

# IPmux-2L, IPmux-4L

## TDM Pseudowire Gateways



Legacy over PSN  
solution for  
transmitting E1  
streams over packet  
switched networks

**TDMIP**  
Driven®

- Comprehensive support for pseudowire/circuit emulation standards including TDMoIP, CESoPSN, SAToP and HDLCoPSN
- Built on TDMoIP technology, implementing IETF, MFA Forum, ITU-T for Pseudowire Emulation Edge-to-Edge (PWE3)
- E1 and serial traffic emulation over MPLS, IP and Ethernet networks
- Support for both framed (full or fractional) and unframed E1 traffic

IPmux-2L, IPmux-4L are a TDM pseudowire access gateway extending TDM-based services over packet switched networks. It also serves as an Ethernet-based access device.

**Note:** IPmux-4L devices with GbE interface are covered in a separate data sheet.

### PSEUDOWIRE PERFORMANCE

The units provide a legacy over PSN solution for transmitting E1 streams over packet switched networks (PSNs). The device converts the data stream from its user E1 and high-speed data (IPmux-2L only) ports into packets for transmission over the network. The addressing scheme of these packets is IP or MPLS.

These packets are transmitted via the IPmux-2L, IPmux-4L Ethernet network port to the PSN. A remote pseudowire device converts the packets back to TDM traffic.

The ASIC-based architecture provides a robust and high performance pseudowire solution with minimal processing delay.

The unit supports various legacy over packet transport types, including TDMoIP, CESoPSN, SAToP and HDLCoPSN.

**RAD**

data communications

The Access Company

# IPmux-2L, IPmux-4L

## TDM Pseudowire Gateways

### Preserve investment in legacy equipment in migration to PSN

High-performance ASIC-based buffering and forwarding techniques achieve minimal end-to-end processing delay. Configurable packet size balances PSN throughput and delay while a jitter buffer compensates for packet delay variation (jitter) of up to 200 msec in the network.

An assigned IANA-registered UDP port number for pseudowire simplifies flow classification through switches and routers.

#### CLOCKING

Synchronization between TDM devices is maintained by deploying advanced clock distribution mechanisms. The clocking options are:

- Internal – The IPmux-2L, IPmux-4L internal clock oscillator provides the master clock source for the TDM circuit
- Loopback – The transmit clock is derived from the TDM or serial data port receive clock
- Adaptive – The clock is recovered from the PSN
- External – An external clock source synchronizes the device via its two E1 ports to input or output a 2.048 Mbps clock reference.

The system clock ensures a single clock source for all TDM links and uses master and fallback timing sources for clock redundancy. The system also supports two different clock sources from two TDM links at the same time.

#### PSEUDOWIRE QoS

IPmux-2L, IPmux-4L support VLAN tagging and priority labeling according to 802.1p&q. Pseudowire packets are assigned a dedicated VLAN ID and 802.1p bit.

The ToS or Diffserv of the outgoing pseudowire packets are user-configurable. This allows assigning pseudowire packets a higher priority in IP networks.

EXP bits are used for QoS marking of the TDMoMPLS traffic in MPLS networks.

#### PSEUDOWIRE TIMING (IPmux-4L)

End-to-end synchronization between circuits is maintained by deploying advanced clock recovery mechanisms.

Clock recovery conforms to G.823 and G.824 traffic interface using G.8261-defined scenarios.

Advanced clock recovery conforms to G.823 synchronization interface using G.8261-defined scenarios and achieves 16 ppb clock accuracy.

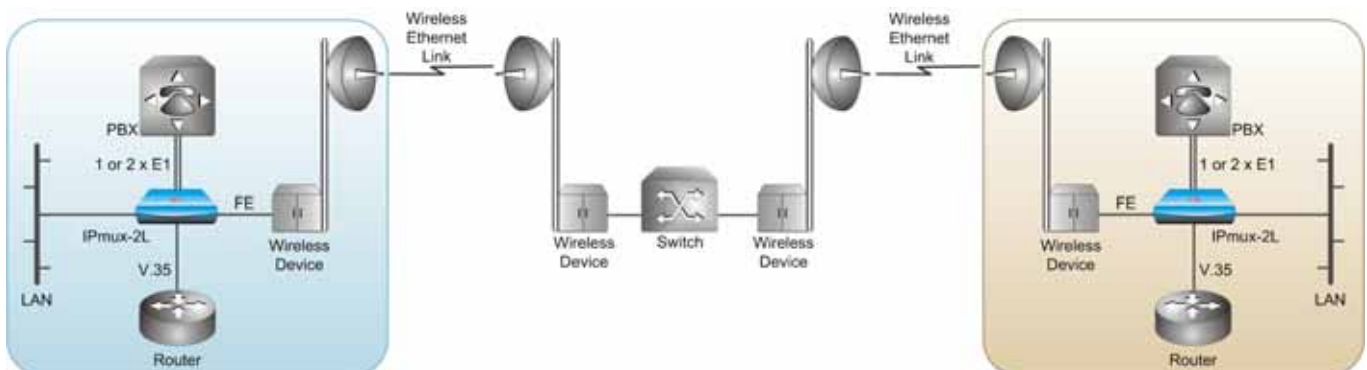


Figure 1. LAN and TDM Services over a Wireless Ethernet Link

### TDM INTERFACE

One or two (IPmux-2L) or two/four (IPmux-4L) E1 ports provide connectivity to any standard E1 device.

E1 interfaces feature:

- Integral LTU for long haul applications
- G.703 unframed and G.704 framed modes
- CAS and CRC-4 bit generation (E1).

### SERIAL INTERFACE (IPmux-2L)

An IPmux-2L data port is available for an n×64 kbps serial connection to legacy equipment.

Provided via 25-pin D-type connector, the serial port supports the following interfaces:

- X.21
- V.24/RS-232
- RS-530/RS-422
- V.35
- V.36/RS-449.

DCE/DTE modes are selected via adapter cables and IPmux-2L clock configuration.

**Note:** IPmux-2L can be ordered with serial data port only, with no E1 interfaces installed.

### ETHERNET INTERFACE

IPmux-2L, IPmux-4L include the following Ethernet ports:

- One network port (copper or fiber optic)
- Two user ports (both copper, or one copper and one fiber optic).

The network and user ports support autonegotiation, VLAN tagging and rate limiting.

### ETHERNET CAPABILITIES

An internal Layer-2 Ethernet switch of IPmux-2L, IPmux-4L includes three Ethernet ports. One port serves as a network interface and the other two serve for user Ethernet traffic.

Each Ethernet port features:

- Port-based rate limiting for bandwidth control
- Four priority queues (strict or weighted) for handling traffic with different service demands. Traffic is classified according to IP Precedence, 802.1P, DSCP or port default priority.
- Port-based VLAN membership for ingress traffic restriction
- Port-based VLAN tagging
- Double VLAN tagging (VLAN stacking)
- Bridging and filtering.

The device supports standard IP features, such as ICMP (ping), ARP, next hop and default gateway.

Lower Opex of TDM service by utilizing packet infrastructure

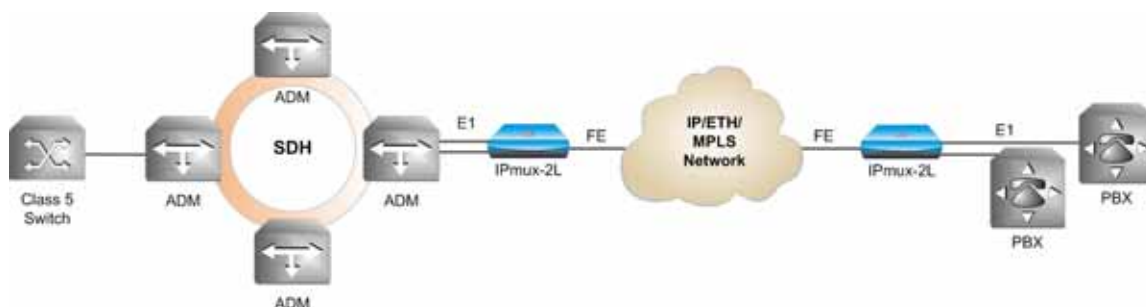


Figure 2. TDM Backhaul and Trunking over a PSN

# IPmux-2L, IPmux-4L

## TDM Pseudowire Gateways

### MANAGEMENT

IPmux-2L, IPmux-4L can be configured and monitored locally via an ASCII terminal, or remotely via Telnet or Web browser.

Management traffic can run over a dedicated VLAN.

Software can be downloaded via a local terminal using XMODEM/YMODEM, or remotely, using TFTP. After downloading a new software version, IPmux-2L, IPmux-4L automatically saves the previous version in non-volatile memory for backup purposes. Also, copies of the configuration file may be downloaded and uploaded to a remote workstation for backup and restore purposes.

Current date and time are retrieved from a dedicated server, using SNTP.

### DIAGNOSTICS

External and internal loopbacks check TDM and serial link connectivity.

A built-in internal and external BERT utility is used to monitor the TDM link quality.

Virtual Cable Test (VCT) check the quality of Ethernet cables, connectors and terminations, identifying a cable break or short.

The following E1 physical layer performance statistics are available: LOS, LOF, LCV, RAI, AIS, FEBE, BES, DM, ES, SES, UAS and LOMF.

LAN and IP layer network condition statistics, such as packet loss and packet delay variation (jitter), are monitored and stored by the device.

Fault isolation, statistics and event logging are also available.

RAD's TDM PW OAM verifies connectivity and prevents pseudowire configuration mismatch.

## Specifications

### E1 INTERFACE

#### Number of Ports

1 or 2 (IPmux-2L), 2 or 4 (IPmux-4L)

#### Compliance

ITU-T Rec. G.703, G.704, G.706, G.732, G.823

#### Data Rate

2.048 Mbps

#### Line Code

HDB3, AMI

#### Framing

Unframed, framed, multiframe; with or without CRC-4

#### Signaling

CAS, CCS (transparent)

#### Line Impedance

120 $\Omega$ , balanced  
75 $\Omega$ , unbalanced

#### Signal Levels

Receive:

0 to -36 dB with LTU (long haul)

0 to -10 dB without LTU (short haul)

Transmit balanced:  $\pm 3V \pm 10\%$

Transmit unbalanced:  $\pm 2.37V \pm 10\%$

#### Jitter and Wander Performance

Per ITU-T G.823

#### Connector

Balanced: RJ-45

Unbalanced: coax BNC

Carrier-grade voice  
quality without  
compression, or  
silence suppression

**SERIAL INTERFACE (IPmux-2L only)****Number of Ports**

1

**Interface Type**

X.21, V.24/RS-232, RS-530/RS 422, V.35, V.36/RS 449

**Timing**

DCE – IPmux-2L provides both Tx and Rx clock to the user equipment. Optionally the incoming data can be sampled with an inverted clock.

DTE1 – IPmux-2L provides the Rx clock. The attached user equipment provides the Tx clock.

DTE2 – The attached user equipment provides both Tx and Rx clocks.

**Note:** X.21 interface supports DCE mode only. V.24 interface supports asynchronous DCE mode only.

**Control Signals**

CTS – constantly ON or follows RTS, user-selectable

DCD – constantly ON, unless a fault in the PSN network is detected

**Data Rate**
 $n \times 64 \text{ kbps}$  ( $N = 1, 2, \dots, 32$ )
**Connector**

25-pin, D-type, female

**ETHERNET INTERFACE****Number of Ports**

3 (1 network, up to 2 user)

**Port Combination**

1 SFP-based, 2 built-in UTP

**Type**

Electrical: 10/100BaseT

Fiber optic: 100BaseFx, 100BaseLX10, 100BaseBx10

**Fast Ethernet SFPs**

For full details, see the SFP Transceivers data sheet at [www.rad.com](http://www.rad.com)

**Note:** It is strongly recommended to order this device with **original RAD SFPs installed**. This will ensure that prior to shipping, RAD has performed comprehensive functional quality tests on the entire assembled unit, including the SFP devices. RAD cannot guarantee full compliance to product specifications for units using non-RAD SFPs. For detailed specifications of the SFP transceivers, refer to the SFP Transceivers data sheet.

**Connector**

LC

**PSEUDOWIRE CONNECTIONS****Standards Compliance**

IETF: RFC 4553 (SAToP), RFC 5087 (TDMoIP), RFC 5086 (CESoPSN) and RFC 4618 (HDLCoPSN)

ITU-T: Y.1413

MFA: IA 4.1, IA 8.0.0

**Number of PW Connections**

63 (IPmux-2L), 64 (IPmux-4L)

**Jitter Buffer Size**

0.5–200 msec (unframed) with 0.1 msec granularity

1.5–200 msec (framed) with 0.5 msec granularity

**GENERAL****Timing**

Internal

External input or output via an E1 or serial port

Loopback

Adaptive

**Adaptive Clock Characteristics**

According to G.823 traffic interface

**Management**

SNMPv1v2c

Telnet

ASCII terminal via V.24 (RS-232) DCE port

Web browser

**Diagnostics**

Loopbacks: E1 port local/remote, serial port local/remote

BERT: E1 port internal/external

VCT: Ethernet ports

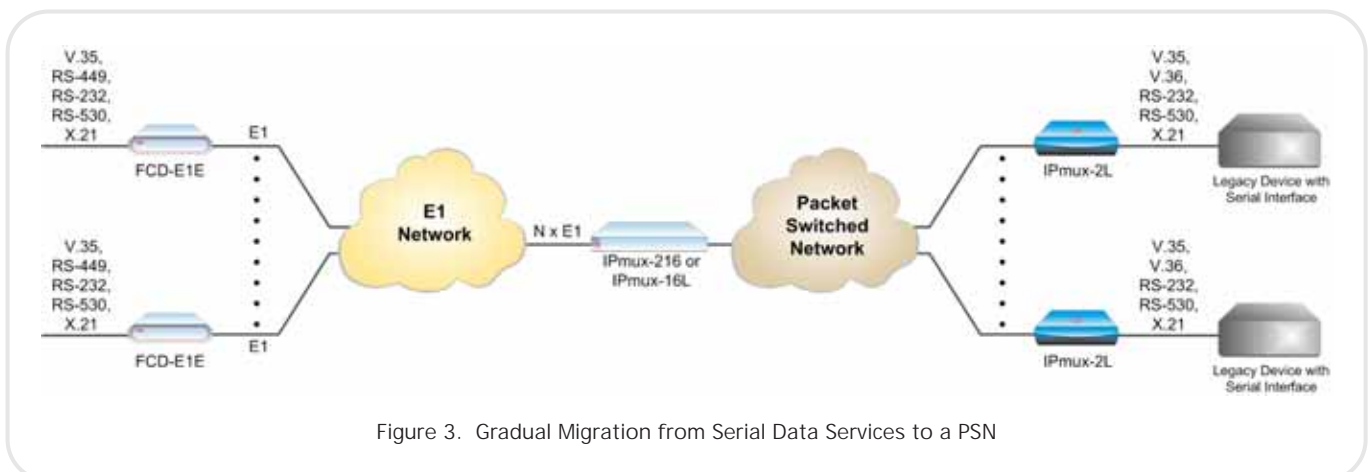


Figure 3. Gradual Migration from Serial Data Services to a PSN

# IPmux-2L, IPmux-4L

## TDM Pseudowire Gateways

### Statistics

E1 (per G.826 and RFC 2495)

Ethernet (per RFC 2819)

Jitter buffer indication (overflow, underflow, sequence error, max/min jitter buffer levels)

### Indicators

PWR (green) – Power status

TST (yellow) – Test status

ALM (red) – Alarm status

LOC/REM (red/red) – E1 local/remote sync loss

LINK/ACT (green/yellow) – Ethernet link/activity status on RJ-45 or SFP

### Power

AC/DC: 100–240 VAC or 48/60 VDC nominal (40 to 72 VDC)

### Power Consumption

8W max (IPmux-2L)

9W max (IPmux-4L)

### Physical

Height: 43 mm (1.7 in)

Width: 217 mm (8.5 in)

Depth: 170 mm (6.7 in)

Weight: 0.5 kg (1.1 lb)

### Environment

Temperature: 0° to 50°C (32° to 122°F)

Humidity: Up to 90%, non-condensing

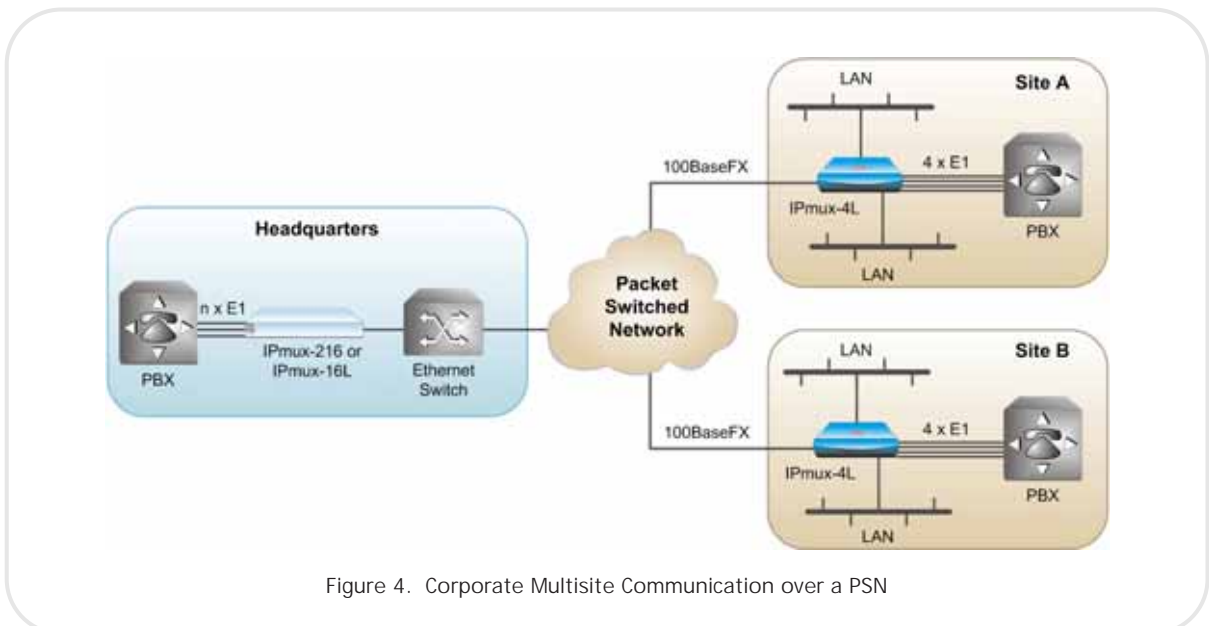








Figure 4. Corporate Multisite Communication over a PSN

Table 1. IPmux Family Product Comparison

Feature	IPmux-2L (Ver. 1.0)	IPmux-4L (Ver. 1.0)	IPmux-4L (GbE) (Ver. 2.0)	IPmux-16L (Ver. 1.0)	IPmux-24 (Ver. 3.5)	IPmux-216 (Ver. 3.5)
						
TDM service ports	1, 2 × E1	2, 4 × E1	4 × E1	8, 16 × E1	1, 2, 4 × E1/T1	8, 16 × E1/T1
Ethernet network ports	1 × FE	1 × FE	1 × GbE network, 2 × GbE network/user	3 × GbE network/user 3 × FE network/user	1 × GbE/FE network, 1 × GbE/FE network/user	1 × GbE/FE network 1 × GbE/FE network/user
Ethernet subscriber ports	1 or 2 × FE	1 or 2 × FE	4 × FE		1 × GbE/FE	1 × GbE/FE
Number of PWs	63	64	64	256	64	256
Multi-pseudowire	✓	✓	✓	✓	✓	✓
Advanced clock recovery	–	✓	✓	✓	✓	✓
Redundant power supply	–	–	–	–	–	✓
External clock port	–	–	–	✓	Optional	✓
Serial data port	Optional	–	–	–	–	–
SSH, SSL, RADIUS	–	–	–	–	✓	✓
Network management system	RV-EMS	RV-EMS	RV-EMS	RV-EMS	RV-SC/TDMoIP, RV-EMS (basic shelf view)	RV-SC/TDMoIP, RV-EMS (basic shelf view)

## IPmux-2L, IPmux-4L

## TDM Pseudowire Gateways

## Ordering

## IPmux-2L STANDARD CONFIGURATIONS

IPMUX-2L/1E1

IPMUX-2L/1E1/N

IPMUX-2L/1E1/RS232/N

IPMUX-2L/1E1/V35

IPMUX-2L/1E1CX

IPMUX-2L/1E1CX/N

IPMUX-2L/2E1

IPMUX-2L/2E1/N

## IPmux-4L STANDARD CONFIGURATIONS

IPMUX-4L/2E1/UTP

IPMUX-4L/4E1

IPMUX-4L/4E1/N

IPMUX-4L/4E1/UTP

IPMUX-4L/4E1CX/N/A

## SPECIAL CONFIGURATIONS

IPmux-2L/\$/{/+1/

IPmux-4L/\$/{+1/~

## Legend

\$ TDM interface:

N No E1 interface

1E1 1 balanced E1 (IPmux-2L)

1E1CX 1 unbalanced E1 (IPmux-2L)

2E1 2 balanced E1

2E1CX 2 unbalanced E1

4E1 4 balanced E1 (IPmux-4L)

4E1CX 4 unbalanced E1 (IPmux-4L)

{ Serial interface (Default=no serial interface):

V35 V.35 interface

V36 V.36/RS-449 interface

RS530 RS-530 interface

X21 X.21 interface

RS232 RS-232 interface

+1 Fiber optic Ethernet interface (in addition to two 10/100BaseT ports)

N SFP-ready slot

1 Fast Ethernet/STM-1,  
1310 nm, multimode, LED,  
2 km (1.2 mi)2 Fast Ethernet/STM-1,  
1310 nm, single mode, laser,  
15 km (9.3 mi)3 Fast Ethernet/STM-1,  
1310 nm, single mode, laser,  
40 km (24.8 mi)4 Fast Ethernet/STM-1,  
1310 nm, single mode, laser,  
80 km (49.7 mi)10A Fast Ethernet/STM-1, Tx -  
1310 nm, Rx - 1550 nm,  
single mode (single fiber),  
laser (WDM), 20 km  
(12.4 mi)10B Fast Ethernet/STM-1, Tx -  
1550 nm, Rx - 1310 nm,  
single mode (single fiber),  
laser (WDM), 20 km  
(12.4 mi)

UTP 10/100BaseT (IPmux-4L)

*Note: For single-fiber applications, a device with the SFP-10A interface should always be used opposite a device with the SFP-10B interface, and vice versa.*

~ Clock recovery (Default=standard clock recovery):

A Advanced clock recovery mechanism (per E1 port)

## SUPPLIED ACCESSORIES

Power cord

AC/DC adapter plug

## OPTIONAL ACCESSORIES

The following cables convert the IPmux-2L 25-pin serial data port connector into the respective interface. Cable length is 2m (6 ft).

## CBL-HS2/V/1/\$

Adapter cable for connecting a data port in DCE timing mode to V.35 port

## CBL-HS2/V/2/\$

Adapter cable for connecting a data port in DTE1 timing mode to V.35 port

## CBL-HS2/V/3/\$

Adapter cable for connecting a data port in DTE2 timing mode to V.35 port

## CBL-HS2/R/1/\$

Adapter cable for connecting a data port in DCE timing mode to V.36/RS 449 port

## CBL-HS2/R/2/\$

Adapter cable for connecting a data port in DTE1 timing mode to V.36/RS-449 equipment

## CBL-HS2/R/3/\$

Adapter cable for connecting a data port in DTE2 timing mode to V.36/RS-449 port

## CBL-HS2/X/1/\$

Adapter cable for connecting a data port in DCE timing mode to X.21 port

\$ Cable connector:

F Female

M Male

## CBL-DB9F-DB9M-STR

Control port cable

## RM-33-2

Hardware kit for mounting one or two IPmux-2L, IPmux-4L units into a 19-inch rack

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