP or TDMoMPLS method.

IPmux-11 supports two Ethernet user ports for user LAN connectivity.

Configuration and management are provided via the IPmux-11 local terminal, Web-based management utility, Telnet or RADview management tool (SNMP).

Operation Modes

This section describes the IPmux-11 operation modes, which are:

- Unframed E1/T1
- Fractional E1/T1
- Fractional E1/T1 with CAS.

Unframed

In the unframed mode, the incoming bit stream from each channel (regardless of framing) is converted into IP over Ethernet frames. This option provides clear channel end-to-end service (unframed).

Fractional

In the fractional mode, the incoming bit stream is regarded as a sequence of N × 64 kbps timeslots (according to framing). Each predefined group of timeslots is converted into a structure block. The structure block is packetized into IP frames and transmitted.

This mode allows transmission of several selected timeslots without the whole E1 or T1 frame, as in transparent mode.

Fractional with CAS

In the fractional-with-CAS mode, the structure block (as described under Fractional Operation Modes, above) also includes Channel Associated Signaling (CAS) from timeslot 16 (E1) or robbed bit (T1). The relevant portion of the signaling channel is packetized and sent to the destination.

Timeslot Assignment in a Bundle

A bundle is a group of timeslots associated with a specific E1 or T1 channel. IPmux-11 places individual or multiple TDM timeslots (up to 31 timeslots for E1 or up to 24 for T1) into bundles with a single IP address destination.

Testing

Diagnostic capabilities include E1/T1 local and remote loopback tests for rapid localization of faults. The E1/T1 traffic can be looped locally, toward the line, or toward the remote end (see *Chapter 6* for more information).

Timing Modes

The E1/T1 Tx clock can operate in several timing modes to provide maximum flexibility for connecting the IPmux-11 E1 or T1 channels.

Each of the clocks must be configured correctly on both the receive and transmit ends to ensure proper operation and prevent slips (see *Figure 1-3*, *Figure 1-4* and *Figure 1-5*).

The E1/T1 available Tx modes are:

- Loopback timing – the E1/T1 Tx clock is derived from the E1/T1 receive (Rx) clock.
- Adaptive timing – in this mode, the E1 or T1 Tx clock is regenerated using the adaptive method. In this method, the fill level of the buffer receiving packets is monitored. If the buffer begins to overfill, the regenerated Tx clock frequency increases to avoid overflow. If the buffer begins to empty, the Tx clock frequency (toward the TDM device) decreases to avoid underflow.

- Internal timing – in this mode, the Tx clock is derived from an internal oscillator.
- External timing – in this mode the Tx clock is derived from the external clock input. The external clock port also outputs the input clock signal to allow connection to other units, if needed.

Note *In adaptive timing the regenerated clock is subject to network packet delay variation. That is why the quality of the adaptive clock depends on the quality of the network.*

Network Timing Schemes

The following paragraphs describe typical timing schemes and the correct timing mode settings for achieving end-to-end synchronization.

External Network Timing

When the edges of the network are synchronized by an external network clock source, all the IPmux-11 units should be configured to work in loopback timing mode (see *Figure 1-3*). This topology enables any-to-any connectivity.

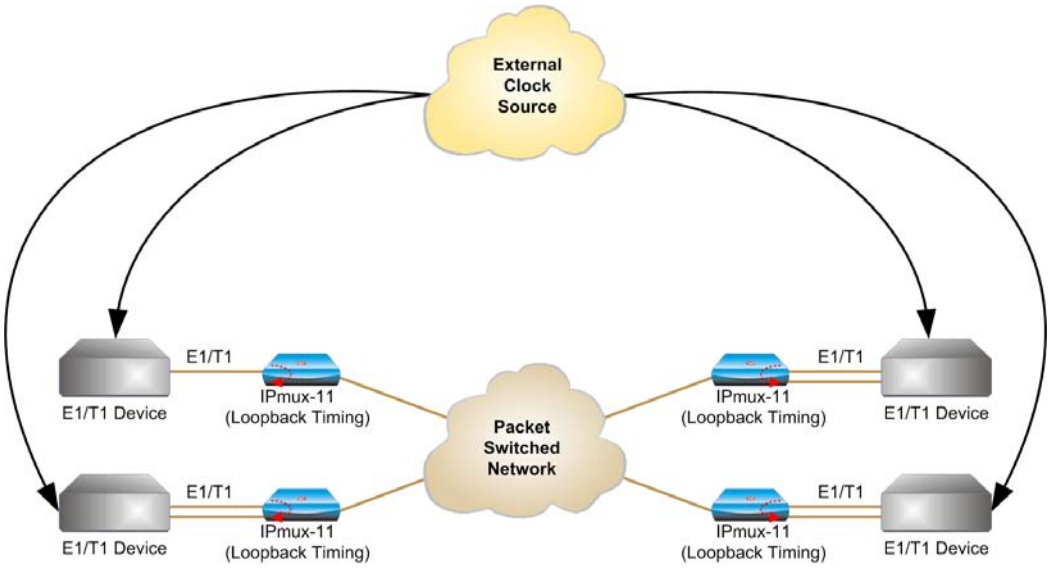

Figure 1-3. IPmux-11 in Loopback Timing Mode

External timing from the network can also be issued to IPmux-11 by external clock input.

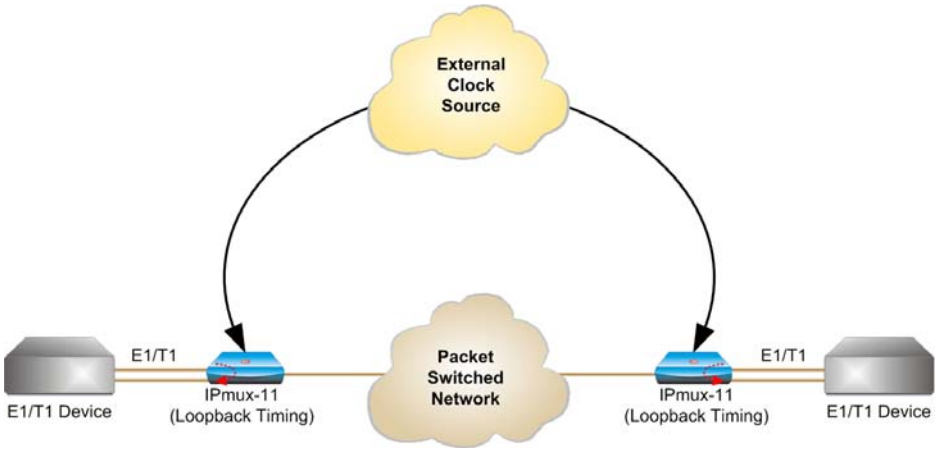

Figure 1-4. IPmux-11 in External Clock Mode

Single Source Clock Network

When a common clock is not available on all the ends of the network, one of the IPmux-11 devices is configured to work in loopback timing, while the other IPmux-11device is configured to work in adaptive timing (see *Figure 1-5*).

Figure 1-5. IPmux-11 in Adaptive Timing Mode

Frame Format

TDMoIP

The Ethernet frame sent by IPmux-11 is a UDP datagram that transfers E1/T1 payload bytes over IP over Ethernet (UDP payload + UDP header + IP header + Ethernet header). The UDP payload is equal to TDM bytes per frame (TDM bytes/frame configuration). *Table 1-2* specifies the structure of the different headers, special fields, and the payload in the Ethernet packet.

Figure 1-6. TDMoIP Frame Structure

Table 1-2. TDMoIP Frame Structure

	Field Length (Bytes)	Field	
ETH Layer	7	Preamble	
	1	SFD	
	6	Destination MAC Address	
	6	Source MAC Address	
LLC Layer	2	Type	***Note:*** *IEEE 802.1p&Q VLAN Tagging (additional 4 bytes if enabled)*
IP Layer	1	Vers/HLEN	
	1	Service Type	
	2	Total Length	
	2	Identification	
	1	Flags/Fragment Offset (most)	
	1	Fragment Offset (least)	
	1	Time to Live	
	1	Protocol	
	2	Header Checksum	
	4	Source IP Address	
	4	Destination IP Address	
UDP Layer	2	UDP Source Port	The UDP source port field is used to transfer a destination bundle number. See *Note* below.
	2	UDP Destination Port	
	2	UDP Message Length	
	2	UDP Checksum	
Data Layer	...	Payload	
ETH Layer	4	CRC	

Note

The UDP Source Port value calculation depends on the selected TDMoIP version (1 or 2):

- *TDMoIP version 2: The UDP Source Port value equals **0x2000 + Destination Bundle Number**, it is always greater than 8192.*
- *TDMoIP version 1:*
  - *During normal operation the UDP Source Port value equals **Destination Bundle Number + 1** (for example, for bundle 1 the UDP Source Port equals 2). The allowed range for the UDP Source Port values in the normal state is from 0 to 8191.*
  - *If a bundle is in the local fail state, the MSB of the UDP Source Port is set to 1 to indicate the local fail state to the remote equipment. In this case the UDP Source Port value equals **0x8000 + Destination Bundle Number + 1**. The UDP Source Port value in the local fail state is always greater than 32768.*

VLAN Support

VLAN, according to IEEE 802.1p&Q, adds four bytes to the MAC layer of the Ethernet frame. The user can set the contents of these bytes, MAC layer priority and VLAN ID. In this mode, only VLAN format frames are sent and received by IPmux-11. *Figure 1-7* shows the VLAN tag format.

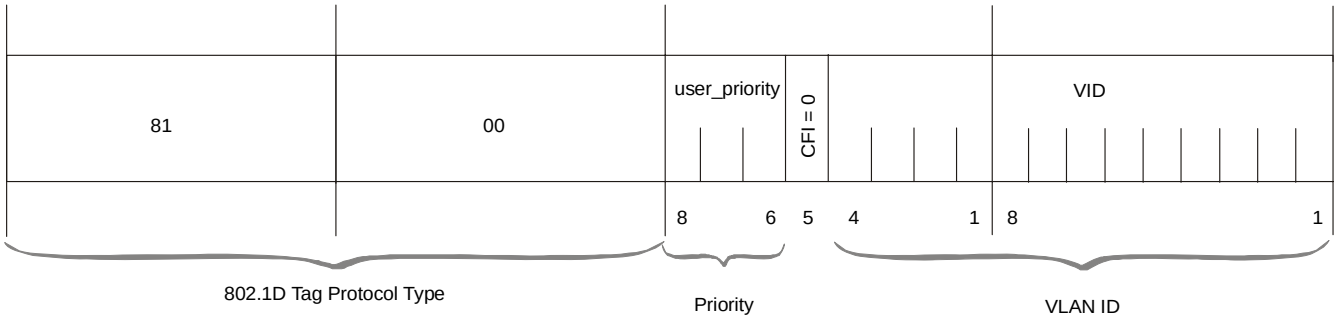

Figure 1-7. VLAN Tag Format (802.1p&Q)

UDP Support

Table 1-3. UDP Ports Definition

Field Length (Bits)	Field Description	Value	Function
2 bytes	UDP Source Port	2–497d*	Destination timeslots bundle
2 bytes	UDP Destination Port	2142d	Standard TDMoIP UDP port

* The MSB of this field can be either 1 or 0 for inband end-to-end proprietary signaling.

Note *The UDP Source Port field is used for destination timeslots bundle indication.*

For more information about VLAN tagging, refer to IEEE standard 802.1p&Q.

TDMoMPLS

Figure 1-9 and *Table 1-4* illustrate TDMoMPLS frame structure.

Figure 1-8. TDMoMPLS Frame Structure

Table 1-4. TDMoMPLS Frame Structure

	Field Length (Bytes)	Field	
ETH Layer	7	Preamble	
	1	SFD	
	6	Destination MAC Address	
	6	Source MAC Address	
LLC Layer	2	Type	← ***Note:*** *IEEE 802.1p&Q VLAN Tagging (additional 4 bytes if enabled)*
MPLS Layer	20	Outer label	
	3	EXP	
	1	Stacking bit	
	8	TTL	
	20	Inner label	← The inner label field is used to transfer a destination bundle number.
	3	EXP	
	1	Stacking bit	
	8	TTL	
Data Layer	...	Payload	
ETH Layer	4	CRC	

Packet Delay Variation

Packets are transmitted at set intervals. Packet Delay Variation is the maximum deviation from the nominal time the packets are expected to arrive at the far end device. IPmux-11 has a buffer that compensates for the deviation from the expected packet arrival time to prevent IPmux-11 buffers from emptying out or overflowing.

Packet Delay Variation is an important network parameter. Large PDV (exceeding the jitter buffer configuration) will cause receive buffer underflows and errors at the TDM level (see *Figure 1-9*).

To compensate for large PDV, configure the PDVT (jitter) buffer to a higher value.

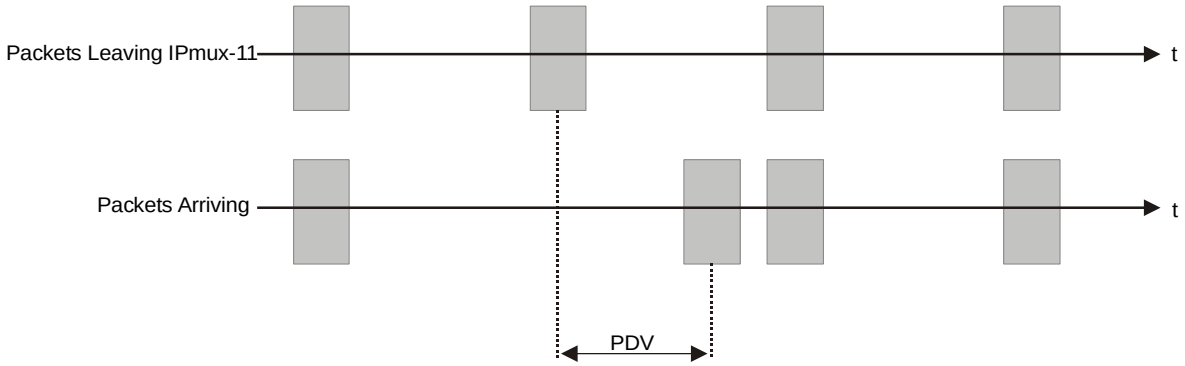

Figure 1-9. Packet Delay Variation

PDVT (Jitter) Buffer

IPmux-11 is equipped with a Packet DVT (Delay Variation Tolerance) buffer. The PDVT buffer or jitter buffer is filled by the incoming IP packets and emptied out to fill the TDM stream. The buffer begins to empty out only after it is half full in order to compensate for packet starvation from the Ethernet side. The time it takes for half of the buffer to empty out is the maximum DVT time. The PDVT (jitter) buffer is designed to compensate for packet delay variation caused by the network + packetization delay. It supports a delay variation of up to 300 ms for E1 or T1.

PDVT Buffer Effect on Delay

The PDVT buffer is on the TDM path; it adds to the total end-to-end delay (see delay calculation, below).

Packetization Delay

When IPmux-11 builds a frame, a packetization delay is introduced. The packetization delay is calculated according to the following formula:

$$\text{Packetization delay (ms)} = \frac{47 \times N \times 0.125}{TS}$$

Where:

$$N = \frac{\text{TDM bytes/frame}}{48}$$

TS = number of assigned timeslots (in unframed mode= 32 for E1, 24 for T1)

Jitter Buffer Depth

The jitter buffer depth is configured according to the following formula:

Jitter buffer = PDV introduced by the network (measured or estimated) + packetization delay.

Note *For a bundle that contains a few timeslots (i.e. 1 to 3,) the recommended number of TDM bytes/frame is 48 in order to prevent excessive packetization delay.*

Ethernet Throughput

Increasing payload size reduces the ratio of the TDMoIP header segment in the packet, thus reducing the total Ethernet throughput.

Increased payload reduces the IP/Ethernet overhead segment of the total packet and thus can reduce the total Ethernet throughput.

On the other hand, packetization delay is increased; this contributes to a higher end-to-end delay. This effect can be small and negligible when a full E1 (or many timeslots) are transferred, but can be very significant when few timeslots are transferred. In this case, when configuring a large value of TDM bytes/frame, the packetization delay can be very large and may exceed the maximum PDVT (jitter) buffer on the receiving end.

Configuring the TDM bytes per frame (TDM bytes/frame) parameter has impact on the Ethernet throughput (bandwidth or traffic traveling through the Ethernet). This parameter controls the number of TDM bytes encapsulated in one frame.

The TDM bytes/frame parameter can be configured to N × 48 bytes where N is an integer between 1 and 30.

➤ **To calculate Ethernet throughput as a function of TDM bytes/frame:**

Ethernet load (bps) = [(frame overhead (bytes) + TDM bytes/frame) × 8] × frames/second

Frame overhead = Ethernet overhead + IP overhead = 46 bytes

Note *The frame overhead does not include:*

- *Preamble field: 7 bytes*
- *SFD field: 1 byte*
- *Interframe gap: 12 bytes*
- *VLAN field (when used): 4 bytes.*

Frame/second =

Unframed: 5447/**n** for a full E1

4107/**n** for a full T1

Framed: 8000 × **k**/(46.875 x n)

Where **k** = number of assigned timeslots

Where $\mathbf{n} = \frac{\text{TDM bytes/frame}}{48}$

The maximum Ethernet throughput mode is calculated by:

Unframed

$$\underbrace{(\mathbf{VLAN} + \mathbf{frame\ overhead} + \mathbf{payload})}_{\text{frame size}} * \left\{ \frac{\overbrace{8000 * TS}^{\text{data}}}{47 * n} \right\} * 8\,\text{bits}$$

Framed

$$\underbrace{(\mathbf{VLAN} + \mathbf{frame\ overhead} + \mathbf{payload})}_{\text{frame size}} * \left\{ \frac{\overbrace{8000 * TS}^{\text{data}} + \overbrace{\frac{8000 * \mathbf{TS}}{(47 * 8) - 1}}^{\text{pointer}} + \overbrace{500 * \left\lceil \frac{\mathbf{TS}}{2} \right\rceil}^{\mathbf{CAS}}}{47 * n} \right\} * 8\,\text{bits}$$

Where:

- **VLAN** is an optional field: if enabled it adds 4 bytes to the frame overhead
- **payload** = number of TDM bytes in frame, (48, 96, 144, 192, … 1440)
- **frame overhead** = size of 46 bytes, include MAC, LLC, IP and UDP layer
- **CAS** is signaling (framed mode only)
- **TS** is number of assigned timeslots.

The result in both the equations is in bits per second (bps).

Round Trip Delay

The voice path round-trip delay is a function of all connections and network parameters.

$$(\pm 2 \text{ msec}) \text{ RTDelay}_{(\text{msec})} = 2 \times [\frac{47 \times \mathbf{N}}{\mathbf{NTS}} \times 0.125 \text{ msec} + \text{PDVT buffer msec} + 1 \text{ msec}] +$$

network round trip delay

Where

$$\mathbf{N} = \frac{\text{TDM bytes/frame}}{48}$$

NTS = number of assigned timeslots (in unframed mode= 32 for E1, 24 for T1)

Reorder and Duplication of Ethernet Frames

IPmux-11 handles situations in the IP network where:

- Packets are reordered by the network
- Packets are duplicated.

Reordering Frames

The ability to correct problems of reordering depends on the selected payload (TDMoIP) format: version 1 (V1) or version 2 (V2).

Frame reordering is supported for odd values of payload, i.e. 1, 3, 5, 7, …, 29 in V1 mode or for any payload in V2 mode.

You can reorder up to seven frames for V1 and up to 64 frames for V2; the number depends on the number of TDM bytes/frame size and buffer size.

The number of frames that can be reordered is calculated by:

$$\frac{(\text{Jitter Buffer[msec]} - 1)(\text{Ts} \times 8)}{47 \times \text{Payload}}$$

Where:

- **Ts** = number of timeslots
- **Payload** = number of TDM bytes in frame, i.e. 1, 3, 5, 7, …, 29 for V1 or 1, 2, 3, …, 29 for V2.

Note *For V1 the maximum number of frames that can be reordered is 7, even if the calculation result exceeds 7. For V2 the maximum number of frames that can be reordered is 64, even if the calculation result exceeds 64.*

Duplicated Frames

When frames are duplicated, IPmux-11 only uses the later frame.

OAM Connectivity

When a destination IPmux-11 is lost, the traffic load that is transmitted to that IPmux is significantly decreased (several packets per second per connection). The IPmux starts transmitting at full rate only when it detects an IPmux at the remote side.

OAM connectivity is used to detect a valid connection (the remote IPmux will confirm it recognizes the connection and that it is enabled). It prevents flooding by a handshake.

The control packets are run over a unique bundle number that is used for this purpose. The control packets have the same VLAN ID and TOS of the originating connection. The control packet uses the TDMoIP UDP number.

OAM connectivity can be set to Disable/Enable.

Note *For control packets, the UDP checksum is not calculated nor checked.*

End-to-End Alarm Generation

An end-to-end alarm generation mechanism exists in IPmux-11 to facilitate the following alarms:

- Unframed – AIS is transmitted toward the near-end PBX in event of:
  - Far-end LOS, AIS
  - PDVT underflow/overflow.
- Framed – Timeslot/CAS configurable alarm pattern is transmitted toward the near-end PBX in event of:
  - Far-end LOS, LOF, AIS
  - PDVT underflow/overflow.

Trail-Extended Mode

To enhance fault condition reporting capabilities, remote IPmux-11 transfers RDI, LOS and AIS conditions received from the remote E1 device to the local E1 device (see *Figure 1-10*).

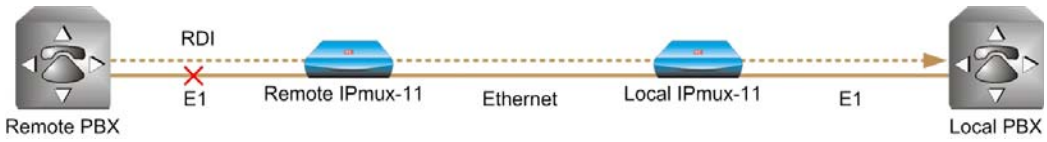

Figure 1-10. Fault Indication Transfer

IPmux-11 transfers fault conditions only if the payload format is configured to V2. The fault conditions are transferred as follows:

- Framed E1 or T1: RDI as RDI, LOS and AIS as AIS
- Unframed E1 or T1: LOS and AIS as AIS.

VLAN Traffic Behavior

Table 1-5 lists the IP and VLAN validity checks that are performed with each Ethernet packet that is received by IPmux-11.

Table 1-5. VLAN Check for Packets that are Received by IPmux-11

Packet Type	Source IP Check	VLAN Check
Management	Performed	Performed
TDM over IP	Performed	Performed
Receiving ping	Not performed	Not performed, even if it is one of the IPs that is configured for the manager or for the connection
ARP	Not performed	
Telnet	Performed only when Telnet access mark is from manager	Performed only when Telnet access mark is from manager

Table 1-6 lists the IP and VLAN validity checks that are performed with each Ethernet packet that is sent by IPmux-11.

Table 1-6. VLAN Check for Packets Sent by IPmux-11

Packet Type	VLAN Support
Management	As configured for the manager
TDM over IP	As configured for the connection
Answer to ping	Packet with VLAN tagging: IPmux-11 replies with the same VLAN ID (even if it is s one of IPs configured for the manager or for the connection). Packet without VLAN tagging: if it is one of the IPs configured for the manager or for the connection, the IPmux-11 replies with the VLAN ID that is in the manager or connection configuration.
ARP initiated by IPmux-11 Telnet Ping initiated by IPmux-11	No VLAN value unless it is to one of the managers or the connection's IP address

Ethernet Ports

The Ethernet user ports allow a user to aggregate both TDMoIP traffic and his private network LAN traffic to a single Ethernet network connection without requiring an access switch. This is a cost-effective solution for MTU or small-office applications. A rate limiter to restrict user port traffic is supported.

IPmux-11 contains an internal bridge where one of its ports is connected to a TDMoIP interworking function, two external bridge ports is used as the user ports, and the fourth is used as an Ethernet network port.

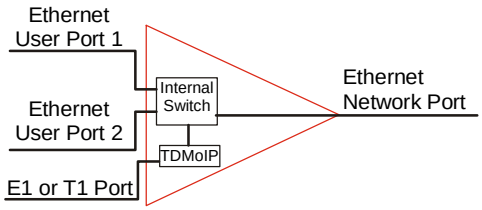

Figure 1-11. IPmux-11 with Two Ethernet User Port

Note *Priority is always given to TDMoIP packets inside the internal switch.*

Switch Operation Modes

IPmux-11 offers two user LAN ports in addition to the LAN port on the network side. The device performs switching at Layer 2. The switch supports both transparent bridging and VLAN-aware bridging. The switch supports rate limiting of traffic going from the user ports to the network port. It supports up to 1024 MAC addresses (depending on their values and the order in which they are learned).

The switch modes are described later in this section. They are:

- Transparent
- Untagged
- Tagged
- Double tagged.

Rate Limiter Option

In this option a rate limiter is available to limit user port traffic. This feature is valuable when a limited bandwidth is used to extend the Ethernet link (generally when the Ethernet link rate is limited/shaped to a lower rate after IPmux). In this case TDMoIP packets will be dropped by a lower-rate device even if it was prioritized at the IPmux internal switch. This is prevented by limiting the user port to actual link rate minus TDMoIP bandwidth.

Network and user traffic can be limited to the following data rates:

- Network interface (egress) – 256 kbps, 512 kbps, 1 Mbps, 2 Mbps, 4 Mbps, 5 Mbps, 8 Mbps, 10 Mbps, 16 Mbps, 20 Mbps, 25 Mbps, 40 Mbps, 50 Mbps, 80 Mbps
- User interface (ingress) – 256 kbps, 512 kbps, 1 Mbps, 2 Mbps, 4 Mbps, 8 Mbps, 16 Mbps, 32 Mbps, 64 Mbps

When the rate limiter is disabled, there is automatic per-port limiting of 64 Mbps on every port, for protection against broadcast, multicast, and flooding, which could otherwise saturate the channel. If the default VLAN priority is lowered, then this automatic limit is lowered accordingly, to maintain this protection. Setting the default VLAN priority changes the automatic rate limiting in the following manner:

Table 1-7. Automatic Per-Port Rate Limiting

Default VLAN Priority	Automatic Rate Limiting
4 - 7	64 Mbps
2 - 3	32 Mbps
0 - 1	16 Mbps

Table 1-8 illustrates relations between rate limiting and VLAN tagging modes.

Table 1-8. Rate Limiting and VLAN Tagging Modes

Rate Limiting / VLAN Tagging	Enabled	Disabled
Transparent, Untagged	Frame priority is determined by the default priority of the port. The optional values are 0–7. In order to assign highest priority to the TDM traffic, it is necessary to configure default priority of the appropriate port to 6 or 7. For all the other ports, default priority can be configured to any value in the range of 0–5, depending on the rate limiting setting.	Frame priority is determined by the default priority of the port. The optional values are 0–7. In order to assign highest priority to the TDM traffic, it is necessary to configure default priority of the appropriate port to 6 or 7. For all the other ports, default priority can be configured to any value in the range of 0–5.
Tagged	Frame priority is determined by the default priority of the port. The optional values are 0–7. In order to assign highest priority to the TDM traffic, it is necessary to configure default priority of the appropriate port to 6 or 7. For all the other ports, default priority can be configured to any value in the range of 0–5, depending on the rate limiting setting.	Frame priority is determined by the tag priority of the frame. In order to assign highest priority to the TDM traffic, it is necessary to configure tag priority of the TDM frame to 6 or 7. For all the other frames, tag priority can be configured to any value in the range of 0–5. If an untagged frame is received, its priority is determined by the default priority of the port.
Double Tagged	Frame priority is determined by the default priority of the port. If the TDM traffic is tagged, in order to assign highest priority to it, it is necessary to set the frame tag priority to 6 or 7.	For the frames coming from the user ports towards the network port, priority is determined by the default priority of the port. For frames coming from the network port towards the user ports, priority is determined by the tag priority of the frame. If TDM traffic is tagged, in order to assign highest priority to it, it is necessary to set the frame tag priority to 6 or 7.

Switch Behavior When Handling User and Network Traffic

The way the network and user ports handle the traffic depends on the selected port mode (transparent, untagged, tagged or double tagged) and frame type (untagged, tagged or double tagged). *Table 1-9* lists all operation modes of the network and user ports. The modes are explained in greater detail in *Table 1-10*, *Table 1-11*, *Table 1-12*, *Table 1-13*, *Table 1-14*, *Table 1-15* and *Table 1-16*.

Table 1-9. Switch Behavior (User and Network Traffic)

Network / User	Transparent	Untagged	Tagged	Double Tagged
Transparent	Mode A	Mode B	Mode C	Not applicable
Untagged	Mode B	Mode D	Mode E	Not applicable
Tagged	Mode C	Mode E	Mode F	Not applicable
Double Tagged	Mode G	Not implemented	Not implemented	Not applicable

Table 1-10. Mode A

Ingress	Egress
If a tagged frame enters a transparent port, it is switched to the other transparent port	The transparent port transmits the frame unmodified (tagged)
If an untagged frame enters a transparent port, it is switched to the other transparent port	The transparent port transmits the frame unmodified (untagged)

Table 1-11. Mode B

Ingress	Egress
If a tagged frame enters the transparent port, it is switched to the untagged port	The untagged port removes the tag, and transmits the frame untagged
If a tagged frame enters the untagged port, it is switched to the transparent port	The transparen*t port* transmits the frame unmodified (tagged)
If an untagged frame enters the transparent port, it is switched to the untagged port	The untagged port transmits the frame unmodified (untagged)
If a untagged frame enters the untagged port, it is switched to the transparent port	The transparent port transmits the frame unmodified (untagged)

Table 1-12. Mode C

Ingress	Egress
If a tagged frame enters the transparent port, it is switched to the tagged port	• If the tagged port is not a member of the frame's VID, the frame is discarded • The tagged *port* is a member of the frame's VID, the frame is transmitted unmodified (tagged)
• If a tagged frame enters the tagged port, which is not a member of its VID, the frame is discarded • If a tagged frame enters the tagged port, which is a member of its VID, the frame is switched to all other members	The transparent port transmits the frame unmodified (tagged)
If an untagged frame enters the transparent port, it is switched to the tagged port	• If the tagged port is not a member of the transparent port default VID, the frame is discarded • If the tagged port is a member of the transparent port default VID, it adds tag (VID is the transparent port default VID and PRI is the transparent port default PRI), and transmits the frame tagged
• If an untagged frame enters the tagged port, which is not a member of its default VID, the frame is discarded • If an untagged frame enters the tagged port, which is a member of its VID, the frame is switched to all other members	The transparent port transmits the frame unmodified (untagged).

Table 1-13. Mode D

Ingress	Egress
If a tagged frame enters an untagged port, it is switched to the other untagged port	The untagged port removes the tag, andtransmits the frame untagged
If an untagged frame enters an untagged port, it is switched to the other transparent port	The untagged port transmits the frame unmodified (untagged)

Table 1-14. Mode E

Ingress	Egress
If a tagged frame enters the untagged port, it is switched to the tagged port	If the tagged port is not a member of the frame VID, the frame is discarded If the tagged port is a member of the frame VID, the frame is transmitted unmodified (tagged)
• If a tagged frame enters the tagged port, which is not a member of its VID, the frame is discarded • If a tagged frame enters the tagged port, which is a member of its VID, the frame is switched to all other members	The untagged port removes the tag and transmits the frame untagged
If an untagged frame enters the untagged port, it is switched to the tagged port	• If the tagged port is not a member of the untagged port default VID, the frame is discarded • If the tagged port is a member of the untagged port default VID, the tagged port adds tag (VID is the untagged port default VID and PRI is the untagged port default PRI), and transmits the frame tagged
If an untagged frame enters the tagged port, which is not a member of its default VID, the frame is discarded If an untagged frame enters the tagged port, which is a member of its default VID, the frame switched to all other members	The untagged port transmits the frame unmodified (untagged)

Table 1-15. Mode F

Ingress	Egress
• If a tagged frame enters the tagged port, which is not a member of the frame VID, the frame is discarded • If a tagged frame enters the tagged port, which is a member of the frame VID, the frame is switched to all other members	The tagged port transmits the frame unmodified (tagged.)
• If an untagged frame enters the tagged port, which is not a member of its default VID, the frame is discarded • If an untagged frame enters the tagged port, which is a member of its default VID, the frame is switched to all other members	The tagged port adds tag (VID is the ingress tagged port default VID and PRI is the ingress tagged port default PRI), and transmits the frame tagged

Table 1-16. Mode G

Ingress	Egress
If a double-tagged frame enters the transparent port, it is switched to the double-tagged port	• If the double-tagged port is not a member of the first VID of the frame, the frame is discarded • If the double-tagged port is a member of the first VID of the frame, it removes the firs tag and transmits the frame tagged.
If a tagged frame enters the transparent port, it is switched to the double-tagged port	• If the double-tagged port is not a member of the frame VID, the frame is discarded • If the double-tagged port is a member of the frame VID, it removes the tag and transmits the frame untagged
If an untagged frame enters the transparent port, the frame is discarded	
If a tagged frame enters the double-tagged port, the port adds tag (VID is the double-tagged port default VID and PRI is the double-tagged port default PRI), and switches the frame to the transparent port	The transparent port transmits the frame unmodified (double tagged)
If an untagged frame enters the double-tagged port, the port adds tag (VID is the double-tagged port default VID and PRI is the double-tagged port default PRI), and switches the frame to the transparent port	The transparent port transmits the frame unmodified (tagged)

Note

When operating in the Mode G, the following rules apply:

- *No VLANs can be created on the network port.*
- *Each user port has to be a member of its default VLAN ID, no other VLANs are valid.*
- *Both user ports can get the same default VLAN ID.*
- *In either case, no traffic is allowed between two user ports.*

Switch Behavior When Handling Management Traffic

Table 1-17 lists operation modes of the network port when handling the management traffic.

Table 1-17. Switch Behavior (Management Traffic)

Option \ Port	Transparent	Untagged	Tagged	Double-Tagged
Manager Tagged	No limitations	Not applicable	Port must be a member of manager VID	Not applicable
Manager Untagged	No limitations	No limitations	Not applicable	Not applicable
TDMoIP Tagged	No limitations	Not applicable	Network port must be member of TDMoIP VID	Not applicable
TDMoIP Untagged	No limitations	No limitations	Not applicable	Not applicable
Ping Tagged (Initiated by IPmux-11)	No limitations	No limitations	Port must be a member of ping VID	Not applicable
Ping Untagged (Initiated by IPmux-11)	No limitations	No limitations	Not applicable	Not applicable
Ping/ARP Tagged (Not Initiated by IPmux-11, Manager or TDMoIP VID)	No limitations	No limitations	Port must a member of ping/ARP VID	Not applicable
Ping/ARP Untagged (Not Initiated by IPmux-11, Manager or TDMoIP VID)	No limitations	No limitations	Not applicable	Not applicable
Telnet Access Enable	No limitations	Telnet source port must not be tagged	Port must be a member of Telnet source port VID	Not applicable
Telnet Access Managers	No limitations	According to Manager options	According to Manager options	Not applicable

1.4 Technical Specifications

E1 Interface	*Compliance*	ITU-T Rec. G.703, G.704, G.706, G.732, G.823
	Data Rate	2.048 Mbps
	Line Code	HDB3
	Framing	Unframed, framed, multiframe; with or without CRC-4
	Signaling	CAS, CCS (transparent)
	Line Impedance	120Ω, balanced; 75Ω, unbalanced
	Signal Levels	Receive: 0 to -36 dB with LTU (long haul) 0 to -10 dB without LTU (short haul) Transmit pulse amplitude, balanced: ±3V ±10% Transmit pulse amplitude, unbalanced: ±2.37V ±10%
	Jitter Performance	As per ITU-T G.823
	Connector	Balanced: RJ-45 Unbalanced: Two BNC coax (via an adapter cable)
T1 Interface	*Compliance*	ANSI T1.403, AT&T TR-62411, ITU-T Rec. G.703, G.704, G.824
	Data Rate	1.544 Mbps
	Line Code	B8ZS, B7ZS, AMI
	Framing	Unframed, SF, ESF
	Signaling	CAS (robbed bit), CCS (transparent)
	Line Impedance	100Ω, balanced
	Signal Levels	Receive: 0 to -36 dB Transmit pulse amplitude: ±3V ±20%; 0 dB, -7.5 dB, -15 dB (CSU), user-selectable ±2.7V ±10%, 0 to 655 feet, (DSU), user-selectable
	Jitter Performance	As per AT&T TR-62411, G.824
	Connector	RJ-45
Ethernet Interface	*Compliance*	IEEE 802.3, 802.3u, 802.1p&Q
	Number of Ports	Network: 1 (copper or fiber) User: up to 2 (copper only)
	Data Rate	UTP: 10 Mbps or 100 Mbps, full or half-duplex Fiber: 100 Mbps full-duplex
	Frame Size	1536 bytes max (user port)
	Fiber Optic Specifications	See *Table 1-1*
	Connector	LC, SFF-based

Timing	*Transmit*	• Internal • External input or output via dedicated connector: E1/T1 or 2048/1544 kHz squarewave (RS-485 electrical levels) • Loopback • Adaptive
Pseudowire Connections	*Number of Connections*	1
	Jitter Buffer Size	3–300 msec with 1 msec granularity
Management	Methods	• SNMPv1 • Telnet • RADview Service Center TDMoIP (ordered separately) • ASCII terminal via V.24 (RS-232) DCE port
Diagnostics	*Loopbacks*	• E1/T1 local loopback • E1/T1 remote loopback • T1 Facility Type 1 (FAC1) in-band remote loopback
Statistics	*E1/T1*	As per G.826 and RFC 2495
	Ethernet	As per RFC 2819
	Receive Buffer Indication	Overflow, underflow, sequence error
Indicators	*General*	PWR (green) – Power status ALM (red/yellow) – Alarm status EXT CLK (red/green) – External clock status
	E1	E1 SYNC (red/green) – E1 synchronization
	T1	T1 SYNC (red/green) – T1 synchronization
	Ethernet	LINK/ACT (green) – Link/activity status
Power	*AC/DC Source*	100–240 VAC or -40/-60 VDC
	Power Consumption	8W max
Physical	*Height*	43.7 mm (1.72 in)
	Width	217 mm (8.55 in)
	Depth	170 mm (6.7 in)
	Weight	0.5 kg (1.1 lb)
Environment	*Temperature*	0°C to 50°C (32°C to 122°F)
	Humidity	Up to 90%, non-condensing

Chapter 2
Installation and Setup

2.1 Introduction

This chapter describes installation and setup procedures for the IPmux-11 unit.

After installing the unit, refer to *Chapter 3* for the operating instructions.

If a problem is encountered, refer to *Chapter 6* for test and diagnostic instructions.

Warning

Internal settings, adjustment, maintenance, and repairs may be performed only by a skilled technician who is aware of the hazards involved.
Always observe standard safety precautions during installation, operation, and maintenance of this product.

2.2 Site Requirements and Prerequisites

The IPmux-11 device is intended for installation on desktop, 19-inch racks and walls. All the connections are made at the rear panel. A hardware kit (RM-33-2) for mounting one or two IPmux-11 units into a 19-inch rack is available from RAD. Drilling template for wall installation is provided at the end of the manual.

AC-powered IPmux-11 units should be installed within 1.5m (5 ft) of an easily-accessible grounded AC outlet capable of furnishing the voltage in accordance with IPmux-11 nominal supply voltage.

DC-powered IPmux-11 units require a -48 VDC power source, which must be adequately isolated from the main supply.

Allow at least 90 cm (36 in) of frontal clearance for operating and maintenance accessibility. Allow at least 10 cm (4 in) clearance at the rear of the unit for signal lines and interface cables.

The ambient operating temperature of IPmux-11 should be 0 to 50°C (32 to 122°F), at a relative humidity of up to 90%, non-condensing.

2.3 Package Contents

The IPmux-11 package includes the following items:

- One IPmux-11 unit
- Power cord
- IEC 60320 AC/DC adapter plug
- CBL-DB9F-DB9M-STR control port cable (if ordered)
- CBL-RJ45/2BNC/E1/X adapter cable for unbalanced E1 interface (if ordered)
- RM-33-2 rack mount kit (if ordered).

2.4 Connecting the Ethernet Equipment

IPmux-11 is connected to the Ethernet network equipment via the fiber optic LC or 8-pin RJ-45 electrical port designated ETH 1. Connection to the Ethernet user equipment is made via two 8-pin RJ-45 electrical ports designated ETH 2 and ETH 3. Refer to *Appendix A* for the RJ-45 connector pinout.

Connecting the Ethernet Network Equipment

Figure 2-1 and *Figure 2-2* illustrate typical rear panels of the IPmux-11 unit with fiber optic LC and electrical RJ-45 network connectors, respectively.

➤ **To connect to the Ethernet network equipment with fiber optic interface:**

- Connect IPmux-11 to the Ethernet network equipment using a standard fiber optic cable terminated with an LC connector.

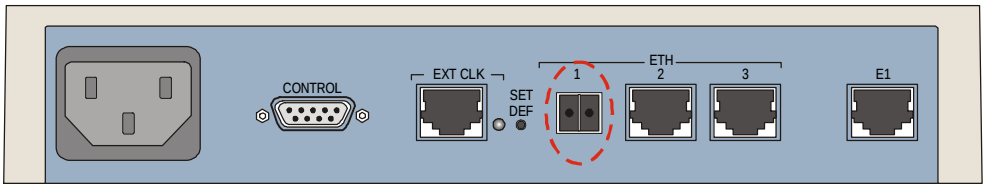

Figure 2-1. ETH 1 Fiber Optic Connector

➤ **To connect to the Ethernet network equipment with a copper interface:**

- Connect IPmux-11 to the Ethernet network equipment using a standard straight UTP cable terminated with an RJ-45 connector.

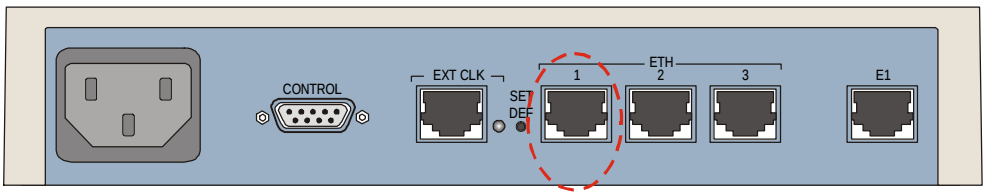

Figure 2-2. ETH 1 Electrical Connector

Connecting the Ethernet User Equipment

Figure 2-3 illustrates a rear panel of the IPmux-11 unit with two user LAN ports.

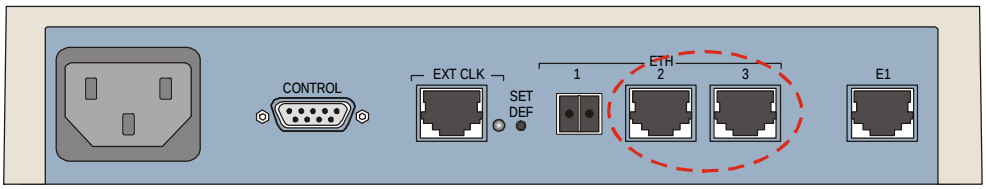

Figure 2-3. ETH 2 and ETH 3 Connectors

➤ **To connect to the Ethernet user equipment:**

- Connect IPmux-11 to the Ethernet user equipment using a standard straight UTP cable terminated with an RJ-45 connector.

2.5 Connecting to the E1/T1 Devices

E1/T1 devices are connected to IPmux-11 via one balanced RJ-45 port designated E1/T1. Unbalanced E1 interface is provided via CBL-RJ45/2BNC/E1/X adapter cable (see *Appendix A* for the connector pinouts and cable wiring diagram).

Caution When connecting balanced E1 or T1 equipment, make sure to use only 4-wire RJ-45 connectors with the following pins used for receiving and transmitting data: 1, 2, 4, 5. Do not use 8-pin RJ-45 connectors.

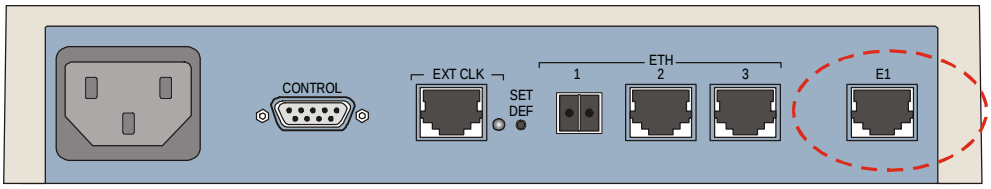

Figure 2-4. E1/T1 Connector

➤ **To connect to the E1/T1 devices with balanced interfaces:**

- Connect IPmux-11 to the E1/T1 devices using standard straight E1/T1 cables.

➤ **To connect to the E1 devices with unbalanced interfaces:**

1. Connect the RJ-45 connector of the adapter cable to the IPmux-11 balanced RJ-45 ports designated E1.
2. Connect the transmit cable to the red coaxial connector of the adapter cable marked ↑.
3. Connect the receive cable to the green coaxial connector of the adapter cable marked ↓.

2.6 Connecting to the External Clock Source

IPmux-11 is connected to the external clock source via a balanced RJ-45 connector designated EXT CLK. Refer to *Appendix A* for the connector pinout.

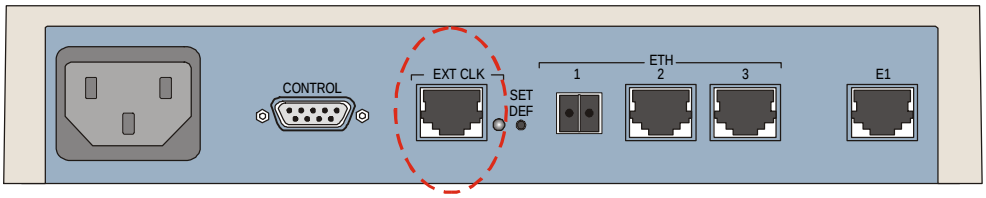

Figure 2-5. EXT CLK Connector

➤ **To connect to the external clock source:**

- Connect IPmux-11 to the external E1 or T1 clock source using an appropriate cable.

2.7 Connecting to the ASCII Terminal

IPmux-11 is connected to an ASCII terminal via a 9-pin D-type female connector designated CONTROL. Refer to *Appendix A* for the connector pinout.

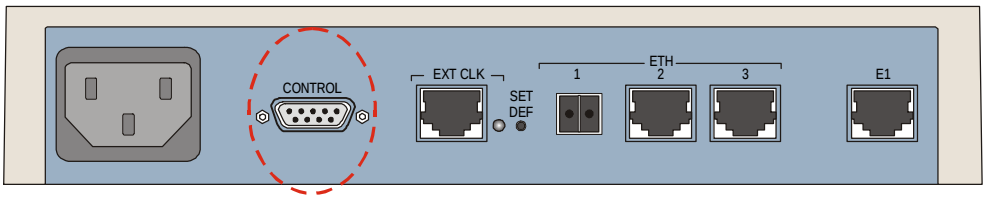

Figure 2-6. CONTROL Connector

➤ **To connect to an ASCII terminal:**

1. Connect the male 9-pin D-type connector of CBL-DB9F-DB9M-STR straight cable available from RAD to the CONTROL connector.
2. Connect the other connector of the CBL-DB9F-DB9M-STR cable to an ASCII terminal.

2.8 Connecting IPmux-11 to Power

IPmux-11 accepts either 110–240 VAC or -48/-60 VDC power through the same power inlet.

Warning

Before connecting or disconnecting any cable, the protective earth terminals of this unit must be connected to the protective ground conductor of the mains (AC or DC) power cord. If you are using an extension cord (power cable) make sure it is grounded as well.
Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting of the protective earth terminal can make this unit dangerous. Intentional interruption is prohibited.

Connecting AC Power

AC power is supplied to IPmux-11 via a 1.5m (5 ft) standard power cable terminated by a standard 3-prong socket. A cable is provided with the unit.

➤ **To connect AC power:**

1. Connect the power cable to the power connector on the IPmux-11 rear panel.
2. Connect the power cable to the mains outlet.

   The unit turns on automatically upon connection to the mains.

Connecting DC Power

A special IEC 60320 adapter for the -40/-60 VDC power connection is supplied with the unit.

➤ **To connect DC power:**

- Refer to the DC power supply connection supplement for instructions how to wire the DC adapters, and to the *Handling Energized Products* section.

Chapter 3

Operation

This chapter:

- Provides a detailed description of the front panel controls and indicators and their functions
- Explains power-on and power-off procedures
- Provides instructions for configuration using a terminal connected to the IPmux-11 control port
- Provides instructions for configuration using a Web browser
- Illustrates the management menus.

For a detailed explanation of parameters on the menus, see *Chapter 4*.

3.1 Turning IPmux-11 On

➤ **To turn on IPmux-11:**

- Connect the power cord to the mains.

  The PWR indicator lights up and remains lit as long as IPmux-11 receives power.

Once it is powered up, IPmux-11 operates automatically. IPmux-11 requires no operator attention once installed, with the exception of occasional monitoring of front panel indicators. Intervention is only required when IPmux-11 must be configured to its operational requirements, or diagnostic tests are performed.

3.2 Controls and Indicators

The unit's LEDs are located on the front and rear panels (see *Figure 3-1*). *Table 3-1* lists the functions of the IPmux-11 LED indicators.

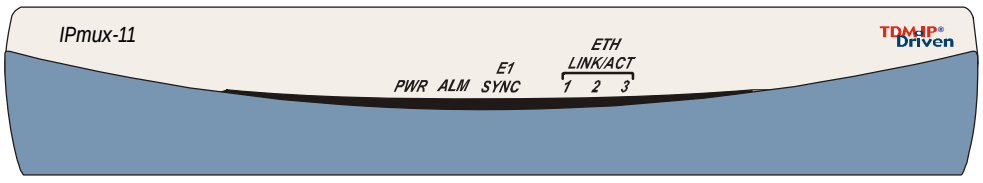

Figure 3-1. IPmux-11 Front Panel

Table 3-1. IPmux-11 LEDs and Controls

Name	Type	Function	Location
PWR	Green LED	ON – Power is ON	Front panel
ALM	Red/yellow LED	ON (red) – Active alarm is stored in the log file ON (yellow) – An alarm is present in the log file OFF – No alarms are stored in the log file	Front panel
E1 SYNC	Red/green LED	ON (green) – E1 link is synchronized ON (red) – E1 link has lost synchronization OFF – E1 link is disabled	Front panel
T1 SYNC	Red/green LED	ON (green) – T1 link is synchronized ON (red) – T1 link has lost synchronization OFF – T1 link is disabled	Front panel
ETH LINK/ACT 1	Green LED	ON – Network Ethernet link is OK Blinks – Data is being transmitted and received on the network Ethernet link	Front panel
ETH LINK/ACT 2	Green LED	ON – User Ethernet link 1 is OK Blinks – Data is being transmitted and received on the user Ethernet link 1	Front panel
ETH LINK/ACT 3	Green LED	ON – User Ethernet link 2 is OK Blinks – Data is being transmitted and received on the user Ethernet link 2	Front panel
EXT CLK	Red/green LED	ON (green) – IPmux-11 is configured to external clock and valid clock input is detected ON (red) – IPmux-11 is configured to external clock and no valid clock input is detected OFF – IPmux-11 is not configured to external clock or the unit is off	Rear panel
SET DEF	Button	Restores default values	Rear panel

3.3 Default Settings

The following table lists the default settings of the IPmux-11 configuration parameters.

Table 3-2. Default Settings

Parameter	Default Value
System	
IP address	Empty
IP mask	Empty
Default gateway	0.0.0.0
DHCP status	Enable
Authentication failure trap	Disable
Trap	SNMP_trap
Read	public
Write	private
Manager IP address	0.0.0.0
Manager location	Empty
Link up/down trap	Empty
Alarm trap	Empty
VLAN tagging	Empty
VLAN ID	Empty
VLAN priority	Empty
User name	su
Permission	Full control
Access	All
Telnet access	Enable
Web access	Enable
Alarm ID	–
Trap status	Active
Baud rate (bps)	115200
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Master clock source	Port1

Table 3-2. Default Settings (Cont.)

Parameter	Default Value
Fall back clock source	Port1
Master clock	External
Fall back clock	Internal
Physical Layer (TDM, E1)	
Admin status	Enable
Transmit clock source	Adaptive
Loopback state	Disable
Rx sensitivity	Short haul
Line type	Framed G.704
Idle code	7E
Send upon fail	OOS code
OOS code	FF
OOS signaling	Space
Mark signaling code	D
Space signaling code	1
External Clock interface	Balance
Trail mode	Termination
Physical Layer (TDM, T1)	
Admin status	Enable
Transmit clock source	Adaptive
Line type	ESF
Line code	B8ZS
Line interface	DSU
Line BildOut	0 dB
Line length	0–133
Restoration time	TR-6211 (10 seconds)
Idle code	7E
Send upon fail	OOS code
OOS code	FF
Signaling mode	None
OOS signaling	Space
Mark signaling code	D
Space signaling code	1

Table 3-2. Default Settings (Cont.)

Parameter	Default Value
Trail mode	Termination
Physical Layer (ETH)	
Channel state	Enable
Auto negotiation	• Disable for fiber optic interface • Enable for copper interface
Max capability advertised	100baseT full duplex
Default type	10baseT half duplex
Connection	
Connection mode	Static
Destination IP address	0.0.0.0
Next hop address	0.0.0.0
IP TOS	0
Connection status	Enable
Destination bundle	–
TDM bytes in frame	1
Payload format	V2
OAM connectivity	Disable
Jitter buffer	3
VLAN tagging	Disable
PSN Type	UDP/IP
Outbound label tagging	Disable
Inbound label tagging	Disable
Next Hop Type	IP
Far End Type	(The current device interface type)
Bridge	
Aging time	304
VLAN ID	–
Status	Enable
Rate limit	0 - Disable

3.4 Configuration Alternatives

If required, IPmux-11 can be reconfigured. The IPmux-11 configuration and monitoring operations are performed using any of the following tools:

- ASCII terminal connected to supervisory port
- ConfiguRAD, a Web-based management system, using a Web browser running on a PC connected to the network
- RADview, an SNMP based management system with a graphical user interface. See RADview SC/TDMoIP User's Manual for details.

Detailed configuration procedures are given in *Chapter 4*.

The following functions are supported by the IPmux-11 management software:

- Viewing system information
- Modifying configuration and mode of operation, including setting system default values
- Monitoring IPmux-11 performance
- Initiating diagnostic tests
- Uploading and downloading software and configuration files.

Working with Terminal

➤ **To start a terminal control session:**

1. Make sure all IPmux-11 cables and connectors are properly connected.
2. Connect IPmux-11 to a PC equipped with an ASCII terminal emulation application (for example, Windows Hyper Terminal or Procomm).
3. Turn on the control terminal PC and set its port parameters to 115.2 kbps, 8 bits/character, 1 stop bit, no parity. Set the terminal emulator to ANSI VT100 emulation (for optimal view of system menus).
4. When the initialization and self-test are over, a menu appears displaying initialization and self-test results. If problems are encountered, refer to *Chapter 6* for troubleshooting instructions.

Login

To prevent unauthorized modification of the operating parameters, IPmux-11 supports two access levels: .

- **Superuser** can perform all the activities supported by the IPmux-11 management facility, including defining new users.
- **User**'s access rights (**full control** or **read only**) are defined by the superuser. Users are not allowed to create new users.

➤ **To enter as a superuser:**

1. Enter **su** for user name.
2. Enter **1234** for password.

This allows you to configure all the parameters of IPmux-11, and to change the *su* and *user* passwords.

➤ **To enter as a user:**

1. Enter **user** for user name.
2. Enter **1234** for password.

Note *If the password is invalid in three consecutive attempts, the system becomes inaccessible for 15 minutes.*

➤ **How to use the terminal to perform a desired activity:**

- To select a menu item, type the corresponding line number and then press **<Enter>**. This will either …
  - … display a submenu or a parameter selection screen …

    or …
  - … let you type the (free text) parameter value in the same row

    or …
  - … toggle the current value of the corresponding parameter (relevant to **ENABLE**/**DISABLE** or **ON**/**OFF** selections).
- The type of response to be expected after selecting a menu item is indicated as follows:

>	Selecting that item will display a submenu or a parameter selection screen.
...	Selecting that item will let you type the desired value in the same line.
Nothing	When neither symbol is displayed, selecting that item will toggle the current selection, now shown in brackets (for example, this will change **ENABLE** to **DISABLE** or vice versa).

- When a menu does not fit on one screen (because it includes many lines), it is displayed on two consecutive pages. In this case, you will see **…(N)** after the last line on the first page and **…(P)** after the last line on the second page:
  - While on the first page, press **N** to display the second page
  - While on the second page, press **P** to return to the first page.
- When a configuration screen is organized as a table, a special set of keys is used for navigation within the table (such screens always have a **?** (help) option that displays these keys). The following keys may be used for navigation within tables:

  L – move to the left **R** – move to the right

  ^D – scroll down **^U** – scroll up

  In addition, the following shortcuts are also available:
  - **Tab** – select the next cell that may be changed
  - **M** – switch to the menu mode
  - **G** followed by **<row number>,<col number>** – select a specific cell. For example, type **G2,5** to select the fifth cell in the second row.
- The current value of a parameter is listed within parentheses **( )**. To change a parameter value on a parameter selection screen:

- Type the line number corresponding to the desired value, and then press **<Enter>**
- To enter a value which requires free text entry, type in the desired string and then press **<Enter>**. Use backspace to erase the current string.

  Note that whenever applicable, the allowed range of values of a parameter is listed within square brackets **[ ]**.

- The entry is checked after pressing **<Enter>**, and it is accepted only if it is valid:
  - If you make an error, for example, if you press a key not active on the current screen or select an invalid parameter value, an ERROR indicator appears in the right-hand corner. This indicator disappears as soon as you make a correct operation.
  - If you select a parameter value incompatible with the current operating state or other parameters, you will see a message that explains the error.
- When done with the current screen, press **<Esc>** to return to the previous screen, or type **!** to return directly to the main menu.

Ending a Terminal Configuration Session

➤ **To end the current terminal session:**

- Type **&**.

After a session is ended, it is necessary to enter again a valid user name and password to start a new session.

Working with ConfiguRAD

Web Browser Requirements

The following Web browsers can be used to access the IPmux-11 supervision utility from any location that enables access to the IPmux-11 using Internet protocols.

- Internet Explorer 6.0, running on Windows™ 98, Windows™ 2000, Windows™ XP
- Netscape Communicator 7.1, running on Windows™ NT or Unix.

However, before using Web access, it is necessary to perform a preliminary configuration of IPmux-11.

When using a Web browser, pay attention to the following points:

- Enable scripts
- Configure the firewall that is probably installed on your PC to allow access to the destination IP address
- Disable pop-up blocking software (such as Google Popup Blocker); you may also have to configure your spyware/adware protection program to accept traffic from/to the destination IP address
- Browsers store the last viewed pages in a special cache. To prevent configuration errors, it is absolutely necessary to flush the browser's cache whenever you return to the same screen.

General Web Browsers Operating Procedures

➤ **To manage IPmux-11 via Web browser:**

1. Open the Web browser.
2. Enter the IP address of IPmux-11 in the address field of the browser in the following format: **http://'IP address'** (**'IP address'** stands for the actual IPmux-11 IP address).
3. After entering the address, press **<Enter>** to command the browser to connect.
4. After the opening window is displayed, click **LOGIN**.
5. Perform log-in.

   You will see the main menu.
6. Use standard browser operating procedures to perform the desired activities.

At the left-hand bottom corner, ConfiguRAD provides some auxiliary management tools:

- Status – shows the number of users currently managing IPmux-11
- Trace – opens an additional pane for system messages, progress indicators (ping, software and configuration file downloads) and alarms. It is recommended to keep the trace pane open all the time.
- Refresh All – refreshes all ConfiguRAD display elements.

Overview of Menu Operations

Use these menu trees as a reference aid while performing configuration and control functions. *Chapter 4* illustrates menus and explains parameters.

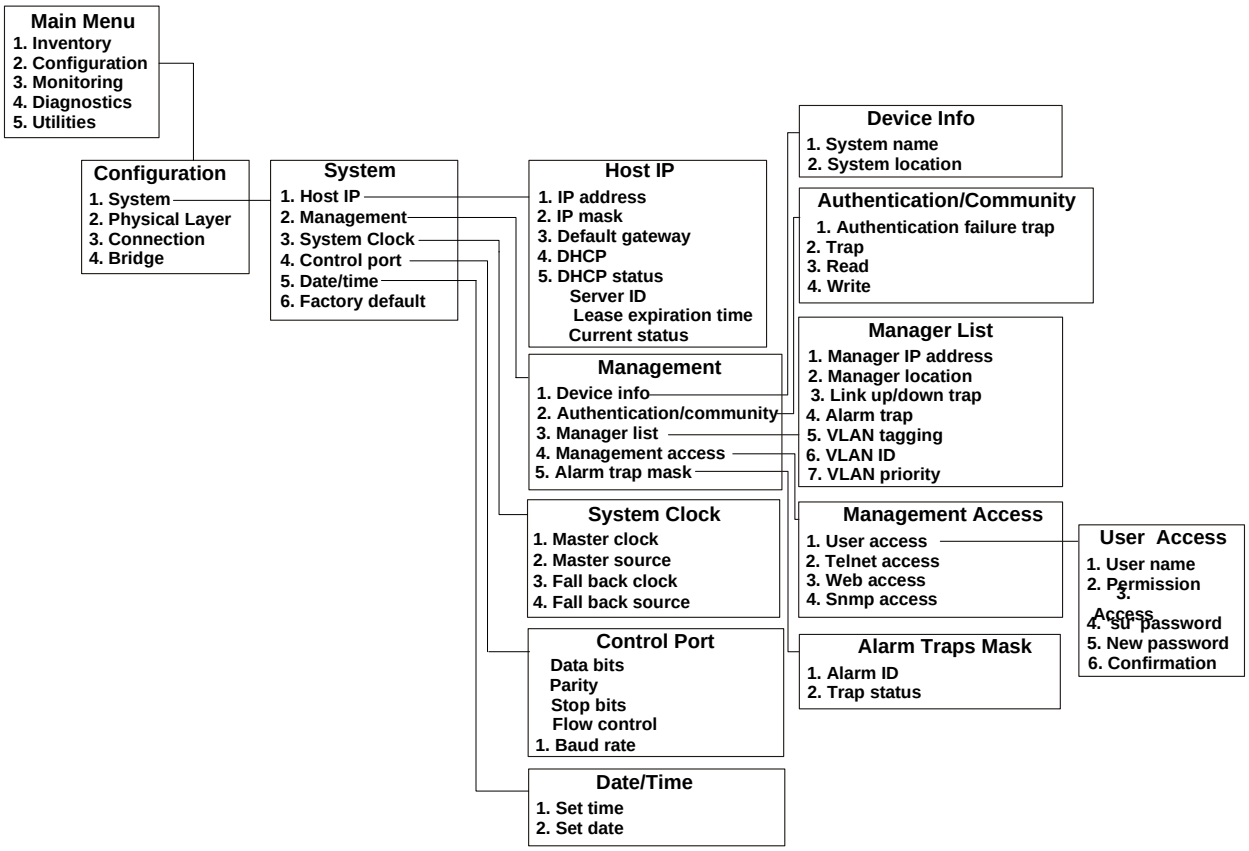

Figure 3-2. Main Menu > Configuration > System

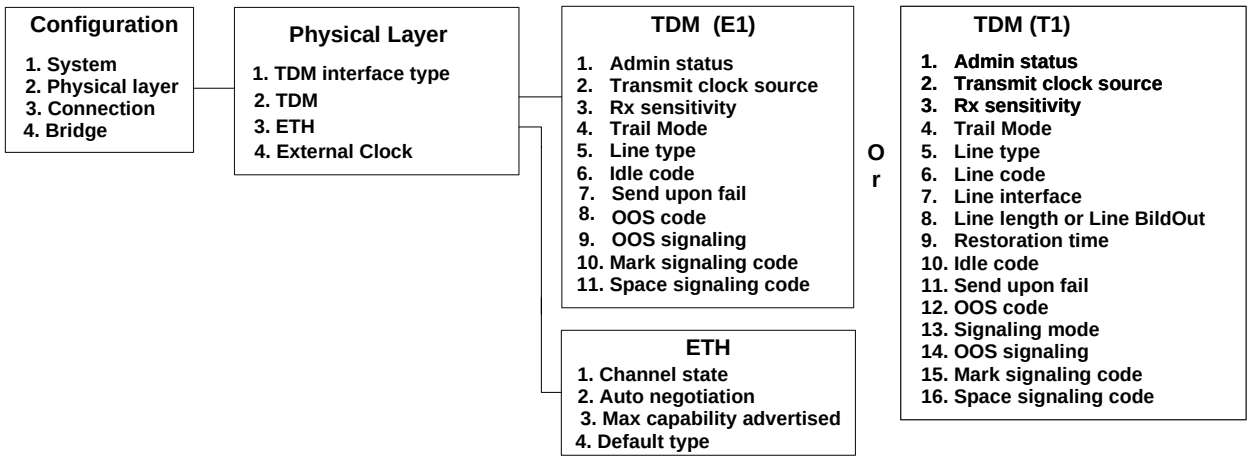

Figure 3-3. Configuration > Physical Layer > TDM and ETH Configuration

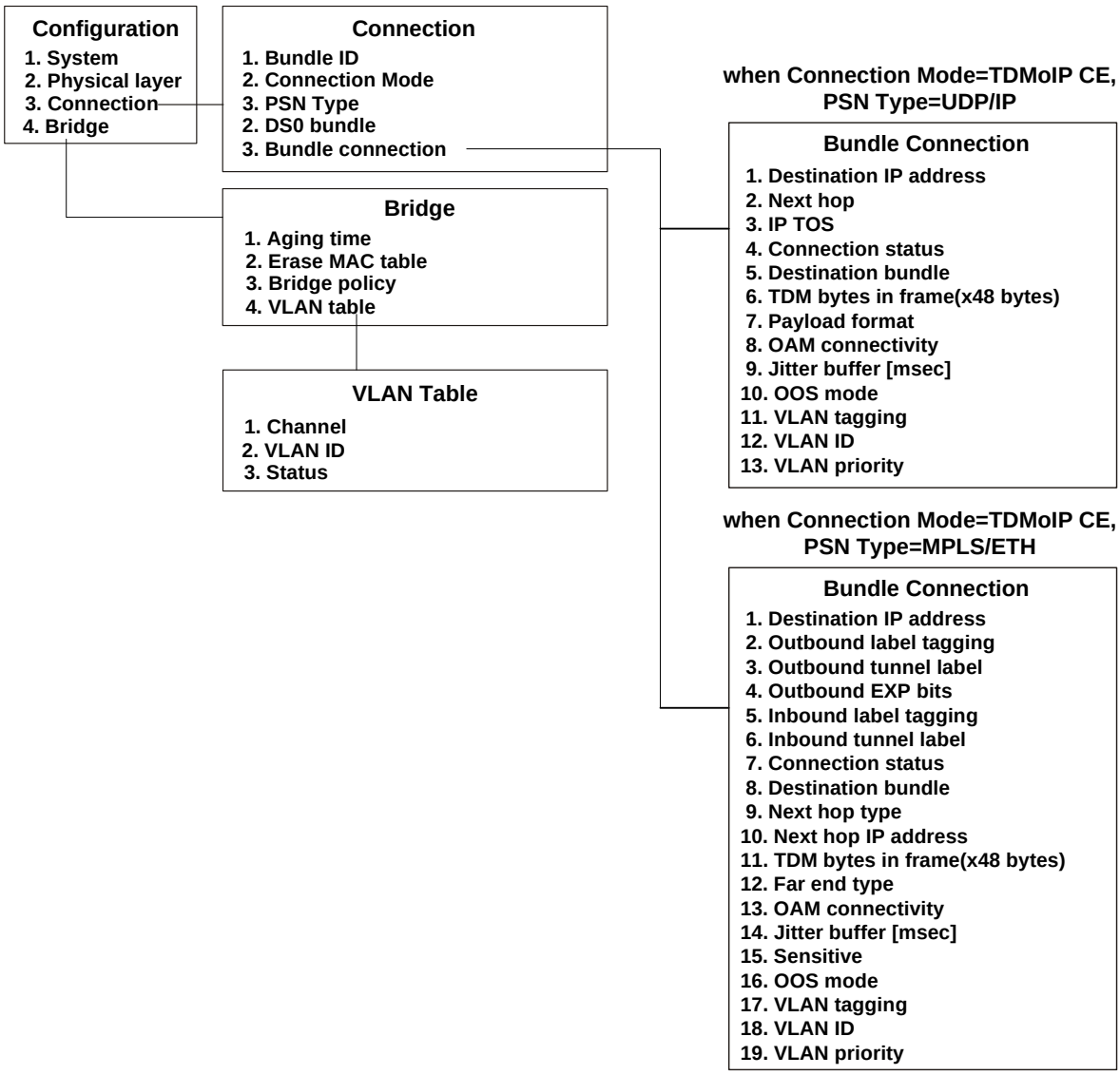

Figure 3-4. Configuration > Connection and Bridge

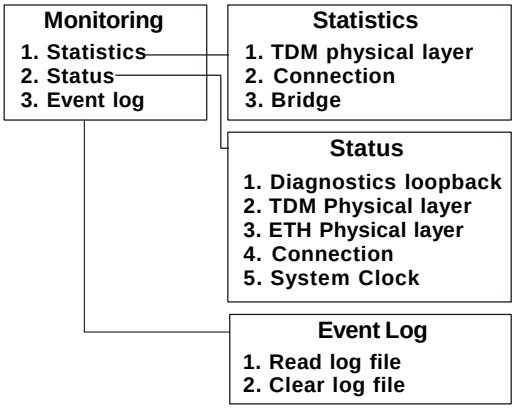

Figure 3-5. Monitoring

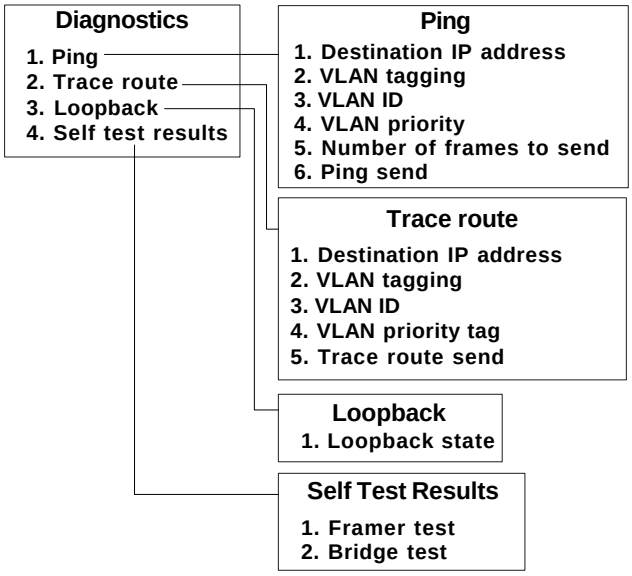

Figure 3-6. Diagnostics

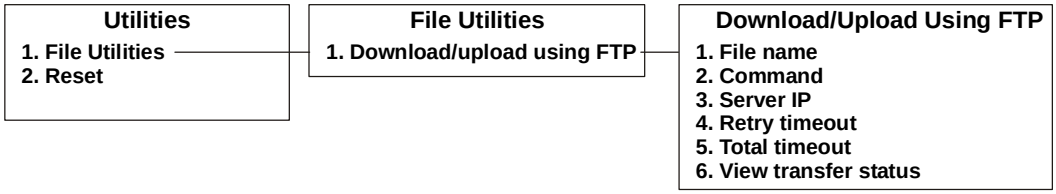

Figure 3-7. Utilities

3.5 Turning IPmux-11 Off

➤ **To power off the unit:**

- Remove the power cord from the power source.

Chapter 4

Configuration

This chapter illustrates the IPmux-11 configuration screens and explains their parameters.

Menu trees of the IPmux-11 management software are shown in *Chapter 3*.

4.1 Configuration Sequence

There are four basic configuration steps that need to be followed when deploying any IPmux unit:

1. IP configuration – Setting the device host IP address and the manager IP address.
2. Physical layer configuration – Setting the TDM parameters (line type, clocking, etc.) according to the application requirements and topology.
3. Creating bundles – Allocating timeslots to bundles
4. Connecting bundles – Directing the bundles defined above to remote IPmux unit.

IPmux-11 can be managed by a network management station that is located on the LAN connected to the one of the unit's Ethernet ports. In order to establish a proper connection, it is necessary to configure IPmux with a basic configuration.

➤ **To perform preliminary IPmux configuration:**

1. Connect an ASCII terminal to the RS-232 control port of IPmux.
2. Log in as Superuser (su).
3. Assign an IP address to IPmux.
4. Assign a subnet mask and a default gateway.
5. You can also enable or disable the IPmux DHCP client.
6. Set read, trap, and read/write communities to public.
7. Set a manager IP address and location.
8. Reset IPmux.

Note *Make sure that you save your settings at each configuration screen.*

4.2 Configuring IPmux-11 for Management

The IPmux-11 management software allows you to perform the following:

- Defining IP parameters of the IPmux-11 host
- Configuring management access
- Configuring control port parameters
- Setting the date and time
- Configuring the system clock
- Resetting IPmux-11 to the default values.

IPmux-11 system parameters are configured via System menu.

➤ **To access System menu:**

1. From the Main menu, select **Configuration**.
   The Configuration menu is displayed.
2. From the Configuration menu, select **System**.
   The System menu appears (see *Figure 4-1*).

```
Configuration>System


 1. Host IP                        >
 2. Management                     >
 3. System clock                   >
 4. Control port                   >
 5. Date/Time                      >
 6. Factory default                >


>

Please select item <1 to 6>

ESC-prev.menu; !-main menu; &-exit                                1 Mngr/s
```

Figure 4-1. System Menu

Configuring IP Host Parameters

IPmux-11 can be managed by a network management station, which is located on the LAN connected to the one of the unit's Ethernet ports. In order to establish a proper connection, it is necessary to configure the following: host IP address, subnet mask, default gateway, its trap, read and write communities. In addition, you can enable or disable DHCP client of the device.

Configuring DHCP Client

To facilitate integration of a new device into a DHCP IP network, if no IP address has been manually configured, IPmux-11 automatically requests one from the DHCP server upon booting. IPmux-11 is shipped with the DHCP client set to **Enable**.

➤ **To enable DHCP client:**

1. From the System menu, select **Host IP**.

   The Host IP menu appears (see *Figure 4-2*).

2. From the Host IP menu, select **DHCP**, and choose **Enable**.

   IPmux-11 starts broadcasting requests for an IP address. When the DHCP server is found, IPmux-11 receives from it all necessary host IP parameters.

3. From the Host IP menu, select **DHCP Status** to view the current status of the IPmux-11 DHCP client:
   - Server ID (IP address of the DHCP server)
   - Lease expiration time (Time when the IP address lease expires)
   - Current status – (Current status of the DHCP client: Locating Available Server, Waiting for Confirmation of Lease, etc)

Note *When the IP address lease is going to expire, DHCP client automatically requests lease extension.*

```
Configuration>System>Host IP
1. IP address                          ... (Empty)
2. IP mask                             ... (Empty)
3. Default gateway                     ... (0.0.0.0)
4. DHCP                                    (Enable)
5. DHCP Status                         >
>
Please select item <1 to 5>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-2. Host IP Menu

Managing IP Parameters of the IPmux-11 Host

IPmux-11 allows entering IP parameters manually or using parameters acquired from the DHCP server.

➤ **To define the IP parameters manually:**

1. Disable DHCP client.

   IPmux-11 releases the current IP address by sending the release message to the DHCP server, sets all host IP parameters to 0.0.0.0 and reboots itself automatically.

2. From the Host IP menu, perform the following:
   - Select **Host IP list** to define the host IP address
   - Select **IP mask** to define the host IP mask.
   - Select **Default gateway** to set the default gateway IP address.

Note *The default gateway must be in the same subnet as the host.*

➤ **To acquire a new IP address from the DHCP server:**

1. From the Host IP menu, set all host IP parameters (host IP, IP mask and default gateway) to 0.0.0.0.
2. Enable the DHCP client.

   IPmux-11 reboots itself automatically and acquires new IP parameters from the DHCP server at startup.

Configuring Management Parameters

You can configure the following management parameters:

- Define system name and location
- Define read, write and trap communities
- Specify network managers
- Enable or disable management access via Telnet or Web browser
- Define alarm masks.

Assigning a Name to IPmux-11 and Its Location

The IPmux-11 management software allows you to assign a name to the unit and its location to distinguish it from the other devices installed in your system.

➤ **To assign a name to IPmux-11 and its location:**

1. From the System menu (*Figure 4-1*), select **Management**.

   The Management menu is displayed.
2. From the Management menu, select **Device info**.

   The Device Info menu appears (see *Figure 4-3*).
3. From the Device Info menu, select **System name** and enter the desired name for the IPmux-11 device.
4. Select **System location**, and enter the desired name for the current IPmux-11 location.

```
Configuration>System>Management>Device info

1. System Name                  ... (IPmux-11)
2. System Location              ... (Branch A)

>
Please select item <1 to 2>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 4-3. Device Info Menu

Defining Read, Write and Trap Communities

You have to assign names for the read, write and trap communities. In addition, you can enable sending the authentication failure trap, if a network manager from an unauthorized community attempts to access IPmux-11.

➤ **To define read, write and trap communities:**

1. From the Management menu, select **Authentication/community**.

   The Authentication/Community menu appears (see *Figure 4-4*).

2. From the Authentication/Community menu, do the following:
   - Select **Authentication failure trap** to enable or disable sending this trap in case of an unauthorized access attempt.
   - Select **Trap** to enter the name of a community to which IPmux-11 will send traps (up to 10 alphanumeric characters, case-sensitive).
   - Select **Read** to enter the name of a community with read-only authorization (up to 10 alphanumeric characters, case-sensitive).
   - Select **Write** to enter the name of a community with write authorization (up to 10 alphanumeric characters, case-sensitive).

```
Configuration>System>Management>Authentication/community

1. Authentication Failure Trap       (Disable)
2. Trap                          ... (SNMP_trap)
3. Read                          ... (public)
4. Write                         ... (private)
>
Please select item <1 to 4>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-4. Authentication/Community Menu

Defining Network Managers

Define or modify the network management stations to which the SNMP agent of IPmux-11 will send traps. Up to 16 managers can be defined. In addition, you can enable or disable manager stations to receive traps.

➤ **To define network managers:**

1. From the Management Access menu (see *Figure 4-1*), select **Manager list**.

   The Manager List menu appears (see *Figure 4-4*).

2. From the Manager List menu, perform the following:
   - Select **Manager IP address**, and enter an IP address of the manager station.
   - Select **Manager Location** and define the port via which the current network manager accesses IPmux-11 according to the options below. This option is available only if the VLAN tagging mode of both user ports is set to Double Tag (see *Configuring the Ethernet Bridge* section below). Only one network manager at a time is allowed to access IPmux-11 via user ports.

Note *It is possible to set up a local or remote management link using the manager location and VLAN configuration. Refer to the configuration example at the end of this section.*

- Network-Eth1 – The network manager accesses IPmux-11 via the network port (Ethernet port 1)
- User1-Eth2 – The network manager accesses IPmux-11 via the user port 1 (Ethernet port 2)
- User2-Eth3 – The network manager accesses IPmux-11 via the user port 2 (Ethernet port 3).

- Select **Link up/down trap**, and choose **On** to enable the management station to receive a trap when a link failure (link down) or link recovery (link up) occurs. Choose **Off** to disable Link Up/Down trap.
- Select **Alarm trap**, and choose **On** or **Off** to enable or disable sending alarm trap to the manager station.
  - On – The alarm trap is sent to the management station informing of any alarm which is not masked (see *Masking Alarms* in Chapter 6). Both entry and exit from an alarm state are declared.
  - Off – No alarm trap is sent to the management station, even if the alarm is masked.
- Select **VLAN tagging**, and choose **On** or **Off** to consider or ignore the VLAN tagging of the management traffic coming from the management station.
- Select **VLAN ID**, and enter the ID of the management station VLAN (1–4095).
- Select **VLAN priority**, and enter the priority of the management station VLAN (0–7).

```
Configuration>System>Management>Manager list

1. Manager IP address            ... (0.0.0.0)
2. Manager location              ... (Empty)
3. Link up/down trap                 (On)
4. Alarm trap                        (Off)
5. VLAN tagging                      (Off)
6. VLAN ID                       ... (0)
7. VLAN priority                 ... (0)
>
Please select item <1 to 7>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 4-5. Manager List Menu

Configuration Example

Local Management

Figure 4-6 illustrates how to manage a local IPmux-11 from an NMS connected via Ethernet user port 2.

- VLAN tagging mode of the Ethernet user ports is configured to Double Tag
- User and management traffic are separated by different VLANs
- Manager location is set to User2-Eth3.

IPmux-11 separates management traffic sent to the local device MAC and marked by VLAN 1 from the user traffic marked by VLAN 100. The management traffic is processed by the local IPmux-11. The user traffic is sent to its destination via the network interface.

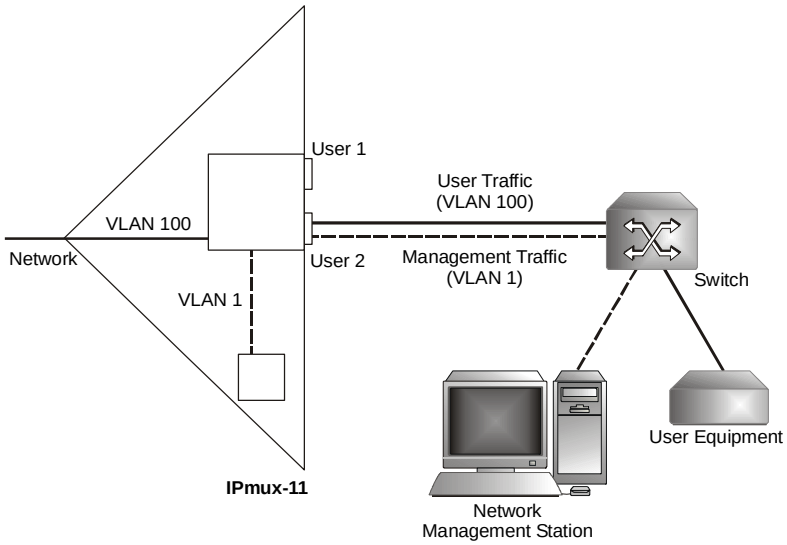

Figure 4-6. Local Management via User Ethernet Port

Remote Management

Figure 4-7 illustrates how to manage a local and remote IPmux-11 units from an NMS connected via Ethernet user port 2 of the local device.

- VLAN tagging mode of the Ethernet user ports of both IPmux-11 is configured to Double Tag
- User and management traffic are separated by different VLANs
- Manager location of the local IPmux-11 is set to User2-Eth3.
- Manager location of the remote IPmux-11 is set to Network-Eth1.

IPmux-11 separates management traffic marked by VLAN 1 from the user traffic marked by VLAN 100. When the local IPmux-11 detects that the management traffic has been sent to the MAC of the remote unit, it forwards the traffic to its destination via the network interface.
The remote IPmux-11 processes the management traffic received via its network interface and responds to the management requests.

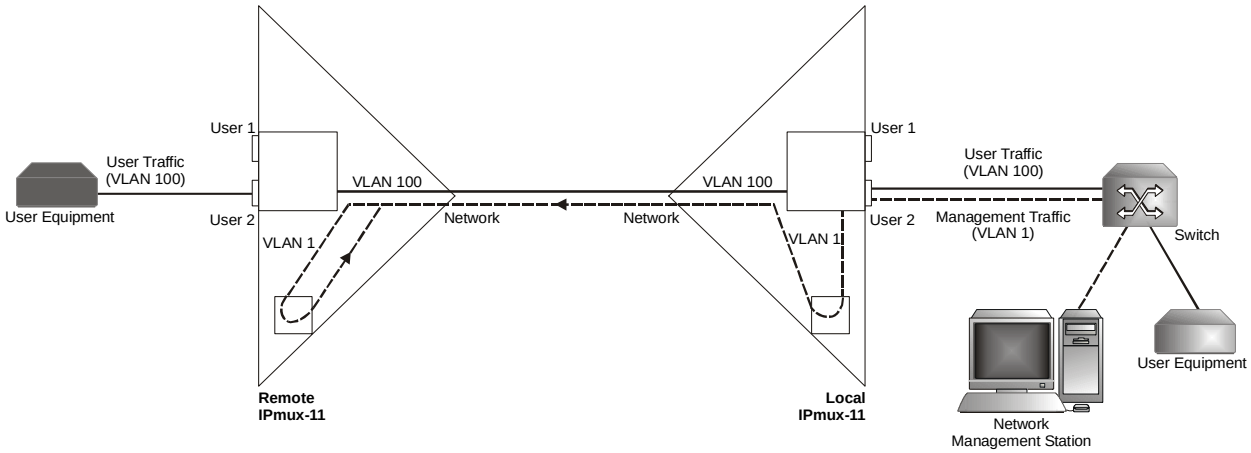

Figure 4-7. Remote Management via User Ethernet Port

Configuring Management Access Permissions and Methods

The user access rights, as well as SNMP, Telnet and Web access authorization are configured via the Management Access menu.

➤ **To access The Management Access menu:**

- From the Management menu, select **Management access**.

The Management Access menu is displayed (*Figure 4-8*).

```
Configuration>System>Management>Management access

1. User access                  >
2. Telnet access                >   (Enable)
3. Web access                   >   (Enable)
>
Please select item <1 to 3>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 4-8. Management Access Menu

Configuring User Access

IPmux-11 management software allows you to define new users, their management and access rights. Only superusers (su) can create new users, the regular users are limited to changing their current passwords, even if they were given full management and access rights.

➤ **To add a new user:**

1. Make sure that you logged in as **su**.
2. From the Management Access menu, select **User access**.

   The User Access menu is displayed (see *Figure 4-9*).
3. From the User Access menu, do the following:
   - Select **User name**, and enter a name for a new user.
   - Select **Permission**, and specify the user's access rights (full control or read-only).

- Select **Access**, and specify the user's access methods (ASCII terminal, Telnet, Web browser, Telnet and Web browser, or all of them).
- Select '**su**' **password**, and enter your current superuser password.
- Select **New password**, and assign a password to a new user name.
- Select **Confirm** and re-enter the new user password to confirm it.
- Save new settings by typing **S**, when asked.

➤ **To delete an existing user:**

- From the User Access menu, do the following:
  - Type **F** or **B** to display a user that you intend to delete.
  - Select '**su**' **password**, and enter your current superuser password.
  - Type **D** to delete the current user.

```
Configuration>System>Management>Management access>User access

1. User name                    ... (su)
2. Permission                   >   (Full Control)
3. Access                       >   (All)
4. 'su' password                 ... ()
5. New password                 ... ()
6. Confirmation                 ... ()
>
Please select item <1 to 6>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 4-9. User Access Menu

Controlling Management Access

You can enable or disable access to the IPmux-11 management system via an SNMP, Telnet or Web-based application. By disabling SNMP, Telnet or Web, you prevent unauthorized access to the system when security of the IPmux-11 IP address has been compromised. When SNMP, Telnet and Web access is disabled, IPmux-11 can be managed via an ASCII terminal only. In addition, you can limit access to the device to only the stations defined in the manager list. *Table 4-1* details management access implementation, depending whether the network managers are defined or not.

➤ **To define the management access method:**

1. From the Management menu, select **Management Access**.

   The Management Access menu appears (see *Figure 4-10*).

2. From the Management Access menu, select **TELNET Access** to configure Telnet access, select **SNMP Access** to configure SNMP access, or select **WEB Access** to configure Web access.
3. Define access mode for each management method:

- Enable (Telnet, SNMP or Web access is enabled)
- Disable (Telnet, SNMP or Web access is disabled)
- Manager Only (Access is allowed only for the stations appearing in the manager list).

Table 4-1. Management Access Implementation

Access Method	Mode	Who is Allowed to Access IPmux-11	
		Network Manager(s) Defined	Network Manager(s) not Defined
SNMP Access	Enable	Anybody	Anybody
	Disable	Nobody	Nobody
	Manager Only	Only defined network managers	Nobody
Telnet Access	Enable	Anybody	Anybody
	Disable	Nobody	Nobody
	Manager Only	Only defined network managers	Anybody
Web Access	Enable	Anybody	Anybody
	Disable	Nobody	Nobody
	Manager Only	Only defined network managers	Anybody

```
Configuration>System>Management>Management Access

1. User Access                          >
2. TELNET access                        >  (Enable)
3. SNMP access                          >  (Disable)
4. WEB access                           >  (Enable)
>

ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-10. Management Access Menu

Configuring Control Port Parameters

Configuration parameters of the IPmux-11 control port, except for the baud rate are set at the factory and cannot be changed by the user (see *Figure 4-11*). These parameters have the following values:

- Data bits – 8
- Parity – None
- Stop bits – 1
- Flow control – None.

➤ **To select the baud rate:**

1. From the System menu (*Figure 4-1*), select **Control port**.

   The Control Port menu is displayed (see *Figure 4-11*).

2. From the Control Port menu, select **Baud rate**, and configure baud rate of the IPmux-11 terminal control port to the desired value (9600, 19200, 38400, 57600 or 11520 bps).

```
Configuration>System>Control port
   Data bits                          (8)
   Parity                        >    (None)
   Stop bits                          (1)
   Flow control                  >    (None)
1. Baud rate (bps)               >    (115200)
>
Please select item <1 to 1>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-11. Control Port Menu

4.3 Configuring IPmux-11 for Operation

Configuring the System Clock

You can configure the parameters of the IPmux-11 system clock, including the master clock and fall back clock. If the clock is adaptive or Rx clock then you can also configure the clock source.

Note *If the configured fallback clock source fails, the internal timing is used as the fallback clock source instead.*

➤ **To configure the system clock:**

1. From the System menu (*Figure 4-1*), select **System clock**.

   The System clock menu appears (See *Figure 4-12).*

2. From the System clock menu, configure the following:
   - Master clock (Master clock type):
     - Internal
     - Adaptive
     - Rx clock
   - Master source (Master clock source):
     - Channel 1
     - Channel 2
     - Channel 3

- Channel 4
- External

- Fall back clock (Fall back clock type):
  - Internal
  - Adaptive
  - Rx clock
  - None
- Fall back source (Fall back clock source):
  - Channel 1
  - Channel 2
  - Channel 3
  - Channel 4
  - External

3. Type **S** to save your changes.

```
Configuration>System>System clock


 1. Master clock                >   (Rx clock )
 2. Master source               >   (External  )
 3. Fall back clock             >   (Adaptive )
 4. Fall back source            >   (Channel 1 )


>

Please select item <1 to 4>
S - save
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-12. System Clock Menu

Configuring IPmux-11 at the Physical Level

The TDM (E1 or T1) and Ethernet interfaces of IPmux-11 must be configured at the physical level.

```
Configuration>Physical layer

 1. TDM                              >
 2. Eth                              >
 3. External clock interface       (Balance)



>

Please select item <1 to 3>

ESC-prev.menu; !-main menu; &-exit                                    1 Mngr/s
```

Figure 4-13. Physical Layer Menu

Configuring the E1 TDM Interface

The E1 and T1 interfaces of IPmux-11 are configured via the TDM menu. IPmux-11 automatically detects whether the interface is E1 or T1, and displays the appropriate menu.

➤ **To configure the E1 interface:**

1. From the Configuration menu, select **Physical layer**.
   The Physical Layer menu appears.
2. From the Physical Layer menu, select **TDM**.
   The TDM (E1) menu appears (see *Figure 4-14*).
3. From the TDM (E1) menu, configure the following:
   - Admin Status:
     - Enable (E1 link is enabled)
     - Disable (E1 link is disabled)
   - Transmit clock source:
     - Adaptive (Adaptive clock regeneration)
     - Loopback (E1 recovered Rx clock is used as the Tx clock)
     - Internal (Tx clock is received from an internal oscillator)
     - System (System clock is used as the Tx clock)

- Rx sensitivity (Maximum attenuation of the receive signal that can be compensated for by the interface receive path):
  - Short haul (-10 dB)
  - Long haul (-32 dB)
- Trail Mode (Enables the end-to-end transfer of TDM OAM (Operation, administration, and maintenance) data in framed mode, when the payload format is set to V2.
  - Termination (Trail-extended mode is disabled; the TDM networks function as separate OAM domains)
  - Extension (Trail-extended mode is enabled; OAM data is passed between the TDM networks)
- Line type (E1 framing mode):
  - Unframed G.703 (Framing is not used)
  - Framed G.704 (G.704 framing, CRC-4 function disabled)
  - Framed G.704 CRC4 (G.704 framing, CRC-4 function enabled)
  - Framed MF (CAS enabled, CRC-4 function disabled)
  - Framed MF CRC4 (CAS enabled, CRC-4 function enabled).
- Idle Code (code transmitted to fill unused timeslots in the E1 frames): 00 to ff.

4. If you configure the Line type to Framed MF or Framed MF CRC4, type **N** to display the next page of E1 parameters (*Figure 4-15*):
   - Send Upon Fail (Notification sent to the E1 side if Ethernet link fails):
     - OOS Code (Out-of-service code)
     - AIS (Alarm indication signal)
   - OOS code (Code to be sent to the E1 side if Ethernet link fails): 0–ff
   - OOS signaling (Out-of-service signaling method. OOS signal is sent toward the IP path when loss of signal, loss of frame, or AIS is detected at the E1 line. The OOS signal is also sent toward the E1 line when packet receive buffer overrun or underrun occurs.):
     - Space (Code specified by the Space Signaling Code parameter is sent)
     - Mark (Code specified by the Mark Signaling Code parameter is sent)
     - Space Mark (Space code is sent in the first 2.5 seconds, then mark code is sent)
     - Mark Space (Mark code is sent in the first 2.5 seconds, then space code is sent)
   - Mark signaling code: 0–f
   - Space signaling code: 0–f
5. Type **S** to save the changes.

```
Configuration>Physical layer>TDM (E1)
    Channel ID                (1)
    Restoration time         >(CCITT)
    Signaling mode            (CAS Disabled)

1. Admin status               (Enable)
2. Transmit clock source     >(Adaptive)
3. Rx sensitivity             (Short haul)
4. Trail mode                 (Termination)
5. Line type                 >(Framed G.704)
6. Idle code[0 - ff]         ... (7E)
7. Send upon fail             (OOS Code)
8. OOS Code[0 - ff]           (FF)
   (N)
>
Please select item <1 to 11>
ESC-prev.menu; !-main menu; &-exit                                1 Mngr/s
```

Figure 4-14. TDM (E1) Menu (Page 1)

```
Configuration>Physical layer>TDM (E1)
   ...(P)
9. OOS signaling                      >   (Space)
10. Mark signaling code[0 - f]         ... (D)
11. Space signaling code[0 - f]        ... (1)
>
Please select item <1 to 11>
ESC-prev.menu; !-main menu; &-exit                                1 Mngr/s
```

Figure 4-15. TDM (E1) Menu (Page 2)

Configuring the E1 External Clock Interface

For the units with the E1 user interface it is necessary to define the external clock interface type: balanced or unbalanced. When it is set to unbalanced, connection to the external clock source must be performed via CBL-RJ45/2BNC/E1/X adapter cable.

➤ **To configure the external clock E1 interface type:**

- From the Physical Layer menu (Configuration > Physical Layer), select **External Clock Interface** and choose its type: balanced or unbalanced.

Configuring the T1 TDM Interface

The procedure for configuring the T1 port is similar to the procedure described above for configuring the E1 port.

➤ **To configure T1 interface:**

- From the TDM (T1) menu, configure the following:
  - Admin Status:
    - Enable (T1 link is enabled)
    - Disable (T1 link is disabled)
  - Transmit clock source:
    - Adaptive (Adaptive clock regeneration)
    - Loopback (E1 recovered Rx clock is used as the Tx clock)
    - Internal (Tx clock is received from an internal oscillator)
    - System (System clock is used as the Tx clock)
  - Rx sensitivity (Maximum attenuation of the receive signal that can be compensated for by the interface receive path):
    - Short haul (-10 dB)
    - Long haul (-32 dB)
  - Trail Mode (Enables the end-to-end transfer of TDM OAM (Operation, administration, and maintenance) data in framed mode, when the payload format is set to V2.
    - Termination (Trail mode is disabled; the TDM networks function as separate OAM domains)
    - Extension (Trail mode is enabled; OAM data is passed between the TDM networks)
  - Line type (T1 framing mode):
    - Esf (24 frames per multiframe)
    - SF (D4) (12 frames per multiframe)
  - Line code (Line code and zero suppression method used by the port):
    - B7ZS
    - B8ZS
    - AMI
  - Line interface:
    - DSU (DSU interface)
    - CSU (CSU interface)
  - Line length (DSU mode only, length of a cable in feet between the IPmux-11 T1 port connector and the network access point):
    - 0–133
    - 133–266
    - 266–399
    - 399–533
    - 533–655

- Line buildOut (CSU mode only, Tx gain level relative to T1 output transmit level)
  - 0 dB (No attenuation)
  - 7.5 dB (Attenuation of 7.5 dB relative to the nominal transmit level)
  - 15 dB (Attenuation of 15 dB relative to the nominal transmit level)
- Restoration time (Time required for the T1 port to return to normal operation after sync loss):
  - TR-6211 (10 seconds)
  - Fast (1 second)
- Idle Code (Code transmitted to fill unused timeslots in the T1 frames): 00 to ff.
- Send Upon Fail (Notification sent to the T1 side if Ethernet link fails):
  - OOS Code (Out-of-service code)
  - AIS (alarm indication signal)
- OOS code (Code to be sent to the T1 side if Ethernet link fails): **0**–**ff**
- Signaling mode:
  - None
  - Robbed Bit
- OOS signaling (Out-of-service signaling method. OOS signal is sent toward the IP path when loss of signal, loss of frame, or AIS is detected at the T1 line. The OOS signal is also sent toward the T1 line when packet receive buffer overrun or underrun occurs.):
  - **Space** (Code specified by the Space Signaling Code parameter is sent)
  - **Mark** (Code specified by the Mark Signaling Code parameter is sent)
  - **Space Mark** (Space code is sent in the first 2.5 seconds, then mark code is sent)
  - **Mark Space** (Mark code is sent in the first 2.5 seconds, then space code is sent)
- Mark signaling code: **0**–**f**
- Space signaling code: **0**–**f**

```
Configuration>Physical layer>TDM (T1)
    Channel ID                (1)
1. Admin status               (Enable)
2. Transmit clock source     >(Adaptive)
3. Rx sensitivity             (Short haul)
4. Trail mode                 (Termination)
5. Line type                 >(ESF)
6. Line code                 >(B8ZS)
7. Line interface            >(DSU)
8. Line length (feet)        >(0-133)
9. Restoration time          >(TR-621 (10 seconds))
10.                   Idle Code[0 - ff]                 ... (7E)
   (N)
>
Please select item <1 to 16>
ESC-prev.menu; !-main menu; &-exit                                1 Mngr/s
```

Figure 4-16. TDM (T1) Menu (Page 1)

```
Configuration>Physical layer>TDM (T1)
   ...(P)
11. Send upon fail                          (OOS Code)
12. OOS code[0 - ff]                    ... (FF)
13. Signaling mode                          (Robbed Bit)
14. OOS signaling                       >   (Space)
15. Mark signaling code[0 - f]          ... (D)
16. Space signaling code[0 - f]         ... (1)
>
Please select item <1 to 16>
ESC-prev.menu; !-main menu; &-exit                                1 Mngr/s
```

Figure 4-17. TDM (T1) Menu (Page 2)

Configuring Ethernet Interfaces

IPmux-11 includes one network and up to two user Ethernet ports.

➤ **To configure Ethernet interface:**

1. From the Physical Layer menu, select **ETH**.

   The ETH menu appears (see *Figure 4-18*).

2. From the ETH menu, type **F** to select the Ethernet interface that you intend to configure (**Network-Eth1**, **User1-Eth2** or **User2-Eth3**).

3. When the required Ethernet interface is displayed, configure the following:
   - Channel state:
     - Enable (Current Ethernet interface is enabled)
     - Disable (Current Ethernet interface is disabled)
   - Auto negotiation:
     - Enable (Autonegotiation is enabled)
     - Disable (Autonegotiation is disabled)
   - Max capability advertised (Maximum capability to be advertised during the autonegotiation process):
     - 10BaseT Half Duplex
     - 10BaseT Full Duplex
     - 100BaseT Half Duplex
     - 100BaseT Full Duplex
   - Default type (Rate and duplex mode, if the autonegotiation is disabled):
     - 10BaseT Half Duplex
     - 10BaseT Full Duplex
     - 100BaseT Half Duplex
     - 100BaseT Full Duplex

Note *When autonegotiation protocols do not support each other, this will degrade the connection to a half-duplex mode. In order to avoid this, autonegotiation should be disabled and the ports should be configured manually. Half-duplex degradation will occur also when autonegotiation is enabled at one port and disabled at the opposite port.*

4. Type **S** to save your changes.

```
Configuration>Physical layer>ETH

    Channel                              >   (Network-Eth1)

1. Channel state                             (Enable)
2. Auto negotiation                          (Disable)
3. Max capability advertised             >   (100baseT Full Duplex)
4. Default type                          >   (100baseT Full Duplex)


>

Please select item <1 to 4>
F – Forward
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-18. ETH Menu

Configuring Bundle Connections

IPmux-11 supports one bundle that can include up to 31 E1 or up to 24 T1 timeslots. The bundle can be connected to any bundle of the TDMoIP device that operates opposite IPmux-11. Currently, TDMoIP traffic is sent and received via the network port only.

➤ **To configure bundle connection:**

1. From the Configuration menu, select **Connection**.

   The Connection menu appears (see *Figure 4-19*).

2. Select **DS0 bundle**.

   The DS0 Bundle menu appears (see *Figure 4-20*).

3. From the DS0 Bundle, assign timeslots to the current bundle (1) by selecting a timeslot and choosing **1** (assigned) or **0** (not assigned).

   You can assign all timeslots to the current bundle at once by typing **E**.

   You can cancel assignment of all timeslots to the current bundle at once by typing **L**.

4. From the Connection menu, configure the **PSN Type**:
   - UDP/IP (bundle encapsulation is UDP/IP)
   - MPLS/ETH (bundle encapsulation is MPLS (Multi-Protocol Label Switching) / Ethernet)

Note *PSN Type is only available after Bundle ID has been set.*

5. From the Connection menu, select **Bundle connection**.

   The Bundle Connection menu appears (see *Figure 4-21* and *Figure 4-22*).

Note *IPmux-11 only shows the relevant menu options, depending on the connection mode and PSN type.*

6. From the Bundle Connection menu, configure the following (if it appears in the menu):
   - Destination IP Address (IP address of the destination device): 0.0.0.0 to 255.255.255.255.
   - Outbound Label Tagging:
     - Enable (Outbound labels are enabled)
     - Disable (Outbound labels are disabled)
   - Outbound tunnel label (MPLS transmit label): 0–1048576
   - Outbound EXP bits (MPLS label exp bits): 0–7
   - Inbound label tagging:
     - Enable (Inbound labels are enabled)
     - Disable (Inbound labels are disabled)
   - Inbound tunnel label (MPLS receive label): 0–1048576

- Destination bundle (bundle number in the destination device): 1–8063
- Next hop address (Use the next hop parameter when the destination address is not in the device subnet. In such cases the Ethernet frame is sent to the IP or MAC address of the next hop. If it is not configured, the default gateway is used.): 0.0.0.0 to 255.255.255.255 (if IP) or 00-00-00-00-00-00 to FF-FF-FF-FF-FF-FF (if MAC).
- Next hop type:
  - IP (Type of interface at the next hop is IP)
  - MAC (Type of interface at the next hop is MAC)
- Connection Status:
  - Enable (Connection is enabled)
  - Disable (No frames are sent on this connection)
- TDM Bytes in Frame (x48 bytes) (UDP payload length – this parameter enables reduction of Ethernet throughput): 1–30
- Far end type (Type of the TDM interface of the remote unit):
  - E1 (Type of interface at the far end of the link is E1)
  - E1 (multi-frame) (Type of interface at the far end of the link is E1 multi-frame)
  - T1 (ESF) (Type of interface at the far end of the link is T1 ESF)
  - T1 (SF) (Type of interface at the far end of the link is T1 SF)
  - Unframed / Serial (Type of interface at the far end of the link is unframed or serial)
- OAM connectivity:
  - Enable (The device starts transmitting at full rate after it detects an active, properly configured, the unit on the other side of the line.)
  - Disable (OAM connectivity is disabled)
- Jitter buffer (Desired depth of the jitter (PDVT) buffer. The Packet Delay Variation Tolerance buffer absorbs network delay variation or jitter): 3–300 msec
- OOS Mode (Defines whether Out of Service (OOS) signal will be transmitted. The OOS signal is sent toward the IP path when loss of signal, loss of frame, or AIS is detected at the TDM line. The OOS signal is also sent toward the TDM line when packet receive buffer overrun or underrun occurs.):
  - Tx OOS (OOS transmission is enabled)
  - Stop Tx (OOS transmission is disabled)

- Sensitive (Whether to optimize the clock for accurateness or for constant delay):
  - Data (Accurate clock is more important than constant delay.
  - Delay (Constant delay is more important than accurate clock.
- VLAN Tagging:
  - Enable (VLAN tagging is enabled)
  - Disable (VLAN tagging is disabled)
- VLAN ID: 1–4095
- VLAN priority: 0–7
- IP TOS (IP ToS field in the IP frames transmitted by IPmux-11. ToS configuration configures the **WHOLE** byte, since different vendors may use different bits to tag packets for traffic prioritization. ToS assignment applies to all TDM packets leaving IPmux-11.): 0–255
- Payload Format (TDMoIP format):
  - V1 (Version 1)
  - V2 (Version 2)

Note

- *When PSN Type is **MPLS/ETH** the payload format is always **V2**.*
- *Make sure that selected VLAN is configured as a member of the network port VLANs (see Configuring the Ethernet Bridge below).*

7. Type **S** to save the changes.

```
Configuration>Connection

1. Bundle ID[1 - 1]                    ... (1)
2. Connection mode                      >   (TDMoIP CE)
3. PSN type                             >   (UDP/IP)
4. DS0 bundle                          []>
5. Bundle connection                    >
>
Please select item <1 to 5>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-19. Connection Menu

```
Configuration>Connection>DS0 bundle

         +1     +2     +3     +4     +5     +6     +7     +8     +9     +10
  TS  0  1      0      0      0      0      0      0      0      0      0
  TS 10  0      0      0      0      0      0      0      0      0      0
  TS 20  0      0      0      0      0      0      0      0      0      0
  TS 30  0

 1. Change cell [0 - 1]           ... (0)
>
Please select item <1 to 1>
E - Enable All; L - Disable All
ESC-prev.menu; !-main menu; &-exit; ?-Help                          1 Mngr/s
```

Figure 4-20. DS0 Bundle Menu

```
Configuration>Connection>Bundle connection
TDM channel ID: 1  Bundle ID: 1


 1. Destination IP address                 ... (0.0.0.0)
 2. Next hop                               ... (0.0.0.0)
 3. IP TOS[0 - 255]                        ... (0)
 4. Connection status                          (Enable)
 5. Destination bundle[1 - 8063]           ... (1)
 6. TDM bytes in frame(x48 bytes)[1 - 30]  ... (1)
 7. Payload format                             (V2)
 8. OAM connectivity                           (Disable)
 9. Jitter buffer [msec][3 - 300]          ... (300)
10. OOS mode                                   (Tx OOS)
11. VLAN tagging                               (Enable)
12. VLAN ID[1 - 4095]                      ... (1)
13. VLAN priority[0 - 7]                   ... (7)
>


Please select item <1 to 13>
F - Forward Bundle ID; D - Delete; ? - Help
ESC-prev.menu; !-main menu; &-exit
```

Figure 4-21. Bundle Connection Menu when Connection Mode=TDMoIP CE, PSN Type=UDP/IP

```
Configuration>Connection>Bundle connection
TDM channel ID: 1  Bundle ID: 1

 1. Destination IP address                  ... (0.0.0.0)
 2. Outbound label tagging                      (Enable)
 3. Outbound tunnel label                   ... (4)
 4. Outbound EXP bits                       ... 7
 5. Inbound label tagging                       (Enable)
 6. Inbound tunnel label                    ... (5)
 7. Connection status                           (Enable)
 8. Destination bundle                      ... (1)
 9. Next hop type                               (IP)
10. Next hop IP address                     ... (0.0.0.0)
11. TDM bytes in frame(x48 bytes)           ... (1)
12. Far end type                                (E1)
13. OAM connectivity                            (Disable)
14. Jitter buffer [msec][3 - 300]           ... (300)
15. Sensitive                                   (Data)
16. OOS mode                                    (Tx OOS)
17. VLAN tagging                                (Enable)
18. VLAN ID[1 - 4095]                       ... (1)
19. VLAN priority[0 - 7]                    ... (7)
>
Please select item <1 to 19>
F - Forward Bundle ID; ? - Help
ESC-prev.menu; !-main menu; &-exit
```

Figure 4-22. Bundle Connection Menu when Connection Mode=TDMoIP CE, PSN Type=MPLS/ETH

Configuring the Ethernet Bridge

IPmux-11 contains an internal bridge where one of its ports is connected to a TDMoIP interworking function, two external bridge ports are used as the user ports, and the fourth is used as an Ethernet network port.

➤ **To configure Ethernet bridge:**

1. From the Configuration menu, select **Bridge**.

   The Bridge menu appears (*Figure 4-23*).

2. From the Bridge menu, select **Aging time** and define a period of time in seconds from the moment when a node is disconnected from the network segment or becomes inactive and removal of the node address from the database.
3. Select **Erase MAC table**, if you intend to delete all learned addresses from the MAC table.
4. Select **Bridge policy**, and from the Bridge Policy menu (*Figure 4-24*) define the following:
   - VLAN tagging (operation mode for the corresponding port of internal switch):
     - Transparent
     - Tag (Tagged)
     - Untag (Untagged)
     - DoubleTag (Double Tagged)
   - Default VLAN ID (VLAN associated with untagged frames arriving at the port): 1–4095
   - Default VLAN Priority: 0–7
   - Rate limit:
     - User port: Disable, 256 kbps, 512 kbps, 1 Mbps, 2 Mbps, 4 Mbps, 8 Mbps, 16 Mbps, 32 Mbps, 64 Mbps
     - Network port: Disable, 256 kbps, 512 kbps, 1 Mbps, 2 Mbps, 4 Mbps, 5 Mbps, 8 Mbps, 10 Mbps, 16 Mbps, 20 Mbps, 25 Mbps, 40 Mbps, 50 Mbps, 80 Mbps

Note *Selected rate limiting value for the user port changes available default VLAN priority options for this port in the following manner:*

Rate Limiting	***Default VLAN Priority***
0–8 Mbps	*0–7*
16 Mbps	*0–7*
32 Mbps	*2–7*
*64 Mbps**	*4–7*

** – Since the user traffic entering the switch via ports with 64 Mbps rate limiting receives high priority, it may interfere with TDM traffic, which has high priority by default.*

5. Select **VLAN table**, and from the VLAN Table menu (*Figure 4-25*) configure the following:
   - Channel:
     - Network-Eth1
     - User1-Eth2
     - User2-Eth3
   - VLAN ID (Specifies VLAN, which the current bridge port will be a member of): 1–4095

- Status:
  - Enable (Adds the current port as a VLAN member)
  - Disable (Disables VLAN membership of the current port)

```
Configuration>Bridge

1. Aging time [sec] <0-Disable>[0 - 4080]      ... (304)
2. Erase MAC table
3. Bridge policy                                  []>
4. VLAN table                                      >
>
Please select item <1 to 4>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-23. Bridge Menu

```
Configuration>Bridge>Bridge policy

  Channel                 Network-Eth1    User1-Eth2      User2-Eth3
  VLAN tagging            Tag             Transparent     Transparent
  Default VLAN ID         1               1               1
  Default VLAN priority   0               0               0
  Rate Limit              0-Disable       0-Disable       0-Disable
1. Transparent
2. Tag
3. UnTag
4. DoubleTag
>
Please select item <1 to 4>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-24. Bridge Policy Menu

```
    Network channel VLANs:        >   (25)
    User1 channel VLANs:          >   (101)
    User2 channel VLANs:          >   (-)
1. Channel                       >   (Network-Eth1)
2. VLAN ID[1 - 4095]             ... (1)
3. Status                            (Enable)
>
Please select item <1 to 3>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-25. VLAN Table Menu

4.4 Additional Tasks

Displaying the IPmux-11 Inventory

The IPmux-11 inventory displays information on current software and hardware revisions of the unit. It also provides the IPmux-11 interface description.

➤ **To display the IPmux-11 inventory:**

- From the Main menu, select **Inventory**.

```
Inventory

    SOFTWARE
     Boot version                    (1.00  )
     Application version             (2.00D1  01/02/2005 16:47:18)
     Backup version                  (2.00D1  01/02/2005 16:47:18)

    HARDWARE
     Version                         (1.00  )
     MAC address                     (0020D2213FE7)


... (N)


ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 4-26. Inventory Screen (Page 1)

```
Inventory


... (P)

    INTERFACE
     TDM1                            (E1 over UTP)
     ETH1/Net                        (ETHERNET over Multimode LC)
     ETH2/User1                      (ETHERNET over UTP)
     ETH3/User2                      (ETHERNET over UTP)
     External clock                  (UTP)



ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 4-27. Inventory Screen (Page 2)

Setting the Date and Time

You can set the date and time for the IPmux-11 internal real-time clock.

➤ **To set date and time:**

1. From the System menu (*Figure 4-1*), select **Date/time**.

   The Date/Time menu appears (see *Figure 4-28*).

2. From the Date/Time menu, select **Set time**, and enter the current time in the hh:mm:ss format.
3. Select **Set date**, and enter the current date in the yyyy:mm:dd format.

```
Configuration>System>Date/time
1. Set time <HH:MM:SS>           ... (09:12:06)
2. Set date <YYYY-MM-DD>         ... (2004-01-18)
>
Please select item <1 to 2>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-28. Date/Time Menu

Displaying the IPmux-11 Status

The IPmux-11 software allows displaying information on the physical layer and bundle connections. This section describes only status information of the IPmux-11 device. For description of IPmux-11 alarms, refer to *Chapter 6*.

The status information is available via the Status menu.

➤ **To access the Status menu:**

1. From the Main menu, select **Monitoring.**

   The Monitoring menu appears.

2. From the Monitoring menu, select **Status**.

   The Status menu appears (see *Figure 4-29*).

```
Monitoring>Status

1. Diagnostics loopback      >
2. TDM Physical layer        >
3. ETH Physical layer        >
4. Connection                >
5. System clock              >
>
Please select item <1 to 4>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-29. Status Menu

Displaying the Diagnostics Loopback Information

You can view the status of the diagnostics loopback.

➤ **To display the diagnostics loopback information:**

- From the Status menu, select **Diagnostics loopback**.

```
Monitoring>Status>Diagnostics loopback

    Channel ID              (1)             Loopback state:     >   (Disable)




|>


ESC-prev.menu; !-main menu; &-exit                                    1 Mngr/s
```

Figure 4-30. Diagnostics loopback Screen

Displaying the TDM Physical Layer Information

You can view the status of the TDM layer at the physical level.

➤ **To display the TDM physical layer information:**

- From the Status menu, select **TDM Physical layer**.

```
Monitoring>Status>TDM physical layer (T1)

    Channel ID              (1)             Loopback state:     >   (Disable)




|>


ESC-prev.menu; !-main menu; &-exit                                    1 Mngr/s
```

Figure 4-31. TDM Physical Layer Screen

Displaying the Ethernet Physical Layer Information

You can view the status of the Ethernet connections at the physical level.

➤ **To display the Ethernet physical layer information:**

1. From the Status menu, select **ETH Physical layer**.

   The Physical Layer screen is displayed (see *Figure 4-32*).

2. From the Physical Layer screen, type **F** to toggle between the available Ethernet interfaces.

```
Monitoring>Status>Eth Physical layer

    Channel                  >   (Network-Eth1)
    Mode                     >   (Full Duplex)
    Rate(Mbps)               >   (100)
    Status                   >   (Connected)




>


F - forward
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-32. ETH Physical Layer Screen

Displaying the Bundle Connection Information

You can display information on the current bundle connection, its connectivity status, collected sequence errors, and statistics for underflows and overflows of the jitter buffer (see *Chapter 6* for details on the bundle statistics).

➤ **To display the bundle connection information:**

1. From the Status menu, select **Connection.**

   The Connection screen is displayed (see *Figure 4-33*).

2. Select **Bundle ID** and enter the number of the bundle whose status you wish to display.

   The Bundle Status screen contains the following information:

   - Connectivity Status:
     - Disabled: No activity in the channel. The channel is disabled.
     - OK: Both the remote and the local IPmux receive Ethernet frames, (however, there may be problems such as sequence errors, underflows, overflows, as explained below).
     - Local Fail: The local IPmux-11 does not receive Ethernet frames.
     - Remote Fail: The remote IPmux-11 does not receive Ethernet frames.
     - Unavailable: The remote IPmux-11 does not reply to OAM messages (only applicable when OAM is enabled).
     - Validation Fail: The remote IPmux-11 replies, but there is a configuration error (only applicable when OAM is enabled).
     - Standby: Redundant bundle is OK and waiting for redundancy switching (only applicable when Redundancy is enabled).
     - TDM Fail: There is LOS/LOF at the TDM side (only applicable when Redundancy is enabled).

Note *When the bundle connection status is Disabled, Local Fail or Remote Fail, the connection counters are disabled.*

- Sequence errors – total number of sequence errors occurred on the bundle
- Jitter buffer underflows – total number of jitter buffer underflows occurred on the bundle
- Jitter buffer overflows – total number of jitter buffer overflows occurred on the bundle.

Note *Sequence Errors, Jitter Buffer Underflows and Jitter Buffer Overflows descriptions are given in Chapter 6.*

```
Monitoring>Status>Connection

    Destination IP address:      (1.1.1.1)
    Next hop MAC address:        (000000000000)

    Connectivity status:     >   (OK)

    Sequence errors:             (0)
    Jitter buffer underflows:    (0)
    Jitter buffer overflows:     (0)

 1. Bundle ID[1 – 1]         ... (1)



>


R - reset counters
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-33. Connection Screen

Displaying the System Clock Information

You can view the status of the active system clock.

➤ **To display the system clock status:**

- From the Status menu, select **System clock**.

```
Monitoring>Status>System clock


   Active clock                  >   (Adaptive)
                                 >   (Channel 1)
ESC-prev.menu; !-main menu; &-exit
```

Figure 4-34. System clock status screen

Transferring Software and Configuration Files

Software and configuration files can be transferred using TFTP.

➤ **To transfer a file using TFTP:**

1. From the Utilities menu, select **File Utilities**.

2. From the **File Utilities**, select **Download/Upload using TFTP**.
3. From the Download/Upload using TFTP menu, configure the following:
   - File name (Name of the file that you intend to transfer)
   - Command (Operation type)
     - No operation
     - Software download
     - Software upload
     - Configuration download
     - Configuration upload
     - Software download And reset
   - Server IP (IP address of the TFTP server)
   - Retry Timeout (Interval between connection retries in seconds).
   - Total Timeout (TFTP connection timeout in seconds)
   - View Transfer Status (Current status of the TFTP transfer)
4. Save the changes.

   IPmux-11 starts file transfer using TFTP.

```
Utilities>File Utilities>Download/upload using TFTP

1. File name                    ... (FILE.IMG)
2. Command                      >   (No operation)
3. Server IP                    ... (0.0.0.0)
4. Retry timeout(sec)[0 - 1000]  ... (1)
5. Total timeout(sec)[0 - 1000]  ... (5)
6. View transfer status         >
>

ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 4-35. Download/Upload Using TFTP Menu

Resetting IPmux-11

IPmux-11 supports two types of reset:

- Reset to the default setting
  - Resetting all parameters
  - Resetting all parameters, except for management values
- Overall reset of the device.

Resetting IPmux-11 to the Defaults

You can reset IPmux-11 to its default settings. The reset to the defaults does not affect the master clock setting. In addition, you can reset local IPmux-11 without affecting its management parameters (IP address, mask and default gateway).

➤ **To reset IPmux-11 to the default settings:**

1. From the System menu (*Figure 4-1*), select **Factory default**.
2. From the Factory Default menu, perform one the following steps:
   - Select **All** to reset all IPmux-11 parameters to the default settings.
   - Select **Except Management** to reset all parameters, except for IP address, mask and default gateway values.

   IPmux-11 displays the following message:
   `Configuration will be lost and System will be reset. Continue ??? (Y/N)`
3. Type **Y** to confirm the reset.

   IPmux-11 performs the requested type of reset.

   Alternatively, you can reset IPmux-11 to the defaults by pressing the SET DEF button on the rear panel.

Resetting IPmux-11

You can perform an overall reset of IPmux-11.

➤ **To reset IPmux-11:**

1. From the Main menu, select **Utilities**.

   The Utilities menu appears (see *Figure 4-36*).
2. From the Utilities menu, select **Reset**.

   A confirmation message appears.
3. Type **Y** to confirm the reset.

```
Utilities
1. File utilities           >
2. Reset
>
Please select item <1 to 2>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 4-36. Utilities Menu

Chapter 5

Configuring IPmux-11 for a Typical Application

This chapter provides detailed instructions for setting up a typical application using two IPmux-11 units.

5.1 Overview

Application

The section provides detailed instructions for configuring two IPmux-11 units operating opposite each other (see *Figure 5-1*).

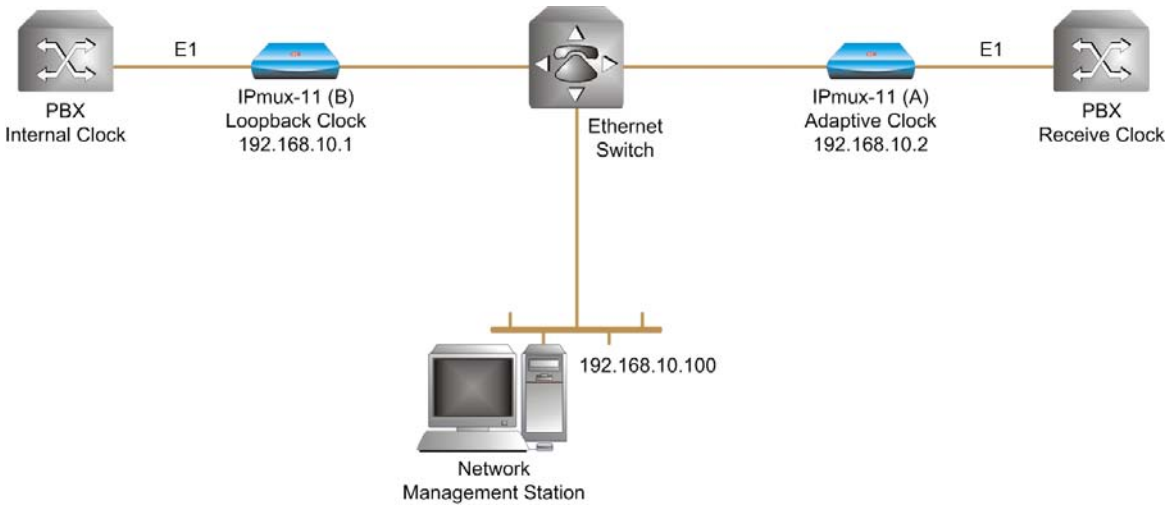

Figure 5-1. Two IPmux-11 Units Operating Opposite Each Other

Guidelines for Configuring IPmux-11 Units

There are four basic configuration steps (described below) that need to be followed when deploying any IPmux unit.

1. IP Configuration – Setting the device host IP address and the manager IP address.
2. Physical layer configuration – Setting the TDM parameters (line type, clocking, etc.) according to the application requirements and topology.
3. Creating bundles – Allocating timeslots to bundles
4. Connecting bundles – Directing the bundles defined above to remote IPmux unit.

Table 5-1. Configuration Summary

Device	E1 Parameters	IP Parameters	Bundle Parameters	Bundle Connection
IPmux-11 (A)	• Transmit clock source: adaptive • Line type: Framed G.704 CRC-4 enabled • CAS: disabled	Host IP address: 192.168.10.2	Bundle 1 Timeslots in bundle: 1–10	Bundle 1 of IPmux-11 (B)
IPmux-11 (B)	• Transmit clock source: Loopback • Line type: Framed G.704 CRC-4 enabled • CAS: disabled	Host IP address: 192.168.10.1	Bundle 1 Timeslots in bundle: 1–10	Bundle 1 of IPmux-11 (A)

5.2 Configuring IPmux-11 Units

This section explains how to configure IPmux-11 units. The configuration procedure is similar for both units, except for defining different host IP addresses, different clocking modes and different destination IP address for the bundle connection. Refer to *Chapter 3* for explanation of how to select management options and save the changes.

Configuring the IP Parameters

➤ **To configure the host IP parameters:**

- Display the Host IP menu (**Configuration** > **System** > **Host IP**), and configure the IP address and mask of the host:
  1. Disable the DHCP mechanism
  2. Save the changes
  3. Set the IPmux-11 (A) host IP address – 192.168.10.2
  4. Set the IPmux-11 (B) host IP address – 192.168.10.1
  5. Save the changes.

```
Configuration>System>Host IP
1. IP address                          ... (192.168.10.2)
2. IP mask                             ... (255.255.255.0)
3. Default gateway                     ... (0.0.0.0)
4. DHCP                                    (Disable)
5. DHCP Status                         >
>
Please select item <1 to 5>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 5-2. Configuring Host IP Parameters for IPmux-11 (A)

➤ **To configure the manager list:**

1. Display the Manager List menu (**Configuration** > **System** > **Management** > **Manager list**), and enter IP parameters for the network manager station:
   - NMS IP address – 192.168.10.100
   - Manager location – Network-Eth1.
2. Save the changes.

```
Configuration>System>Management>Manager list

1. Manager IP address            ... (192.168.10.100)
2. Manager location              >   (Network-Eth1)
3. Link up/down trap                 (Disable)
4. Alarm trap                        (Disable)
5. VLAN tagging                      (Disable)
>
Please select item <1 to 5>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 5-3. Configuring Network Manager

Configuring E1 Parameters at the Physical Layer

➤ **To configure E1 parameters at the physical layer:**

1. Display the TDM (E1) Configuration menu (**Configuration** > **Physical layer** > **TDM (E1)**), and configure the following parameters:
   - IPmux-11 (B) transmit clock source – Loopback
   - IPmux-11 (A) transmit clock source – Adaptive
   - Line type – Framed G.704 CRC.
2. Save the changes.

```
Configuration>Physical layer>TDM (E1)
    Channel ID                (1)
    Restoration time         >(CCITT)
    Signaling mode            (CAS Disabled)
1. Admin status               (Enable)
2. Transmit clock source     >(Adaptive)
3. Rx sensitivity             (Short haul)
4. Trail mode                 (Termination)
5. Line type                 >(Framed G.704 CRC)
6. Idle code[0 - ff]         ... (7E)
7. Send upon fail             (OOS Code)
8. OOS Code[0 - ff]           (FF)
   (N)
>
Please select item <1 to 11>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 5-4. Configuring E1 at the Physical Level for IPmux-11 (A)

Configuring Bundles

➤ **To assign timeslots to a bundle:**

1. Display the Connection menu (**Configuration** > **Connection**), and assign a number 1 to a bundle.
2. Display the DS0 Bundle Configuration menu (**Configuration** > **Connection** > **DS0 bundle**), and assign timeslots 1 to 10 to bundle 1.

```
Configuration>Connection>DS0 bundle configuration

         +1     +2     +3     +4     +5     +6     +7     +8     +9     +10
  TS  0  1      1      1      1      1      1      1      1      1      1
  TS 10  0      0      0      0      0      0      0      0      0      0
  TS 20  0      0      0      0      0      0      0      0      0      0
  TS 30  0

 1. Change cell [0 - 1]           ... (0)
>
Please select item <1 to 1>
E - Enable All; L - Disable All
ESC-prev.menu; !-main menu; &-exit; ?-help                          1 Mngr/s
```

Figure 5-5. Assigning Timeslots to a Bundle

➤ **To connect the bundles:**

1. Display the Bundle Connection Configuration menu (**Configuration** > **Connection** > **Bundle connection**) and configure the following parameters:
   - Destination IP address for IPmux-11 (A) bundle –192.168.10.1
   - Destination IP address for IPmux-11 (B) bundle – 192.168.10.2
   - Connection status – Enable
   - Destination bundle – 1
   - Jitter buffer – 5 msec
   - OAM Enabled.
2. Leave all other parameters with their default values.
3. Save the changes.

```
Configuration>Connection>Bundle connection
1. Destination IP address                    ... (192.168.10.1)
2. Next hop                                  ... (0.0.0.0)
3. IP TOS                                    ... (0)
4. Connection status                             (Enable)
5. Destination bundle [1 - 496]              ... (1)
6. TDM bytes in frame(x48 bytes)             ... (1)
7. Payload format                                (V2)
8. OAM connectivity                              (Enable)
9. Jitter buffer<msec>[3 – 300]              ... (5)
10. VLAN tagging                                 (Disable)
>
Please select item <1 to 10>
ESC-prev.menu; !-main menu; &-exit                          1 Mngr/s
```

Figure 5-6. Connecting the Bundle for IPmux-11 (A)

Chapter 6

Troubleshooting and Diagnostics

This chapter describes how to:

- Monitor performance
- Detect errors
- Handle alarms
- Troubleshoot problems
- Perform diagnostic tests.

6.1 Monitoring Performance

IPmux-11 provides powerful performance monitoring tools, which consist of the following three levels:

- E1/T1 statistics – Status of the physical E1/T1 parameters (signal, framing, etc.)
- LAN statistics – Ethernet connection status (speed, duplex mode, bytes transmitted & received, etc.)
- Bundle connection statistics – TDMoIP bundle connection status on the Ethernet/IP network level.

Displaying E1/T1 Statistics

E1/T1 statistics refer to the physical status of the E1/T1 traffic reaching IPmux-11 from the adjacent E1/T1 device.

The E1 statistics parameters comply with the G.703, G.704, G.804, G.706, G.732, and G.823 standards.

The T1 statistics parameters comply with the ANSI T.403, AT&T R62411, G.703, G.704 and G.804 standards.

E1/T1 statistics are monitored and saved under consecutive intervals. Each interval is 15 minutes long. There are 96 intervals, which represent the last 24 hours. Whenever a new interval is started, the counters are reset to zero. The old interval shows the total of events that occurred during its 15-minute period.
The current active interval is always marked as interval 0 (you will see that the **Time Since** counter is running). The previous interval is marked as 1 and so on.
The E1/T1 statistic counters cannot be reset manually.

➤ **To view the E1/T1 statistics:**

1. From the Monitoring menu (*Figure 6-6*), select **Statistics**.

   The Statistics menu appears.

2. From the Statistics menu, select **Physical Layer**.

   The Physical Layer (E1) or Physical Layer (T1) screen appears (see *Figure 6-1*).

3. Select **Interval**, enter the number of the interval whose statistics you wish to display, and press **Enter**

   or

   Type **<** (**Shift**+.) to scroll backward or **>** (**Shift**+**,**) to scroll forward through the available intervals.

```
Monitoring>Statistics>Physical layer (E1)

    Channel ID              (1)
    LOS:                    (0)             DM:                     (0)
    LOF (Red):              (0)             ES:                     (0)
    LCV:                    (0)             SES:                    (0)
    RAI (Yellow):           (0)             UAS:                    (0)
    AIS:                    (0)             LOMF:                   (0)
    FEBE:                   (0)
    BES:                    (0)

    Time Since (sec):       (366)           Valid Intervals:        (96)
 1. Interval            ... (0)


>
< - Prev Interval; > - Next Interval
ESC-prev.menu; !-main menu; &-exit                                  2 Mngr/s
```

Figure 6-1. E1/T1 Statistics

Table 6-1. E1/T1 Statistics

Alarm	Description
LOS	Number of seconds with Loss of Signal. A Loss of Signal indicates that there is either no signal arriving from the adjacent E1/T1 device or no valid E1 voltage mask or no voltage alteration between positive and negative amplitudes. For E1 links, the LOS counter will increase by one for each second during which a consecutive 255 pulses have no pulse of negative or positive polarity. For T1 links, the LOS counter will increase by one for each second during which a consecutive 192 pulses have no pulse of negative or positive polarity. A LOS alarm is also indicated by the front panel E1/T1 SYNC LED (red). The green E1/T1 SYNC LED indicates that the E1/T1 synchronization has been restored). Recommendations: Check the physical layer (connectors, cables, etc.)
LOF (Red)	Number of seconds with Loss of Frame. A Loss of Frame indicates a second that IPmux-11 lost E1/T1 synch opposite its adjacent E1/T1 device. In more detail, this is a period of 2.5 seconds for T1 or 100 msec for E1, during which an OOF (Out Of Frame) error persisted and no AIS errors were detected. For E1 links an OOF defect is declared when three consecutive frame alignment signals have been received with an error. For T1 links, an OOF defect is declared when the receiver detects two or more framing errors within a three msec period for ESF signals and 0.75 msec for D4 signals, or two or more errors out of five or fewer consecutive framing-bits. A LOF alarm is also indicated by the front panel E1/T1 SYNC LED (red). When the IPmux enters a red alarm condition, it sends an Yf bit (yellow alarm or RAI) towards the adjacent E1/T1 device. Recommendations: Check all framing related parameters for E1/T1, and physical connections.
LCV	Number of seconds with Line Code Violations. A Line Code Violation indicates an error on the pulse structure, either a **Bipolar Violation (BPV)** or an **Excessive Zeros (EXZ) error event**. BPV is the occurrence of a pulse with the same polarity as the previous pulse. EXZ is the occurrence of a zero string greater than 15 for AMI or 7 for B8ZS. For an E1 link, the LCV counter will increase by one, for each second during which a BPV or EXZ errors have occurred. For T1 links, the LCV counter will increase for each second during which two consecutive BPVs of the same polarity are received. Complies with ITU-TI.431, 0.161, G775 and G.821 standards. Recommendations: Check physical link for bad/loose connection, impedance matching (balanced or unbalanced) and noisy environment.

Table 6-1. E1/T1 Statistics (Cont.)

RAI (Yellow)	Number of seconds with Remote Alarm Indicators. A Remote Alarm Indicator is sent by a device when it enters RED state (loses sync). **RAI Alarm** indicates that the adjacent E1/T1 device had lost E1/T1 synch and hence sent an RAI towards the IPmux, which entered a Yellow alarm mode (similarly, IPmux sends RAI towards adjacent E1/T1 when IPmux enters LOF state (Red alarm). In both E1/T1 links the RAI counter increases by one for each second during which an RAI pattern is received from the far end framer. The RAI alarm is also indicated by the front panel ALM LED (red). Recommendations: Check reason for E1/T1 device to be in LOF (out of synch state) by checking physical link integrity at the Tx direction of the IPmux towards E1/T1 device and framing related parameters.
AIS	Number of seconds with Alarm Indication Signals. An Alarm Indication Signal implies an upstream failure of the adjacent E1/T1 device. AIS will be sent to the opposite direction of which the Yellow alarm is sent. For E1 links, the AIS counter will increase by one for each second during which a string of 512 bits contains fewer than three zero (0) bits. For T1 links, the AIS counter will increase by one for each second during which an unframed “all 1” signal is received for 3 msec. The AIS condition is indicated by the front panel E1/T1 SYNC LED (red). Recommendations: Check why the E1/T1 device is sending AIS (all ones) stream towards IPmux, for example, Red alarm on a different interface of E1/T1 device (upstream).
FEBE	Number of seconds with Far End Block Errors. The FEBE is sent to transmitting device notifying that a flawed block has been detected at the receiving device. Exists only for E1 MF-CRC4. The FEBE alarm is also indicated by the front panel ALM LED (red). The FEBE counter will increase by one for each second during which the FEBE indication is received. Recommendation: Check physical link integrity.
BES	Bursty Errored Seconds (also known as Errored seconds type B) are seconds during which fewer than 319 and more than one CRC errors occurred with neither AIS nor SEF (Severely Errored Frames) detected. The BES counter will increase by one for each second containing the condition described above. The CRC is calculated for the previous frame in order to prevent processing delay. Complies with AT&T TR-62411 and TR-54016 standards. Not applicable if the line type is set to Unframed. Available only at T1-ESF or E1-CRC4 modes (performance monitoring functionality). Recommendations: Check physical link integrity, G.704 frame format integrity and Sync. (The CRC bits are included in TS0 for E1 multiframe links and in the frame alignment bits for T1 ESF links).
DM	A Degraded Minute is calculated by collecting all the available seconds, subtracting any SES and sorting the result in 60-second groups. The DM counter will increase by one for each 60-second group in which the cumulative errors during the 60-second interval exceed 1E-6. Available in T1-ESF or E1-CRC4 modes only, (performance monitoring functionality). Recommendations: See BES recommendations.

Table 6-1. E1/T1 Statistics (Cont.)

Alarm	Description
ES	An Errored Second is a second containing one or more of the following: • CRC error • SEF (OOF) • AIS (T1 only) • If SES is active ES runs for 10 seconds and then stops. Recommendations: Check physical link integrity. Follow the recommendation concerning LOF, BEF and AIS.
SES	A Severely Errored Second is a second containing one of the following: • 320 or more CRC errors events • One or more OOF defect • One or more AIS events occurred (T1 only) • The SES counter will be cleared after reaching 10 and an UAS will then be activated. Recommendations: Check physical link integrity. See also ES alarm recommendation.
UAS	Unavailable Second parameter refers to the number of seconds during which the interface is unavailable. The UAS counter will start increasing after 10 consecutive SES occurrences and will be deactivated as a result of 10 consecutive seconds without SES. After SES clearance the UAS counter will then diminish 10 seconds from the overall count. Recommendations: See above recommendations.
LOMF	Number of seconds of Loss of Multi Frame. A Loss of Multi Frame indicates a second with no sync on the multi frame mode, i.e., the receiving device is unable to detect the four ABCD bits pattern on. The LOMF alarm is also indicated by the front panel ALM LED (red). TS16 MSB in frame 0 for two consecutive multiframes. Available only for E1 multiframe mode (CAS). Recommendations: Check physical link integrity, signaling method (CAS enable only), and framing-related parameters.

Displaying LAN Statistics

You can display statistic data for the network and user Ethernet ports.

➤ **To view the LAN statistics:**

1. From the Statistics menu, select **Bridge**.

   The Bridge screen appears (see *Figure 6-2*).

2. From the Bridge screen, type **F** to toggle between network and user interfaces. *Table 6-2* describes the LAN statistics data.

3. Type **R** to reset the counters.

```
Monitoring>Statistics>Bridge
    Channel        >   (User1-Eth2)
    Frames Received                          Frames Transmitted
    Total Frames:      (0)                   Correct Frames:    (0)
    Total Octets:      (0)                   Correct Octets:    (0)
    Oversize Frames    (0)                   Collisions:        (0)
    Fragments:         (0)
    Jabber:            (0)
    Dropped Frames:    (0)
    CRC Errors:        (0)
>
F - forward; R - reset counters
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-2. LAN Statistics

Table 6-2. LAN Statistics Parameters

Parameter	Description
Frames Received	
Total Frames	The total number of correct frames received. When a valid connection is established the number should increase steadily.
Total Octets	The total number of octets (bytes) received. When a valid connection is established the number should increase steadily.
Oversize Frames	Number of frames exceeding the maximum allowed frame size, but are otherwise valid Ethernet frames (good CRC).
Fragments	The number of frames that are shorter than 64 bytes and have an invalid CRC.
Jabber	The number of frames that are too long and have an invalid CRC. A jabber is transmission by a data station beyond the time interval allowed by the protocol, usually affecting the rest of the network. In an Ethernet network, devices compete for use of the line, attempting to send a signal and then retrying in the event that someone else tried at the same time. A jabber can look like a device that is always sending, effectively bringing the network to a halt. Recommendations Check network interface card or any other transmitting devices and external electrical interference.
Dropped Frames	Number of dropped frames due to delivery problems. Recommendations: Check the network interface card.
CRC Errors	The amount of frames with invalid CRCs.
Frames Transmitted	
Correct Frames	The number of frames successfully transmitted. When a valid connection is established the number should increase steadily.
Correct Octets	The number of octets successfully transmitted. When a valid connection is established the number should increase steadily.
Collisions	The number of successfully transmitted frames which transmission is inhibited by a collision event. A collision occurs in half-duplex connection when two devices try to transmit at the same time. This counter tracks the number of times frames have collided. This event exists only in half duplex mode, which is not recommended in an IPmux-11 application. Recommendations: Many collisions indicate that the traffic is too heavy for a half duplex media. Set to a full duplex environment if possible.

Displaying Bundle Connection Statistics

The Connection screen provides information about the integrity of the TDMoIP connection, including the jitter buffer statistics. (Each bundle has it own independent jitter buffer).

➤ **To display the bundle connection information:**

1. From the Monitoring menu, select **Statistics**.

   The Statistics menu appears.

2. From the Statistics menu, select **Connection**.

   The Connection screen is displayed (see Figure 6-3).

3. Select **Bundle ID**, enter the number of the bundle whose statistics you wish to display, and press **Enter.**

4. Select **Interval**, enter the number of the interval whose statistics you wish to display, and press **Enter.**

   or

   Type **<** (**Shift**+.) to scroll backward or **>** (**Shift**+**,**) to scroll forward through the available intervals.

```
Monitoring>Statistics>Connection

   Sequence errors:                        ... (0)
   Jitter buffer underflows:               ... (580)
   Jitter buffer overflows:                ... (0)
   Max Jitter buffer deviation [msec]:     ... (5)

   Time since [sec]:                           (580)

 1. Bundle ID[1 - 128]                     ... (33)
 2. Interval                               ... (0)




>

F - Forward Bundle ID; < - Prev Interval; > - Next Interval
ESC-prev.menu; !-main menu; &-exit                              2 Mngr/s
```

Figure 6-3. Connection Statistics Screen

Table 6-2. Bundle Connection Parameters

Parameter	Description
Sequence Errors	The number of seconds with at least one sequence error since the last clear. Each packet transmitted by IPmux-11 holds a sequence number. The receiving IPmux-11 checks these numbers at the receive mechanism and expects to see that each new incoming packet is "in sequence" relative to the previous one (i.e., packet no. 5 is received after no. 4). When, for some reason, this is not the case (i.e., next packet is not in sequence relative to the previous one), this means that there had been a problem with packet flow integrity (and hence data/voice integrity). IPmux will indicate this by increasing the "Sequence Errors" counter by one. There may be two reasons for a Sequence Error notification: Packet or packets are lost somewhere along the network. Re-ordering of packets by network. Packet re-ordering may occur due to queuing mechanisms, re-routing by the network, or when the router updates very large routing tables. Recommendations: • Make sure IPmux-11 traffic has sufficient bandwidth. See *Chapter 1* for throughput calculation. • Make sure Ethernet connection is functioning properly. (See *Displaying LAN Statistics* on page 6-5.) • Make sure Ethernet/IP network provides priority (Quality Of Service) to the IPmux traffic. Priority may be achieved by three means: VLAN tagging, IP TOS marking or by using the constant 2142 decimal value at the "UDP destination Port" field of each TDMoIP packet. • Verify that the IP network devices (switches/routers/modems/etc.) are capable of handling the IPmux PPS rate (Packets Per Second). • Make sure the network devices do not drop/lose/ignore packets. ***Note**: IPmux-11 may support a "reordering mechanism", which can sort packets back to their original order in some situations.*

Table 6-2. Bundle Connection Parameters (Cont.)

Parameter	Description
Jitter Buffer Underflows	The number of seconds with at least one jitter buffer underflow event since the last clear. IPmux-11 is equipped with a "Packet Delay Variation Tolerance" buffer, also called a "jitter buffer", responsible for compensating for IP networks delay variation (IP jitter). The jitter buffer is configured in milliseconds units and exists for each bundle independently. Explanation: Packets leave the transmitting IPmux-11 at a constant rate, but the problem is that they are reaching the opposite IPmux-11 at a rate which is NOT constant, due to network delay variation (caused by congestion, re-routing, queuing mechanisms, wireless media, half-duplex media, etc.). The TDM devices at both ends require a constant flow of data, so they can't tolerate delay variation. Therefore the jitter buffer is required in order to provide the TDM equipment with a synchronous and constant flow. This is done as follows: • Upon startup, the jitter buffer stores packets up to its middle point (the number of packets correlates to the buffer's configured depth in milliseconds). Only after that point it starts outputting the E1/T1 flow towards its adjacent TDM device. The stored packets assure that the TDM device will be fed with data even if packets are delayed by the IP network. Obviously, if packets are delayed too long, then the buffer is gradually emptied out until it is underflowed. This situation is called buffer starvation. Each underflow event increases the jitter buffer underflow counter by one and indicates a problem in the end-to-end voice/data integrity. The second functionality of the jitter buffer is that in adaptive mode the jitter buffer is also a part of a mechanism being used to reconstruct the clock of the far end TDM side. An underflow situation can be a cause of: • Buffer starvation: Packets delay variation causes the buffer to empty out gradually until it is underflowed. • Continuous Sequence Errors. The sequence error means a halt in the valid stream of packet arrival into the jitter buffer. • Packets are being stopped/lost/dropped. • Too small jitter buffer configuration that can't compensate for the network delay variation. • When all system elements are not locked on the same master clock, it will lead to a situation in which data is clocked out of the jitter buffer at a rate different from the one it is clocked into. This will gradually result in either an overflow or underflow event, depending on which rate is higher. The event will repeat itself periodically as long as the system clock is not locked. • When an overflow (see below) situation occurs, IPmux-11 instantly flushes the jitter buffer, causing a forced underflow. So when you need to calculate the real underflow events and not the self-initiated ones, subtract the number of overflows from the total number of underflows counted by the device. Recommendations: • Try increasing the jitter buffer size. • Check reasons for sequence errors or lost/dropped packets (if present), system clocking configuration, Ethernet environment (full duplex) and connection, packets drop/loss/ignore by routers/switches or non-uniform packets output by routers/switches due to queuing mechanisms. • Make sure the same amount of TS for bundle is configured on each side of the IPmux-11 application, and that the "TDM bytes in frame" parameter is identical in both IPmux-11 units. Make sure Ethernet/IP network provides priority (Quality Of Service) to the IPmux-11 traffic. Priority may be achieved by three means: VLAN tagging, IP TOS marking or by using the constant 2142 decimal value at each IPmux "UDP destination Port" field.

Table 6-2. Bundle Connection Parameters (Cont.)

Parameter	Description
Jitter Buffer Overflows	The number of seconds with at least one jitter buffer overflow event since the last clear. Explanation: In steady state, the jitter buffer is filled up to its middle point, which means it has the space to hold an additional similar quantity of packets. Overflow is opposite phenomenon of the Underflow, i.e., when a big burst of packets reaches the IPmux (a burst with more packets than the Jitter Buffer can store), the buffer will be filled up to its top. In this case, an unknown number of excessive packets are dropped and hence IPmux initiates a forced underflow by flushing (emptying) the buffer in order to start fresh from the beginning. An overflow situation always results in an immediate Underflow, forced by the IPmux. After the buffer is flushed, the process of filling up the buffer is started again, as explained above ("Underflow" section). An overflow situation can be a cause of: • A big burst of packets, filling up the buffer completely. The burst itself can often be a cause of some element along the IP network queuing the packets and then transmitting them all at once. • Too small jitter buffer configuration. • When system isn't locked on the same clock, it will lead to a situation in which data is clocked out of the jitter buffer at a rate different from the one it is clocked into. This will gradually result in either an overflow or underflow event, depending on which rate is higher. The event will repeat itself periodically as long as the system clock is not locked. Recommendations: Check network devices and try increasing jitter buffer configuration. Check system's clocking configuration • Make sure the same amount of TS for bundle is configured on each side of the IPmux-11 application, and that the "TDM bytes in frame" parameter is identical in both IPmux-11 units
Max Jitter Buffer Deviation	The maximum jitter buffer deviation (msec) in the interval (300 sec). This is the maximum jitter level IPmux-11 had to compensate for in the selected interval.
Time Since (sec)	The time elapsed, in seconds, since the beginning of the selected interval.

6.2 Detecting Errors

Power-Up Self-Test

IPmux-11 performs hardware self-test upon turn-on. The self-test sequence checks the critical circuit functions of IPmux-11 (framer and bridge). The self-test results are displayed via the Diagnostics menu.

➤ **To display the self-test results:**

1. From the Main menu, select Diagnostics.
   The Diagnostics menu appears (see *Figure 6-4*).
2. From the Diagnostics menu, select **Self Test Results**.
   The Self Test Results screen appears (see *Figure 6-5*).

```
Diagnostics

1. Ping               >
2. Loopback           >
3. Trace route        >
4. Self Test Results  >

>

Please select item <1 to 4>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 6-4. Diagnostics Menu

```
Diagnostics>Self Test Results

1. Framer Test (Pass)
2. Bridge Test (Pass)

>

Please select item <1 to 2>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 6-5. Self Test Results Screen

Using Front Panel LEDs

LED indicators on the front panel IPmux-11 indicate the operating status of the module. The LED indicators are described in *Chapter 3* of this manual.

Working with the Event Log

IPmux-11 maintains an Event Log file, which can hold up to 2048 events. All events are time-stamped.

Displaying Events

➤ **To access the event log:**

1. From the Main menu, select Monitoring.
   The Monitoring menu is displayed (see *Figure 6-6*).
2. From the Monitoring menu, select **Event Log**.
   The Event Log menu is displayed (see *Figure 6-7*).
3. From the Event Log menu, select **Read log file**.
   The Read Log File screen appears (see *Figure 6-8*).
4. In the Read Log File screen, use the **<Ctrl>** + **<U>** and **<Ctrl>** + **<D>** key combinations to scroll the alarm list up and down.

```
Monitoring

1. Statistics          >
2. Status              >
3. Event Log           >

>

Please select item <1 to 3>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-6. Monitoring Menu

```
Monitoring>Event log

1. Read log file       []
2. Clear log file
3. Update bundle connection events                  (Every 1 min)
4. Bundle connection events threshold[1 - 100]  ... (5)

>

Please select item <1 to 4>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-7. Event Log Menu

```
Monitoring>Event Log>Read log file

  Index                 Log entry
     30  2004-01-22  18:20:03 LOGIN VIA TERMINAL
     29  2004-01-22  18:02:13 UAS START              TDM SLOT  CH 1
     28  2004-01-22  18:02:03 LOS START              TDM SLOT  CH 1
     27  2004-01-22  18:02:03 COLD START
     26  2004-01-22  17:56:48 UAS START              TDM SLOT  CH 1
     25  2004-01-22  17:56:38 LOS START              TDM SLOT  CH 1
     24  2004-01-22  17:56:38 COLD START


>

^D - scroll down, ^U - scroll up
ESC-prev.menu; !-main menu; &-exit; ?-help                          1 Mngr/s
```

Figure 6-8. Read Log File

Table 6-3 presents the event types that appear in the event log alphabetically, as well as the actions required to correct the event (alarm) indication.

To correct the reported problem, perform corrective actions in the given order until the problem is corrected. If the problem cannot be fixed by carrying out the listed actions, IPmux-11 must be checked by the authorized technical support personnel.

Table 6-3. Event List

Event	Description	Corrective Action
COLD START	IPmux-11 has been powered up	None
CON LOCAL FAIL	Ethernet frames are not received by the local IPmux-11 on the specified connection	Check Eth/IP path
CON REMOTE FAIL	Ethernet frames are not received by the remote IPmux-11 on the specified connection	Check Eth/IP path
CON STANDBY	Redundancy bundle connection is not the active connection (only applies when redundancy is used)	None
CON TDM FAIL	LOS/LOF on the TDM line forced redundancy switching (only applies when redundancy is used)	Check the TDM line
CON SYNC	Bundle connection failure has ended (only applicable when OAM is Enabled)	None
CON UNAVAILABLE	Remote IPmux is not available (only applicable when OAM is Enabled)	Check the connection of the remote IPmux
CON VALIDATION FAIL	Connection is invalid (only applicable when OAM is Enabled)	Check the bundle parameters
FATAL ERROR	IPmux-11 has encountered an internal fatal error	The IPmux-11 requires servicing
INVALID LOGIN VIA TERMINAL	Invalid user name or password was entered, when attempting to access IPmux-11 via local terminal	None
INVALID LOGIN VIA WEB	Invalid user name or password was entered, when attempting to access IPmux-11 via Web browser	None
INVALID LOGIN VIA TELNET	Invalid user name or password was entered, when attempting to access IPmux-11 via Telnet	None
IP x.x.x.x ASSIGNED BY SERVER x.x.x.x	The current IP address was assigned the IPmux-11 host by DHCP server	None
IP x.x.x.x IS RELEASED	The current IP address was released by IPmux-11	None
JIT BUF OFLOWS END BUNDLE 1	Jitter Buffer Overflows END (see *Configuring the Bundle Statistics Collection* below)	–
JIT BUF OFLOWS START BUNDLE 1	Jitter Buffer Overflows START (see *Configuring the Bundle Statistics Collection* below)	Increase jitter buffer size
JIT BUF UFLOWS END BUNDLE 1	Jitter Buffer Underflows END (see *Configuring the Bundle Statistics Collection* below)	–
JIT BUF UFLOWS START BUNDLE 1	Jitter Buffer Underflows START (see *Configuring the Bundle Statistics Collection* below)	Increase jitter buffer size

Table 6-3. Event List (Cont.)

Event	Description	Corrective Action
LINE AIS END	Line AIS state detected has ended	None
LINE AIS START	IPmux-11 has AIS (alarm indicator signal) state on its E1/T1 port	Check for a fault at the PDH network, on the receive direction
LINE FEBE END	LINE FEBE state detected has ended	None
LINE FEBE START	IPmux-11 has LINE FEBE state on its E1/T1 port	Check for errors in the E1/T1 connection on the transmit direction
LINE RAI END	LINE RAI state detected has ended	None
LINE RAI START	IPmux-11 has LINE RAI (remote alarm indication) state on its E1/T1 port	Check for a fault at the E1/T1 connectivity on the transmit direction
LOGIN VIA TERMINAL	The unit was accessed via local terminal	None
LOGIN VIA WEB	The unit was accessed via Web browser	None
LOGIN VIA TELNET	The unit was accessed via Telnet	None
LOF START	IPmux-11 has a LOF (loss of frame) state on its E1/T1 port	1. Check the E1/T1 cable connection 2. Check all framing-related parameters for E1/T1 interface
LOF END	LOF state detected has ended	None
LOS END	LOS state detected has ended	None
LOS START	IPmux-11 has a LOS (loss of signal) state on its E1/T1 port	1. Check the E1/T1 cable connection 2. Check input signal
PS ACTIVE	IPmux-11 power supply unit is powered on	None
SN ERRORS END BUNDLE 1	Sequence Number ERRORS END (see *Configuring the Bundle Statistics Collection* below)	–
SN ERRORS START BUNDLE 1	Sequence Number ERRORS START (see *Configuring the Bundle Statistics Collection* below)	• Check the Ethernet/IP network • Increase jitter buffer size
SYSTEM USER RESET	The user initiated software reset via the system menu	None
UAS START	Ten consecutive severely errored seconds were detected	Check physical interface connections.
UAS END	Ten consecutive seconds without SES were detected	

Clearing Events

➤ **To clear the event log:**

1. From the Event Log menu, select Clear log file.

   IPmux-11 displays the following message:
   Logfile will be cleared. Continue ??? (Y/N)

2. Type **Y** to confirm the log file clearing.

Configuring the Bundle Statistics Collection

You can set the interval for the bundle statistics collection, as well the statistics threshold.

➤ **To configure the bundle statistic collection:**

- From the Event Log menu (*Figure 6-7*), configure the following:
  - Update bundle connection events: **1 sec**, **1 min**
  - Bundle connection events threshold (a number of events that cause the alarm to be initiated): **1**–**100**.

6.3 Handling Alarms

Masking Alarms

You can mask any IPmux-11 alarm to prevent it from being reported to the management stations.

➤ **To mask alarms:**

1. From the Management menu, select **Alarm trap mask**.
   The Alarm Trap Mask menu appears (see *Figure 6-9*).
2. From the Alarm Traps Mask menu, select **Alarm ID** to choose alarm that you intend to mask:
   - alarmLOS
   - alarmLOF
   - alarmAIS
   - alarmRDI
   - alarmFEBE
   - alarmExtClk
   - bundleConnectionStatus.

Note *List of the alarm traps can be displayed by typing **H**.*

3. Select **Trap Status** to enable or disable masking of the selected alarm.

```
Configuration>System>Management>Alarm trap mask

Active alarm traps:                >   (-)
1. Alarm ID <use 'help'>[1 - 40]      ... (39)
2. Trap status                           (Masked)
>
Please select item <1 to 2>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-9. Alarm Trap Mask Menu

6.4 Troubleshooting

The following table presents the event types as they appear on the Event Log File and lists the actions required to correct the event (alarm) indication.

Table 6-4. IPmux-11 Troubleshooting Chart

Fault	Probable Cause	Remedial Action
E1/T1 equipment connected to IPmux-11 is not synchronized with IPmux-11.	Configuration or physical layer problems	1. Check cables and physical connectivity. 2. Check IPmux-11 E1/T1 configuration and, if necessary, other IPmux-11 parameters. 3. Check E1/T1 physical connection (use loopbacks).
Slips and errors in E1/T1 equipment	• Ethernet port in switch and IPmux-11 are not in the same rate or duplex mode • Ethernet port is set to work in half duplex mode (may cause extreme PDV because of collisions and backoffs) • Timing configuration is not properly set (periodic buffer under/overflows shown on IP channel status menu) • Network PDV or lost frames	1. Check E1/T1 physical connection (use loopbacks). 2. Check timing settings according to explanation in this manual. 3. Check switch and IPmux-11 port configuration (negotiation, rate, duplex mode). 4. Check PDV introduced by the network, and, if necessary, increase PDVT jitter buffer setting..
Echo in voice	High delay in voice path	1. Check network delay and try to decrease it. 2. Try to decrease PDVT (jitter) buffer.

6.5 Testing IPmux-11

Diagnostic capabilities of IPmux-11 include:

- External loopbacks
- Inband remote loopbacks for T1 lines
- Internal loopbacks
- Pinging IP hosts
- Running a trace route.

Running Loopbacks

Running External Loopback

IPmux-11 can be set to start an external loopback to test the connection between the E1/T1 port and the PBX. In this mode, data coming from the PBX is both looped back to the PBX and transmitted forward to the IP network (see *Figure 6-10*).

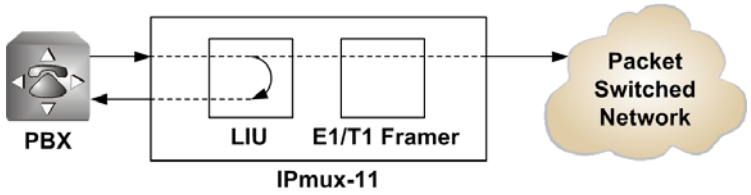

Figure 6-10. External Loopback

Running Internal Loopback

The E1/T1 module can be set to start an internal loopback to test the connection between the E1/T1 port and the IP network. In this mode, data coming from the IP network is both looped back to the IP network and transmitted forward to the PBX connected to the E1/T1 port (see *Figure 6-11*).

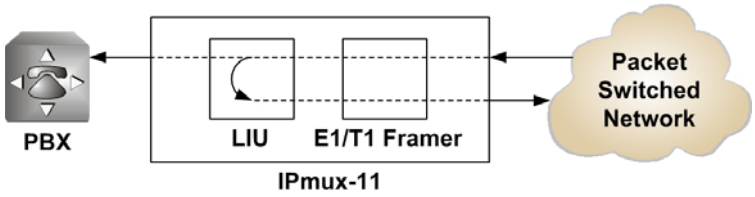

Figure 6-11. Internal Loopback

➤ **To run a loopback:**

1. From the Diagnostics menu (*Figure 6-4*), select **Loopback**.
   The Loopback menu is displayed (see *Figure 6-12*).
2. From the Loopback menu, type **F** to select the E1/T1 link that you intend to test.
3. From the Loopback menu, select **Loopback state**, and choose loopback that you intend to run (Internal or External).

```
Diagnostics>Loopback
Channel ID                  (1)

1. Loopback State           > (External)


>


F - Forward
Please select item <1 to 1>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-12. Loopback Menu

➤ **To disable a loopback:**

- From the Loopback menu, select **Loopback state**, and set it to **Disable**.

➤ **To display the diagnostic loopback status:**

- From the Status menu, select **Diagnostics loopback**.

```
Monitoring>Status>Diagnostics loopback

    Channel ID              (1)             Loopback state:     >   (Disable)









>


ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-13. Diagnostic Loopback Screen

Activating T1 Inband Loopbacks

T1 physical loopbacks can be activated by receiving a loopback activation code from TDM equipment connected to the T1 port. When IPmux-11 receives a loopback activation code, it closes an external loopback (see *Figure 6-14*), or translates the TDM-based loopback activation code into the packet-based pattern and sends it to the opposite IPmux device, which closes an internal loopback (see *Figure 6-15*).

The inband loopback can be activated only if the OAM connectivity is enabled and only one bundle is configured for each port of the device.

An inband loopback is deactivated automatically, if:

- TDM connection is down
- Ethernet connection is down
- The user activated an internal or external loopback manually.

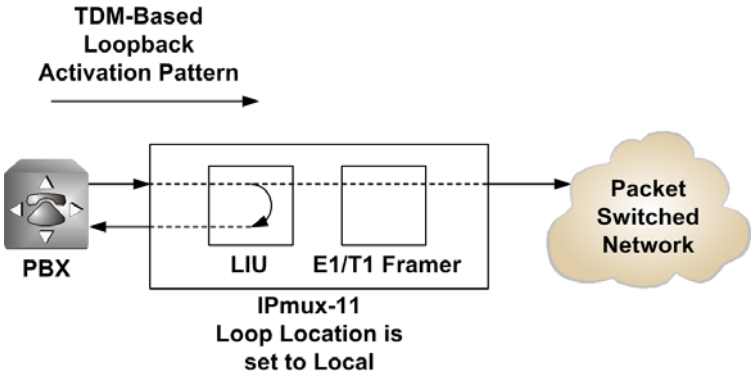

Figure 6-14. T1 Inband Loopback Performed by Local IPmux-11

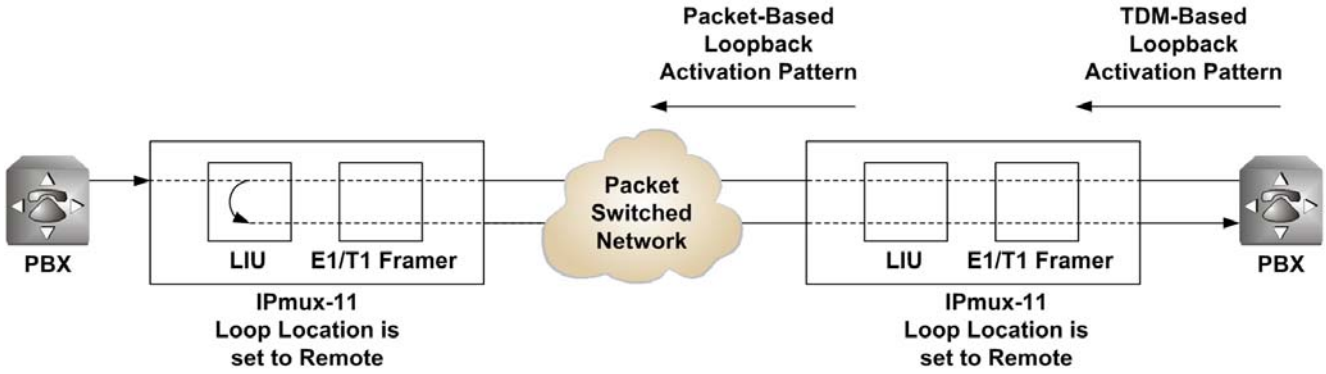

Figure 6-15. T1 Inband Loopback Performed by Remote IPmux-11

➤ **To activate an inband loopback:**

- From the Inband Loop Detection menu (Diagnostics > Loopback > Inband Loop Detection), perform the following:
  - Select **Loop Location** and set it as follows:
    - Local System (External loopback is activated in the local IPmux-11)
    - Remote System (Internal loopback is activated in the remote IPmux-11)
    - Disable (IPmux-11 ignores inband activation code).

- Define loop-up code length (Length of the code to be sent by the TDM device in order to activate a loopback)
- Define loop-up code (Code to be sent by the TDM device in order to activate a loopback)
- Define loop-down code length (Length of the code to be sent by the TDM device in order to deactivate a loopback)
- Define loop-up code (Code to be sent by the TDM device in order to deactivate a loopback).

```
Diagnostics>Loopback (T1)>Inband Loop Detection

1. Loop Location                > (Local System)
2. Loop up length[1 - 8]        ... (5)
3. Loop up code[Hex]            ... (10)
4. Loop down length[1 - 8]      ... (3)
5. Loop down code[Hex]          ... (4)


>
Please select item <1 to 5>
ESC-prev.menu; !-main menu; &-exit                              1 Mngr/s
```

Figure 6-16. Inband Loop Detection Menu

Pinging IP Hosts

You can ping a remote IP host to check the IPmux-11 IP connectivity.

➤ **To ping an IP host:**

1. From the Diagnostics menu (*Figure 6-4*), select **Ping**.
   The Ping menu appears (see *Figure 6-17*).
2. From the Ping menu, configure the following:
   - Destination IP Address (IP address of the host that you intend to ping): 0.0.0.0 to 255.255.255.255.
   - VLAN Tagging:
     - Enable (VLAN tagging is enabled)
     - Disable (VLAN tagging is disabled)
   - VLAN ID: 1–4095
   - VLAN Priority: 0–7

Note *The VLAN ID and VLAN Priority configuration is available only if the VLAN tagging is enabled.*

   - Number of frames to send: **1–4.**
3. Select **Ping** to start sending pings.

```
Diagnostics>Ping

1. Destination IP address             ... (0.0.0.0)
2. VLAN tagging                           (Enable)
3. VLAN ID[1 - 4095]                  ... (0)
4. VLAN priority[0 - 7]               ... (0)
5. Number of frames to send[1 - 4]    ... (1)
6. Ping send

>

Please select item <1 to 6>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-17. Ping Menu

Running a Trace Route

You can run a trace route to a remote IP host to check the IPmux-11 IP connectivity.

➤ **To run a trace route to an IP host:**

1. From the Diagnostics menu (*Figure 6-4*), select **Trace route**.

   The Trace route menu appears (see *Figure 6-18*).

2. From the Trace route menu, configure the following:
   - Destination IP Address (IP address of the host to which you intend to trace the route): 0.0.0.0 to 255.255.255.255.
   - VLAN Tagging:
     - Enable (VLAN tagging is enabled)
     - Disable (VLAN tagging is disabled)
   - VLAN ID: 1–4095
   - VLAN Priority: 0–7

Note *The VLAN ID and VLAN Priority configuration is available only if the VLAN tagging is enabled.*

3. Select **Trace route send** to start the trace route.

```
Diagnostics>Trace route

1. Destination IP address              ... (0.0.0.0)
2. VLAN tagging                            (Enable)
3. VLAN ID[1 - 4095]                   ... (1)
4. VLAN priority tag [0 - 7]           ... (0)
5. Trace route send

>

Please select item <1 to 5>
ESC-prev.menu; !-main menu; &-exit                                  1 Mngr/s
```

Figure 6-18. Trace route Menu

6.6 Frequently Asked Questions

Q: How does the IPmux handle/propagate alarms on the TDM and Ethernet side?

A: The IPmux handles alarms on the TDM and Ethernet side in the following manner:

TDM side alarms
Unframed mode:

- In case of LOS (Loss Of Signal) on the local IPmux side, AIS will be sent towards the IP side, and will then be transferred over the E1/T1 to the remote TDM device.
- All other alarms sent from the near-end TDM device (including information on timeslot 0), will be propagated transparently by the local IPmux, to the remote end TDM device (over the IP connection).

Framed mode:

In case of LOS/LOF/AIS detected on the local IPmux side, a user-configurable conditioning pattern (00 to FF) will be sent on the relevant timeslots (over the IP connection), to the far-end TDM device. A user-configurable conditioning pattern can also be applied on the ABCD bits (CAS signaling 1 to F) going towards the remote PBX.
The frame synch on the E1/T1 level is maintained in favor of the end TDM devices.

Ethernet Side Alarms
Unframed mode:
In case of local failure on the IPmux, or a situation of jitter buffer underflow/overflow, an (unframed) AIS will be sent towards the near-end TDM side.

Framed mode:
In case of local failure on the IPmux, or situation of jitter buffer underflow/overflow, a conditioning pattern (00 to FF) will be sent towards the near-end TDM device on the timeslots related to that specific bundle. A user-configurable conditioning pattern can also be applied on the ABCD bits (CAS signaling 1 to F), going towards the local TDM device.
In this case the synch on the E1/T1 level is maintained in favor of the TDM end devices.

Q: How can I ensure the IPmux TDMoIP traffic priority over an IP Ethernet network?

A: The IPmux units offer three different methods of the TDMoIP traffic prioritization over an IP/Ethernet network:

- VLAN ID (Layer 2)
- ToS field (Layer 3)
- UDP destination port (Layer 4).

Each QoS feature is based on a different OSI level and can be used individually in order to ensure the TDMoIP traffic priority. When determining which feature to use, it is important to verify that the different elements on the network, (Switches / Routers / etc.), support the selected priority mechanism and are also configured to give the highest priority to the labeled IPmux traffic.
Notice that the priority is given to the TDMoIP traffic by the network elements and the IPmux is merely tagging the packets.

VLAN ID
The IPmux complies with the IEEE 802.1p&Q standards. This enables the user to set both VLAN ID and VLAN Priority. It adds four bytes to the MAC layer (Layer 2) of the Ethernet frame. These bytes contain information about the VLAN ID, and the VLAN priority, which runs from 0–7. The IPmux only tags the packets, while the switches are responsible for giving the priority according to the VLAN info. Verify that the IPmux traffic has the highest priority in the relevant Ethernet network.

ToS
There are several RFCs (RFC791, RFC1349, RFC2474) that define how the IP ToS should be configured. The ToS is a byte located in the IP header (Layer 3). In general the Type of Service octet, in most cases, consists of three fields:
The first field, labeled "PRECEDENCE", is intended to denote the importance or priority of the datagram.
The second field, labeled "TOS", denotes how the network should make tradeoffs between throughput, delay, reliability, and cost.
The last field, labeled "MBZ" (for "must be zero") above, is currently unused.
The IPmux can configure the whole IP ToS byte, and therefore it is adaptable to each RFC in the market. The IP ToS parameter in the IPmux is user-configured in terms of decimal value. However, on the frame itself it of course appears in binary format. The decimal value varies between 0 and 255 (8 bits).

A configuration example:
Setting IP precedence of 101 and IP ToS of 1000 will give us the byte 10110000, which means that the IPmux IP ToS parameter should be configured to 176 decimals.

UDP Destination Port
The IPmux uses the UDP protocol (Layer 4) in order to transfer the TDMoIP traffic.
In the UDP protocol, the ¿Destination port¿ field is always set to the decimal value of 2142, hence all the packets leaving the IPmux are tagged accordingly. This unique value was assigned to RAD by the IANA organization for TDMoIP applications.
The network elements may be used to give priority to the TDMoIP traffic according to the UDP destination field.

Q: Does allocating a sufficient bandwidth ensure the proper functionality of an IPmux-based application?

A: A sufficient bandwidth is not enough to ensure a steady environment for the IPmux, since networks loaded with additional non-IPmux LAN traffic (e.g. PC traffic) or incompetent Ethernet/IP network may cause several problems:

- Jitter – The IPmux packets may suffer a delay variation (although all the traffic will eventually pass through due to that fact that there is sufficient bandwidth). Packets will be delayed for different periods of time due to overloaded networks, queuing mechanisms, etc. IPmux can compensate for some jitter (IPmux-1, IPmux-11 up to 300 msec, IPmux-8/16 up to 32 msec for E1 and 24 msec for T1) but bigger jitter will cause problems.
- Misordering – Packets might be sent in different order than the order in which they were originally sent from the IPmux.
- Packet Loss – Packets might be dropped/ignored by some elements in the network (routers/switches) due to insufficient processing power to handle the load, queuing mechanisms, buffer overflows, etc.

Normally these problems are solved by giving priority to the IPmux traffic over all other traffic.
As can be shown, even though there is sufficient bandwidth, there might still be cases in which the traffic will be transmitted from all the sources at the same time and thus create a momentary load on the network element (router/switch), even when this load that does not exceed the available bandwidth. Since the IPmux is constantly transmitting, the TDMoIP traffic will always be a part of such a load.
When no priority is given to the TDMoIP traffic, the network elements will handle the TDMoIP traffic as any other type of traffic.
All the above degrade the performance of the IPmux unit, although an adequate amount of bandwidth is provided for the IPmux.
Refer to FAQ 3338 to understand how to check the IPmux and network performance and how to solve problems.

6.7 Technical Support

Technical support for this product can be obtained from the local distributor from whom it was purchased.

For further information, please contact the RAD distributor nearest you or one of RAD's offices worldwide. This information can be found at www.rad.com (offices – About RAD > Worldwide Offices; distributors – Where to Buy > End Users).

Appendix A
Connector Wiring

A.1 E1 and T1 Connector

Balanced Connector

The E1 and T1 interfaces of IPmux-11 terminate in an 8-pin RJ-45 connector, wired in accordance with *Table A-1*.

Table A-1. E1/T1 Port Connector Pinout

Pin	Designation	Direction	Function
1	RD (R)	Input	Receive data (ring)
2	RD (T)	Input	Receive data (tip)
3, 6	–	–	FGND
4	TD (R)	Output	Transmit data (ring)
5	TD (T)	Output	Transmit data (tip)
7, 8	–	N/A	Not connected

Balanced-to-Unbalanced Adapter Cable

When IPmux-11 is ordered with unbalanced E1 interface, it is necessary to convert the RJ-45 connector to the standard pair of BNC female connectors used by unbalanced E1 interfaces. For that purpose, RAD offers a 150-mm long adapter cable, CBL-RJ45/2BNC/E1/X, wired in accordance with *Figure A-1*.

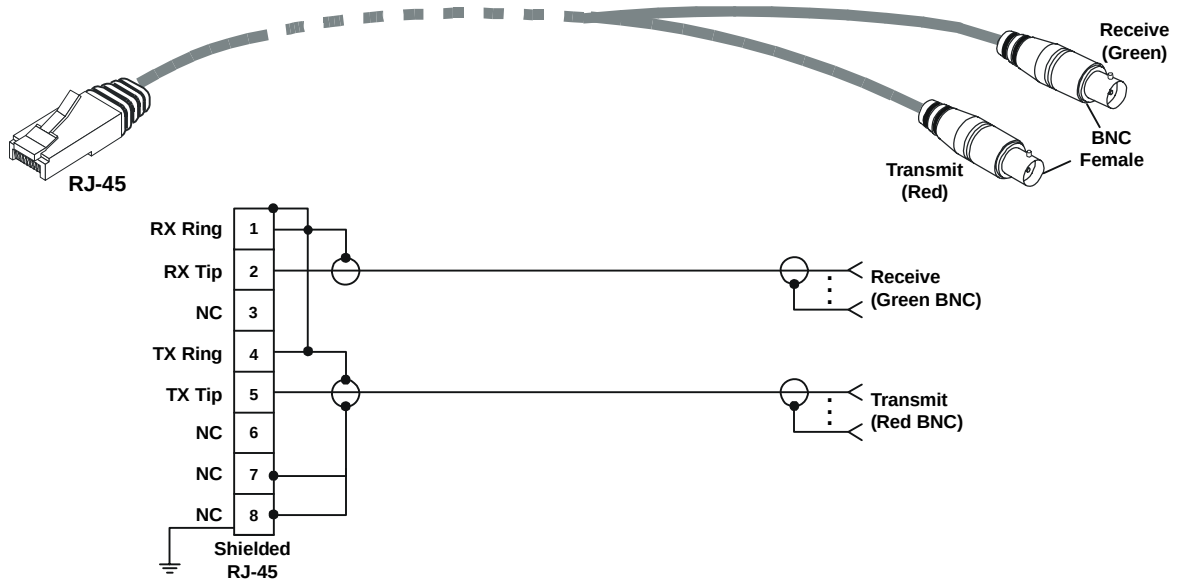

Figure A-1. CBL-RJ45/2BNC/E1/X Cable Wiring Diagram

A.2 Ethernet Connectors

The network and user Ethernet electrical interfaces terminate in 8-pin RJ-45 connectors, wired in accordance with *Table A-2*.

Table A-2. Ethernet Connector Pinout

Pin	Function
1	Tx+
2	Tx–
3	Rx+
4	–
5	–
6	Rx–
7	–
8	–

A.3 CONTROL Connector

The control terminal interface terminates in a V.24/RS-232 9-pin D-type female DCE connector. *Table A-3* lists the CONTROL connector pin assignments.

Table A-3. CONTROL Connector Pinout

Pin	Function
1	–
2	Rx
3	Tx
4	–
5	GND
6	–
7	–
8	–
9	–

A.4 External Clock Connector

The external clock interface terminates in an 8-pin RJ-45 connector. *Table A-4* lists the connector wiring.

Table A-4. EXT CLK Connector Pinout

Pin	Function
1	RxRing (clock in)
2	RxTip (clock in)
3	Alarm In (RS-232 level signal)
4	TxRing (clock out, optional)
5	TxTip (clock out, optional)
6	NC
7	NC
8	NC

Appendix B

Boot Sequence and Downloading Software

This appendix provides a description of the IPmux-11 boot procedure via an ASCII terminal for downloading software.

The file system can hold two compressed copies of the IPmux-11 code. One copy is called the operating file, and the other is called the backup file. The operating file is the default-executable IPmux-11 code. The backup file is used whenever the operating file is absent or corrupted.

B.1 Booting IPmux-11

IPmux-11 boots up automatically. After powering up, no user intervention is required, except when the user wants to access the file system to modify or update the software or the IPmux-11 configuration.

Accessing the Boot Manager

The Boot Manager menu is an option that allows the user to perform basic file transfer operations. These operations are all optional.

➤ **To access the Boot Manager menu:**

- Press **<Enter>** several times immediately after powering up the IPmux-11.

  The Boot Manager menu is displayed (see *Figure B-1*).

```
RAD Boot Manager Version 6.03 (Dec 29 2003)
0 - Exit Boot-Manager
1 - Dir
2 - Set Active Software Copy
3 - Delete Software Copy
4 - Download Files or an Application by XMODEM
5 - Format flash
6 - Show basic hardware information
7 - Perform Reset to the board
8 - System Configuration.
9 - Download an Application by TFTP
Press the ESC key to go back to the Main Menu.
Select:
```

Figure B-1. Boot Manager Menu

From the Boot Manager menu, you can:

- List all files stored in the flash memory
- Exchange the operating and backup files
- Delete the operating file; the backup file becomes the operating file
- Download a new operating file (via XMODEM or TFTP); the previous operating file is saved as the backup file
- Delete all software and configuration files
- Display the basic hardware information (RAM, ROM size etc)
- Reset the IPmux-11 board
- Configure the IPmux-11 IP address, IP mask and default gateway for the consecutive file download via TFTP.

If you choose to exchange or delete a file, you are prompted for confirmation.

B.2 Downloading the Application and Configuration Software

New application software releases are distributed as separate files, which are downloaded to IPmux-11 using the XMODEM protocol or TFTP from the Boot Manager menu. Alternatively, you can download a new software release via TFTP, when the IPmux-11 management software is already running (**Main menu** > **Utilities** > **File Utilities** > **Download/Upload using TFTP**).

The TFTP can also be used for uploading configuration files which contain the IPmux-11 database to the management station. Administrators can use this capability to distribute verified configuration files to all other units which use the similar configuration.

Downloading Application Files via XMODEM

Downloading application files using the XMODEM protocol is performed from the Boot Manager menu.

➤ **To download application file via XMODEM:**

1. Configure your ASCII terminal or terminal emulation utility running on your PC to the 115.2 kbps data rate.
2. Access the Boot Manager menu.

   The Boot Manager menu appears (see *Figure B-1*).
3. From the Boot Manager menu, type **4**.

   IPmux-11 displays the following message:
   `Select Copy number for download ( 0 )`
4. Select the backup partition by typing its number, **0** or **1**.

   IPmux-11 responds with the following string:
   `Please start the XMODEM download.`

5. Send the software release file to IPmux-11 using the XMODEM utility of you terminal application.

   Once the downloading is completed, IPmux-11 saves the new release as an active partition, the former active partition turns into backup, and the boot sequence continues normally.

   If a failure occurs during the download, the partially downloaded software is erased. In this case, only active software is left in the flash memory.

Downloading Application Files via TFTP

➤ **To download application file via TFTP:**

1. From the Boot Manager menu, select **System Configuration**.
2. Configure the IP parameters of IPmux-11 (IP address, IP mask and default gateway). These parameters are valid only for the TFTP file transfer via the Boot Manager.
3. Start a TFTP application.
4. Configure the communication parameters as follows:
   - Connection timeout – more than 30 seconds to prevent an automatic disconnection during the backup partition deletion (about 25 seconds).
   - Block size – 512 bytes.
   - UDP port – 69.
5. Select a local software release file to download.
6. Enter the IPmux-11 IP address.
7. Start downloading.

   IPmux-11 automatically erases the backup partition (it takes about 25 seconds). Once the downloading is completed, IPmux-11 saves the new release as an active partition, the former active partition turns into backup.

Uploading/Downloading Configuration Files via TFTP

You can upload IPmux-11 configuration file to the management station for further distribution to all other units which use the similar configuration.

➤ **To upload application file via TFTP:**

1. Start a TFTP application.
2. Select the configuration to upload.
3. Enter IP address of FTP server.
4. Type **s** to start uploading.

   When the uploading is completed, you can download the configuration file to other IPmux-11 units.

Appendix C

SNMP Management

This appendix provides specific information for IPmux-11 management by SNMP (Simple Network Management Protocol).

The SNMP management functions of IPmux-11 are provided by an internal SNMP agent. The SNMP management communication uses UDP (User Datagram Protocol), which is a connectionless-mode transport protocol, part of the IP (Internet Protocol) protocol suite.

This appendix covers the information related to the SNMP environment.

C.1 SNMP Environment

SNMP Principles

The SNMP is an asynchronous command-response polling protocol. All management traffic is initiated by the SNMP-based network management station, which addresses the managed entities in its management domain. Only the addressed managed entity answers the polling of the management station (except for trap messages).

The managed entities include a function called an SNMP agent, which is responsible for interpretation and handling of the management station requests to the managed entity, and the generation of properly formatted responses to the management station.

SNMP Operations

The SNMP protocol includes four types of operations:

- **getRequest**: Command for retrieving specific management information from the managed entity. The managed entity responds with a **getResponse** message.
- **getNextRequest**: Command for retrieving sequentially specific management information from the managed entity. The managed entity responds with a **getResponse** message.
- **setRequest**: Command for manipulating specific management information within the managed entity. The managed entity responds with a **getResponse** message.
- **trap**: Management message carrying unsolicited information on extraordinary events, which are events that occurred not in response to a management operation reported by the managed entity.

Management Information Base (MIB)

The MIB includes a collection of managed objects. A managed object is defined as a parameter that can be managed, such as a performance statistics value. The MIB includes the definitions of relevant managed objects. Various MIBs can be defined for various management purposes or types of equipment.

An object definition includes the range of values (also called instances) and the following access rights:

- **Read-only**: Instances of that object can be read, but cannot be set.
- **Read-write**: Instances of that object can be read or set.
- **Write-only**: Instances of that object can be set, but cannot be read.
- **Not accessible**: Instances of that object cannot be read, or set.

MIB Structure

The MIB has an inverted tree-like structure, with each definition of a managed object forming one leaf, located at the end of a branch of that tree.

Each leaf in the MIB is reached by a unique path. Thus, by numbering the branching points starting with the top, each leaf can be uniquely defined by a sequence of numbers.

The formal description of the managed objects and the MIB structure is provided in a special standardized format, called ASN.1 (Abstract Syntax Notation 1). Since the general collection of MIBs can also be organized in a similar structure, under IAB (Internet Activities Board) supervision, any parameter included in a MIB that is recognized by the IAB is uniquely defined.

To provide the flexibility necessary in a global structure, MIBs are classified in various classes (branches). One is the experimental branch and another the group of private (enterprise-specific) branch.

Under the private enterprise-specific branch of MIBs, each enterprise (manufacturer) can be assigned a number, which is its enterprise number. The assigned number designates the top of an enterprise-specific sub-tree of non-standard MIBs. Within this context, RAD has been assigned the enterprise number **164**. Therefore, enterprise MIBs published by RAD can be found under **1.3.6.1.4.1.164**.

MIBs of general interest are published by the IAB in the form of a Request for Comment (RFC) document. In addition, MIBs are also often assigned informal names that reflect their primary purpose. Enterprise-specific MIBs are published and distributed by their originator, who is responsible for their contents.

MIBs Supported by the IPmux-11 SNMP Agent

The interpretation of the relevant MIBs is a function of the SNMP agent of each managed entity. The general MIBs supported by the IPmux-11 SNMP agent are:

- rfc1213.mib (except the interfaces view which is supported via RFC 2233)
- ianaiftype.mib (defines the ifType)
- rfc2233.mib (IF-MIB)
- rfc2011.mib
- rfc2012.mib
- rfc2013.mib
- rfc1907.mib
- rfc2683.mib
- rfc1215.mib
- rfc1493.mib
- rfc1643.mib
- rfc2239.mib
- rfc2494.mib
- rfc2261.mib
- rfc1695.mib
- rfc2674.mib
- rfc2819.mib
- rfc2495.mib (except Far End objects and RW configuration objects which are different for each configuration) - replaces RFC 1406; which is now obsolete.
- IPmux RAD private mib.

The IPmux-11 object ID is
iso (1).org(3).dod(6).internet(1).private(4).enterprises(1).rad(164).radGen(6).systems(1).radSysIPMux(3).IPmux11(106)

Enterprise-specific MIBs supported by RAD equipment, including IPmux-1/1E6, are available in ASN.1 format from the RAD Technical Support department.

Management Domains under SNMP

In principle, SNMP allows each management station that recognizes the MIBs supported by a device to perform all the management operations available on that device. However, this is not desirable in actual practice, it is necessary to provide a means to delimit management domains.

SNMP Communities

SNMP delimits management domains by defining communities. Each community is identified by a name, which is an alphanumeric string of up to 255 characters defined by the user.

The IPmux-11 SNMP agent defines strings of up to 10 characters (case sensitive, numeric and alphabetical).

Any SNMP entity (both managed entities and management stations) is assigned a community name by its user. In parallel, the user defines a list of the communities for each SNMP entity that are authorized to communicate with the entity, and the access rights associated with each community (this is the SNMP community name table of the entity).

In general, SNMP agents support two types of access rights:

Read-Only: The SNMP agent accepts and processes only SNMP **getRequest** and **getNextRequest** commands from management stations which have a Read-Only community name.

Read-Write: The SNMP agent accepts and processes all the SNMP commands received from a management station with a Read-Write community name.

Authentication

In accordance with SNMP protocol, the SNMP community of the originating entity is sent in each message.

When an SNMP message is received by the addressed entity, it first checks the originator's community. Messages with community names not included in the SNMP community names table of the recipient are discarded. SNMP agents of managed entities usually report this event by means of an authentication failure trap.

The SNMP agents of managed entities evaluate messages originated by communities appearing in the agent's SNMP community names table in accordance with the access rights, as previously explained. Thus, a **setRequest** for a MIB object with read-write access rights will nevertheless be rejected if it comes from a management station whose community has read-only rights with respect to that particular agent.

Network Management Stations

The IPmux-11 SNMP agent stores the IP address of the Network Management Station (NMS) that is intended to manage it.

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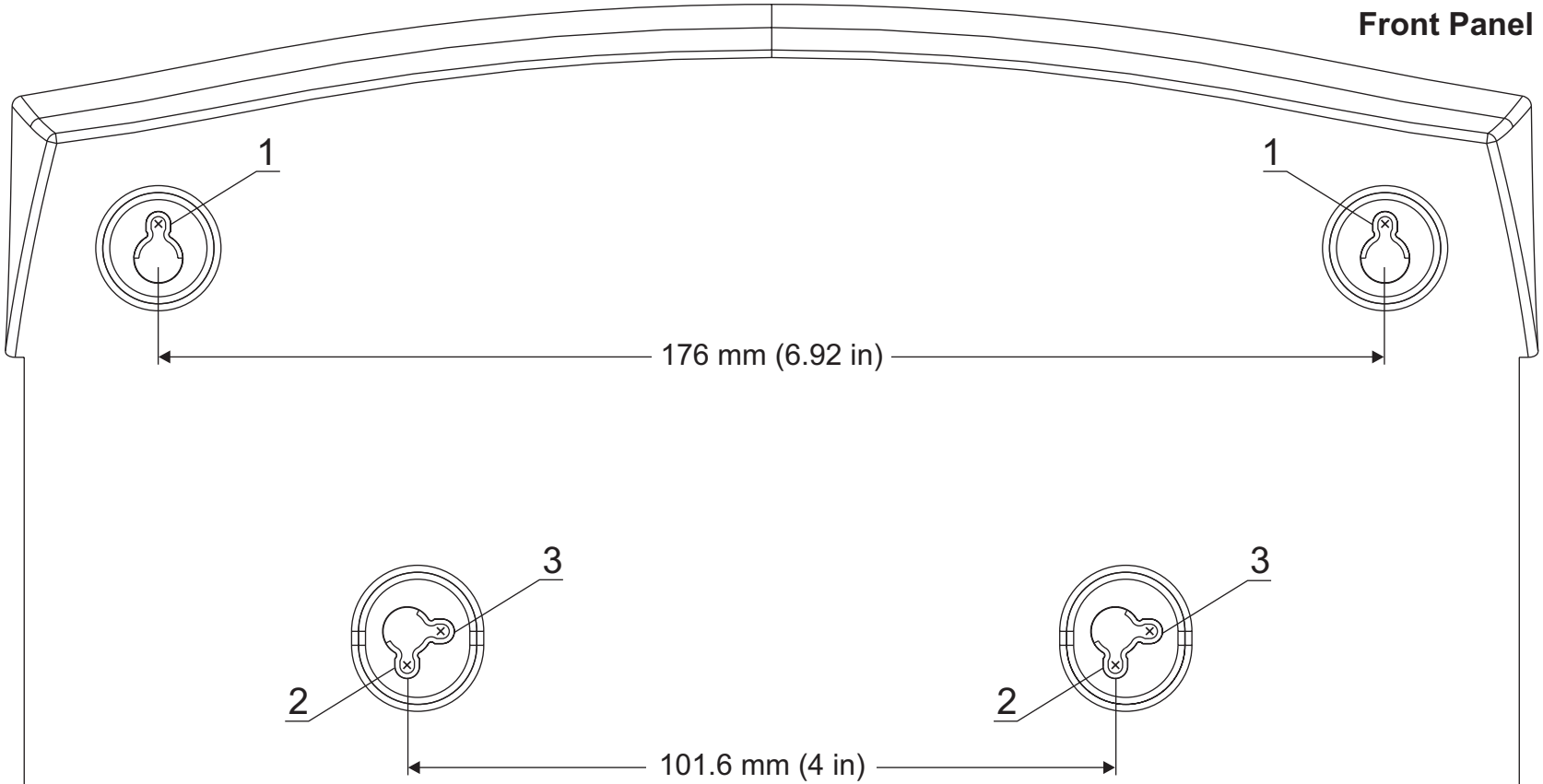
Supplement
Drilling Template for Wall Installation



This panel is drawn to scale.
To drill the holes for a wall installation, tear this page out of the manual or print it on letter-size paper (8.5"x11.0") and hold it against the wall.

LEDs facing up - drill at **1**.
LEDs facing down - drill at **2**.
LEDs facing left - drill at **3**.

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Customer Response Form

RAD Data Communications would like your help in improving its product documentation. Please complete and return this form by mail or by fax or send us an e-mail with your comments.

Thank you for your assistance!

Manual Name: IPmux-11

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Please grade the manual according to the following factors:

	Excellent	*Good*	*Fair*	*Poor*	*Very Poor*
Installation instructions	❒	❒	❒	❒	❒
Operating instructions	❒	❒	❒	❒	❒
Manual organization	❒	❒	❒	❒	❒
Illustrations	❒	❒	❒	❒	❒
The manual as a whole	❒	❒	❒	❒	❒

What did you like about the manual?

Error Report

Type of Error(s) or Problem(s):

- ❒ Incompatibility with product
- ❒ Difficulty in understanding text
- ❒ Regulatory information (Safety, Compliance, Warnings, etc.)
- ❒ Difficulty in finding needed information
- ❒ Missing information
- ❒ Illogical flow of information
- ❒ Style (spelling, grammar, references, etc.)
- ❒ Appearance
- ❒ Other _____

Please list the exact page numbers with the error(s), detail the errors you found (information missing, unclear or inadequately explained, etc.) and attach the page to your fax, if necessary.

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Please add any comments or suggestions you may have.

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