

IP • Express User's Guide

IP • Express XL/ML/MLDI/QT1/QE1

WAN Router Families



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This equipment complies with Part 68 of the FCC rules and the requirements adopted by the ACTA. On the bottom of this equipment is a label that contains, among other information, the FCC product identifier:

US:1ZEDENANML-XL-HUB

If requested, this number must be provided to the telephone company. Telecommunication cables must comply with the applicable FCC Part 68 rules and requirements adopted by the ACTA.

Industry Canada Certification/Registration

IC:4447A-MLXLHUB

Equipment Malfunction

If trouble is experienced with an IP•Express Router, please contact the Engage Communication Service Center. If the equipment is causing harm to the telephone network, the telecommunications service provider may request that you disconnect the equipment until the problem is resolved.

Engage Communication Service Center:
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Chapter 1

Introduction

The IP•Express User's Guide provides the information network administrators require to install and operate any of the IP•Express WAN routers offered by Engage Communication, Inc.

The IP•Express family of WAN routers supports the Internet Protocol (IP) and is ideally suited for connections to the Internet as well as for Enterprise IP interconnectivity. IP•Express routers are available with a wide variety of WAN and LAN interface options offering flexibility and exceptional value for a wide range of routing environments.

About this Guide

Organization

Chapter 1 - Introduction provides a description of the User's Guide as well as a feature description for the XL, ML, MLDI and QT1/QE1 router series which make up the IP•Express family.

Chapter 2 - QuickStart provides concise configuration examples to get the experienced user up and running in the minimum time.

Chapter 3 - The Network Planning chapter offers a broad overview of IP addressing and routing.

Chapter 4 - Installation covers the physical environment and connections required when first installing the routers.

Chapter 5 - Configuration and Operation discusses the initial configuration and ongoing operation utilizing the Command Line Interface.

Chapter 6 - Command Line Reference provides a command-by-command

description of the Engage CLI.

Chapter 7 - Network Security discusses IP filtering and other security concerns, with specific filter examples.

Chapter 8 - Troubleshooting common problems occurring during installation and normal operation.

Appendices - Router specifications, connector pinouts and crossover wiring details.

Glossary - Routing, Telecommunication and TCP/IP terminology.

Intended Audience

This manual is intended for administrators of network systems. The technical content is written for a reader who has basic computer and networking experience.

It is important that any administrator responsible for the installation and operation of Engage IP•Express routers be familiar with network concepts and terms, such as network addressing and internets. These terms are central to an understanding of router services, and are covered in the Glossary section.

The IP•Express Router Family

The IP•Express router family is made up of the XL, ML, MLDI and QT1/QE1 series. The following sections provide a breakdown of the different models in tabular form and describe the wide range of features available.

The IP•Express XL Series

The IP•Express XL Series routers provide a single WAN interface for edge and other CPE applications. Table 1 outlines available models and features.

MODEL	LAN	WAN	BERT	POWER
XL	Single	Serial	N	AC
XL-T1	Single	T1	N	AC
XL-E1	Single	E1	N	AC
XL-H-T1	4 Port Hub	T1	N	DC
XL-H-E1	4 Port Hub	E1	N	DC
XLB-H-T1	4 Port Hub	T1	Y	DC
XLB-H-E1	4 Port Hub	E1	Y	DC

Table 1 - IP•Express XL Models

LAN Interface Options

- **Single** 10BaseT ethernet interface for router applications in multi-node LAN environments.
- **4 Port Hub** integrates a 10BaseT ethernet hub, providing a one-box WAN networking device for basic applications.

WAN Interface Options

- **Serial** interface is utilized for connection to external data communication equipment (DCE) such as T1 multiplexors or E1 DSU/CSU. RS-232, RS-530 and RS-449 signalling is provide through a 25 pin synchronous, serial interface.
- **T1** interfaces offer an integrated T1/fractional T1 DSU/CSU for direct connection to dedicated or frame relay services at speeds up to 1.544 Mbps.
- **E1** interfaces offer an integrated E1/fractionalE1 DSU/CSU for direct connection to dedicated or frame relay services at speeds up to 2.048 Mbps.

Additional Features

- **BERT** provides integrated Bit Error Rate Test and complete looping capabilities, facilitating the troubleshooting of telecommunications service issues.
- **AC** models utilize 24 Vac. An AC power adapter is provided with the router.
- **DC** models utilize 15-26 Vdc. A DC power adapter is provided with the router.

The IP • Express ML Series

The IP•Express ML Series provides multilink capabilities with dual WAN interfaces for edge or hub applications. Table 2 outlines the available ML models and features.

MODEL	LAN	WAN	INV MUX	BERT	POWER
ML-2T1	Single	2xT1	N	N	AC
ML-2E1	Single	2xE1	N	N	AC
ML-2T1-IPM	Single	2xT1	Y	N	AC
ML-2E1-IPM	Single	2xE1	Y	N	AC
ML-H-T1	4 Port Hub	2xT1	N	N	DC
ML-H-E1	4 Port Hub	2xE1	N	N	DC
MLB-H-T1	4 Port Hub	2xT1	N	Y	DC
MLB-H-E1	4 Port Hub	2xE1	N	Y	DC
ML-T1-H-IPM	4 Port Hub	2xT1	Y	N	DC
ML-E1-H-IPM	4 Port Hub	2xE1	Y	N	DC
MLB-T1-H-IPM	4 Port Hub	2xT1	Y	Y	DC
MLB-E1-H-IPM	4 Port Hub	2xE1	Y	Y	DC

Table 2 - IP•Express ML Models

LAN Interface Options

- **Single** 10BaseT ethernet interface for router applications in multi-node LAN environments.
- **4 Port Hub** integrates a 10BaseT ethernet hub, providing a one-box WAN networking device for basic applications.

WAN Interface Options

- **T1** interfaces offer an integrated T1/fractional T1 DSU/CSU for direct connection to dedicated or frame relay services at speeds up to 1.544 Mbps.
- **E1** interfaces offer an integrated E1/fractional E1 DSU/CSU for direct connection to dedicated or frame relay services at speeds up to 2.048 Mbps.

Additional Features

- **BERT** provides integrated Bit Error Rate Test and complete looping capabilities, facilitating the troubleshooting of telecommunications service issues.
- **AC** models utilize 24 Vac. An AC power adapter is provided with the router.
- **DC** models utilize 15-26 Vdc. A DC power adapter is provided with the router.

The IP • Express MLDI Series

The IP•Express MLDI Series provides Multilink capabilities with dual WAN interface plus Drop and Insert Mux capabilities.

The Drop and Insert Multiplexer allows users to combine IP data and PBX or other TDM data on a single T1 or E1 service. This feature is used to connect Branch Office PBXs and Phone switches to an organization's phone system, which has access to the PSTN, to save money on Local

Access Phone charges and interoffice calls. The remote LAN interconnection to the HQ LAN is utilized for centralized database access, shared file servers and other services.

Table 3 outlines the available MLDI models and features.

Model	LAN	WAN	D & I	BERT	Power
MLDI-H-T1	4 Port Hub	2xT1	Y	Y	DC
MLDI-H-E1	4 Port Hub	2xE1	Y	Y	DC

Table 3 - IP•Express MLDI Models

The IP•Express QT1/QE1

The IP•Express QT1/QE1 Series provides Multilink capabilities with a four port WAN interface.

LAN Interface Options

- Single 10/100BaseT full/half duplex Ethernet interface.

The 100BaseT interface introduces new configuration parameters for interface lan1.

Autonegotiate on - Interface determines speed and duplex mode.

Autonegotiate off - Speed and duplex are set manually.

Speed 10 or 100 - 10Mbps or 100Mbps

Duplex - half or full.

WAN Interface Options

- Four **T1** interfaces offer an integrated T1//fractional T1 DSU/CSU for direct connection to dedicated or frame relay services at speeds up to 1.544 Mbps.
- Four **E1** interfaces offer an integrated E1/fractional E1 DSU/CSU for direct connection to dedicated or frame relay services at speeds up to 2.048 Mbps.

Additional Features

- AC models utilize 24 Vac. An AC power adapter is provided with the router.

Table 4 outlines the available QT1/QE1 models and features.

Model	LAN	WAN	Multilink	IPM	BERT	Power
QT1	10/100	1 to 4 T1s	Y	N	N	AC
QT1-IPM	10/100	1 to 4 T1s	Y	Y	N	AC
QE1	10/100	1 to 4 T1s	Y	N	N	AC
QE1-IPM	10/100	1 to 4 T1s	Y	Y	N	AC

Table 4- IP•Express QT1/QE1 Models

Router Administration

Command Line

Engage IP•Express routers are administered using Engage's intuitive Command Line Interface communicating via the rear panel Console port or through telnet connection to any of the router's configured interfaces.

SNMP Support

All Engage products support SNMP (Simple Network Management Protocol) version 1. SNMP support provides access via IP to groups of administrative, configuration-related, and statistical information objects about the Engage device. An IP network connection to the device and a PC with an application which provides an SNMP version 1 client are required.

An SNMP client will query the device and display the information objects and their values to the user. Groups of SNMP information objects are referred to as MIBs (Management Information Base). All Engage products support most of MIB-II (MIB-2). The subgroups of information in MIB-II

are as follows:

System group: contains system information such as a designated system identifier, location, and vendor ID (Engage).

Interface group: contains information about the network connections on the device including interface type, link status, packets transmitted and received.

AT group: contains information about the ARP entries on the device including the values for MAC Address and IP Address for each entry.

IP group: contains IP statistics and configuration on the device including IP packets received, packets discarded, and IP address and subnet mask.

ICMP group: contains statistics for ICMP statistics including packets sent for redirect, port unreachable, or echo requests (Ping).

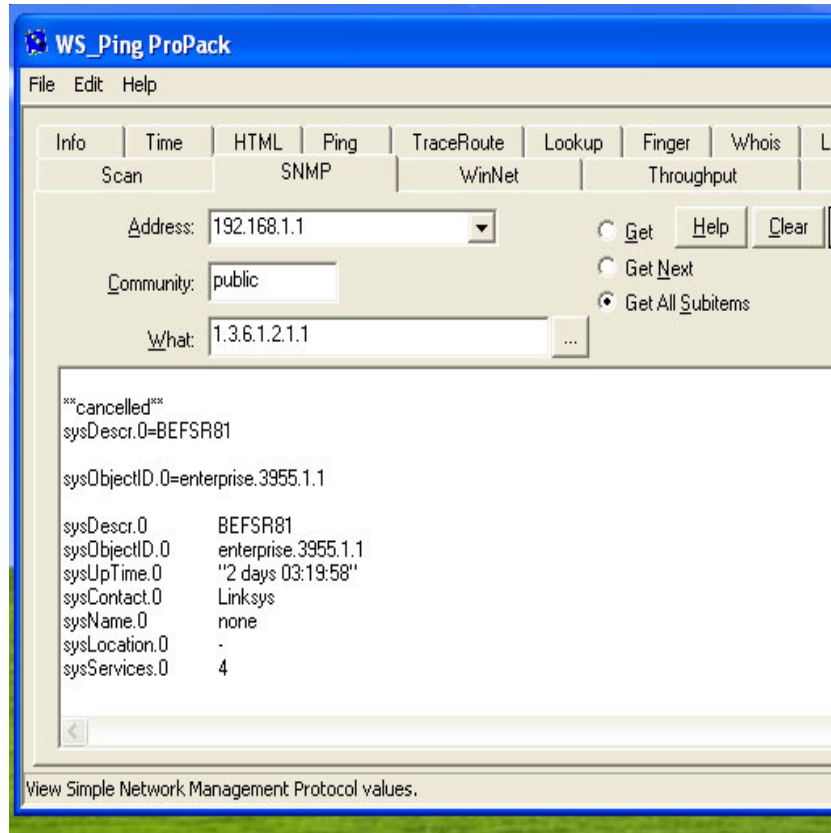
UDP group: contains statistics for UDP including packets received and transmitted, and packets sent to a UDP port with no listener.

SNMP group: contains statistics for the SNMP protocol including packets received and transmitted, error packets, and number of set requests.

For more detail, MIB-II is fully specified in RFC1213, available at <http://www.faqs.org/rfc/rfc1213.html>.

Please note the following screen capture. This is a screen capture from a demo program called WSPing Pro, which provides an SNMP client. The capture shows WSPing Pro displaying information retrieved from SNMP GetNext Requests to a LinkSys router. GetNext Requests are requests to the device that ask for the next objects, and may be concatenated to retrieve a table of information. This was accomplished by selecting "Get All Subitems" under the Object ID of the System group, 1.3.6.1.2.1.1, and clicking "Start". The windows shows the values for sysDescr (device name), sysObjectID (a vendor selected, unique Object ID), systemUpTime (time elapsed since last reboot), etc.

Table 5 - SNMP capture using WSPing Pro



EngageView

MacOS users have the option of administering Engage routers using the EngageView™ network management program. EngageView is used for the configuration of the IP•Express router, including protocol parameters and internal telco equipment settings. Contact Engage Technical Support for download access.

Digital Phone Service Overview

Engage routers utilize dedicated digital phone services. Dedicated lines allow the user continuous access to remote sites. Dedicated connections may be made over leased lines or through Frame Relay services. The connection is always available for data transfer, providing a fast, reliable connection, 24 hours a day.

Types of services which are available vary according to location and service provider. The following is a brief overview of available digital phone services.

T1 Service

A high performance service which provides a maximum transfer speed of 1.544 million bits/second (Mbps). T1 lines are bundled as 24 circuits of 64 Kbps each.

One or more of these 64 Kbps segments may be leased as a fractional T1 (fT1) line providing, for example, 384 Kbps or 512 Kbps bandwidth. A user may elect to send data over one or multiple segments, and use other portions of the line for voice, video, etc.

E1 Service

Another higher-performance service which provides a maximum transfer speed of 2.048 million bps. E1 lines are bundled as 32 circuits of 64Kbps and fractional E1 services are available.

With Engage Communication's Inverse Packet Multiplexing (IPM) these data transfer rates can double.

DDS (dedicated digital service)

Provides a 56,000 or 64,000 bps connection. Due to a wealth of providers, DDS may be less costly than dial-up services and is ideal for businesses with moderate WAN bandwidth requirements.

Chapter 2

Installation QuickStart

This QuickStart is intended for users familiar with the configuration of IP routers using a command line interface who require only the specifics of Engage IP•Express configuration.

Initial communication with the router, including assignment of IP addresses, is covered first. Example configurations follow. The examples cover the most common applications for the IP•Express XL, ML, MLDI and QT/QE1 series.

Initial Communication with the Router

There are several methods of communication with the Engage router for initial assignment of an IP address. Use any method when configuring a new router or a router with an unknown IP address.

Console Port

IP•Express router models are equipped with a Console port permitting serial communication using the Command Line interface, detailed in *Chapter 6: Command Line Interface*.

The Console port is an 8 pin RJ45 female jack. It is configured as a DTE (data terminal equipment) port. For connection to other DTE, such as a terminal, a Null Modem adapter is required. An RJ45-to-db9 adapter is provided with the router which, in addition to providing a physical interface, performs the null modem operation permitting direct connection to other DTE equipment, such as a workstation or PC.

The terminal program for use with the Console port should be configured for serial communication at 9600 Baud, 1 Stop Bit, No Parity, 8 bit fixed. On

first establishing the connection the user should login as

login: **root**

No password is configured initially.

Telnet

A second method employs telnet to *assign* an IP address to the router. The user powers up the router and immediately attempts a telnet connection to the *desired* IP address. If the Telnet session returns a timeout failure, the user should retry immediately - without restarting the router. Repeat these retries for up to two minutes.

When the sequence is successful, the **login:** prompt will appear. Enter the username **root** to open the Telnet session. The user will be asked to confirm that the router should adopt the new IP address.

If the method does not work the first time, the router should be restarted and the procedure retried, as timing constraints may not have been met. See *Chapter 5: Configuration and Operation* for further detail on this method of IP address assignment.

EngageView/MacOS

MacOS users can perform the IP configuration from within EngageView/MacOS, which communicates to the router via AppleTalk. The Macintosh application allows direct configuration of IP parameters. Contact Engage Technical Support for information on downloading EngageView.

Note on communication with router

Connection of an improperly configured WAN interface to a digital telephone service can adversely affect communication with the router. It is suggested that the serial or WAN connection not be made until configuration of that serial interface is complete.

Example Configurations

Eight common IP•Express configurations are detailed in this section. The command line configuration listing is shown for each example and text file versions of the listings are provided on a disk which ships with each IP•Express router.

Editing and Saving Configurations

Users of the command line interface have the option of editing standard Engage configuration listings and “pasting” that configuration to the router. Selected configuration files can be found on the shipping disks as well as at Engage's FTP and Web sites.

Edit the desired configuration listing example using a simple text editor. Connect to the router through Telnet or the console port, then enter the configuration mode with the command: **config**

Paste the edited text, comments and all, to the router, then issue the command: **save**. The router will reset and come up with the new configuration. *Note that existing static routes configured in the router may not necessarily be altered, resulting in bad routes.*

To obtain a router configuration for offline editing, issue the command: **show configuration all** and save the response listing to a file.

Static Route Note

All Static Routes require an explicit TCP/IP Network Address, including the route to the Default Router. A route to IP Address 0.0.0.0 is **not** permitted, instead the default router's IP network is specified.

Example 1: IP•Express XL Connection for Enterprise

Scenario

This basic IP•Express router example illustrates the minimum configuration required to achieve a fully functional network connection between two sites which are not connected to the global Internet. IP addressing requirements are greatly simplified when the user can assign private (or reserved) IP addresses, such as those shown here, rather than work within the constraint of globally unique IP addresses. For further information on IP addressing, see *Chapter 3: Network Planning*.

The routers themselves impose the sole constraint - the IP networks must be unique at each site. This differs from bridged networks which maintain a single IP network across the two sites.

For the example, site 1 uses IP addresses within network 192.168.1.0/24 and site 2 utilizes network 192.168.2.0/24. Note the following:

- A typical convention is to assign the router the first address in the block. Here router 1 ethernet is configured to 192.168.1.1 and the remaining addresses, 192.168.1.2 to 192.168.1.254 are available for devices on the site 1 network.
- If the enterprise network contains more IP networks than the two created here, the IP•Express routers should be configured with a default gateway to enable them to route to other networks. Consider another site 1 router 192.168.1.254 provides connectivity to other enterprise networks. This will serve as the default gateway for both IP•Express routers.
- The use of numbered serial interfaces - i.e. IP addresses assigned to the serial ports - is optional. In this example the serial interfaces are unnumbered.
- RIP, a routing protocol, is enabled on the serial interfaces. Router 2 learns of the 192.168.1.0 network from router 1, and router 1 learns of the 192.168.2.0 network from router 2, eliminating the need to configure those static routes. Further information is available in the

description of RIP provided in *Chapter 6: Command Line Interface*.

- Although the complete router configuration is listed below, the majority of the parameters remain at their default setting. In fact, this configuration will function properly with the configuration of a just the ethernet IP address and, if required, the default gateway for each router.

Configuration File Name

BasicXL.txt

Command Line Listing - Router 1

```
Router Name "Router 1"  
Router Contact "Admin"  
Router Location "5 Broad St."  
IP Default-router 192.168.1.254  
IP Cost 1
```

```
#Static Routes: Network      Next Hop    Cost Interface DLCI
```

```
Interface E1  
IP Address 192.168.1.1/24  
IP Broadcast ONES, address 255.255.255.255  
IP RIP On
```

```
Interface S1  
Type T1  
Protocol Engage  
Poll-CD Off  
Wait-CD Off  
DTR On  
Timeout 0
```

```
T1 Data          Normal  
T1 Clocking Network  
T1 LBO           CSU      0dB  
T1 Framing ESF  
T1 Coding        B8ZS  
T1 Speed         64K  
T1 Spacing Contiguous
```

```
IPRIP On
```

Command Line Listing - Router 2

The configuration for router 2 can be identical to that above with the exception of the ethernet IP address and the optional router informational items. Router 2 should be configured as:

```
Interface E1  
IP Address 192.168.2.1/24
```

Example 2: IP•Express ML - Multiple Routes to Multiple Sites

Scenario

This sample configuration shows a dual port IP•Express which has multiple static routes, pointing to multiple IP networks/subnetworks. Routes are shown to remote networks and subnetworks via serial ports. Other networks are accessed via other routers (200.10.10.1 and 200.10.10.3) on the same ethernet LAN segment.

Only the relevant configuration commands are included.

Configuration File Name

MLRoutes.txt

Command Line Listing

```
IP Default-router 200.10.10.1
IP Cost 1
```

#Static Routes:	Network	Next Hop	Cost	Interface	DLCI
IP Route	157.22.234.0/23	200.10.10.1	1	E1	
IP Route	201.21.21.0/24	201.11.11.1	1	S1	
IP Route	202.12.12.64/26	202.12.12.65	1	S2	
IP Route	203.13.13.128/25	202.12.12.65	1	S2	
IP Route	204.14.14.0/24	200.10.10.3	1	E1	

```
Interface E1
IP Address 200.10.10.2/24
IP Broadcast ONES, address 255.255.255.255
IP RIP On
```

```
Interface S1
Type                T1
Protocol            PPP
Poll-CD             Off
Wait-CD             Off
DTR                 On
Timeout             0
T1 Data             Normal
```

```
IP Address 201.11.11.2/30
IP RIP Off
```

Interface S2
Type T1
Protocol PPP
Poll-CD Off
Wait-CD Off
DTR On
Timeout 0
T1 Data Normal

IP Address 202.12.12.66/26

IP RIP Off

Example 3: IP•Express ML-T1-IPM Inverse Multiplexing 2 T1 lines

Scenario

This sample configuration shows a connection between two dual port T1 IP•Express routers utilizing Engage's Inverse Packet Multiplexing (IPM). By combining the bandwidth of two T1s, the user obtains a throughput of 3 Mbps. The configuration for one of the routers is provided below. Note the following:

- The RIP routing protocol is enabled over the WAN connection. This ensures a level of redundancy. Should one T1 link fail all traffic is automatically routed over the working link. Additionally, no static routes are required pointing to the opposite LAN.
- Inverse Packet Multiplexing functions only with the Engage WAN protocol.
- Inverse Packet Multiplexing requires that port 1 of the local router connect to port 1 of the remote, and port 2 to port 2.
- Query the status of the Inverse Packet Multiplexing with the command **show inverse mux**.
- The default router resides on the same LAN as the IP•Express ethernet interface, therefore no static route is required to point to the default router.
- The serial interfaces are unnumbered in this example.

Configuration File Name

ML-IPM.txt

Command Line Listing

```
Router Name "IPEXpress ML-2T1-IPM"
Router Location "6th Street"
```

```
IP Default-router 10.1.1.1
IP Cost 1
! Default router resides on same LAN as IPEXpress
```

```
!Static Routes:Network      Next Hop      Cost Interface  DLCI
```

! RIP is enabled over the WAN connection - no static route to remote LAN is required

Inverse-Mux On

Interface E1
IP Address 10.1.1.2/24
IPRIP On

Interface S1
Type T1
Protocol Engage
Poll-CD On
Wait-CD On
DTR On
Timeout 0
T1 Data Normal
T1 Clocking Network
T1 LBO CSU 0dB
T1 Framing ESF
T1 Coding B8ZS
T1 Speed 64K
T1 Spacing Contiguous
T1 Channels Full
IPRIP On

Interface S2
Type T1
Protocol Engage
Poll-CD On
Wait-CD On
DTR On
Timeout 0
T1 Data Normal
T1 Clocking Network
T1 LBO CSU 0dB
T1 Framing ESF
T1 Coding B8ZS
T1 Speed 64K
T1 Spacing Contiguous
T1 Channels Full
IPRIP On

Example 4: Drop and Insert Mux Application with IP•Express MLDI-E1

Scenario

Engage IP•Express MLDI models provide dual T1 or E1 ports plus the Drop and Insert Mux capability to permit the utilization of a single T1 or E1 line for both IP data traffic and PBX voice traffic. Additionally, the unit has an integrated four port 10BaseT hub, providing a one-box networking solution in many applications.

The customer data network (LAN) connects to any of the ethernet ports and data traffic is routed between the IP•Express ethernet interface (designated interface **e1** in the CLI) and the TELCO interface (designated interface **s1**).

The customer voice network, typically a connection to a PBX, connects to the DS1 port. This connection typically requires a T1 crossover cable - see *Appendices* for pinout. PBX voice traffic is carried between the DS1 port (interface **s2**) and the TELCO port (interface **s1**).

In this example the E1 bandwidth is divided evenly between data and voice traffic, with E1 channels 1-15 utilized for data and E1 channels 16-30 utilized for voice.

Also note the following:

- Bandwidth configuration is required for interface **s1** only. The remaining E1 bandwidth is **automatically** assigned to interface **s2**. If interface **s2** is allocated partial bandwidth, idle characters are transmitted out the unallocated channels, disrupting the IP data routing path.
- In contrast, the PBX which connects to the DS1 interface (**s2**) must be configured for just the channels of the E1 interface which it will utilize - in this example E1 channels 15-30.
- The T1 or E1 clock source must be synchronous between the TELCO interface (**s1**) and the DS1 interface (**s2**). This is accomplished by setting the E1 Clocking to **Network** for interfaces **s1** and **s2**.
- One potential issue for T1 applications involves the use of the 24th channel for "D" signalling by some PBX systems. This can result in the PBX mistakenly interpreting IP data on that channel as voice calls. The PBX should be configured to not utilize this 24th channel as signalling.

Configuration File Name

MLDI.txt

Command Line Listing

```
Router Name "IPEXpress MLDI-E1"  
Router Contact "Ted Arnold"  
Router Location "1101 Broadway"
```

```
IP Default-router 10.1.1.1  
IP Cost 1
```

```
!Static Routes:Network      Next Hop      Cost Interface  DLCI  
IPRoute      201.34.22.0/24      10.5.1.1  1      S1
```

```
Interface E1  
IP Address 10.1.1.2/24  
IPRIP On
```

```
Interface S1  
Type E1  
Protocol Engage  
Poll-CD On  
Wait-CD On  
DTR On  
Timeout 0  
E1 Data          Normal  
E1 Clocking      Network  
E1 Framing       CRC4  
E1 Coding        HDB3  
E1 Channels Fractional 1 15  
IPRIP On
```

```
Interface S2  
Type E1  
Protocol Engage  
Poll-CD On  
Wait-CD On  
DTR On  
Timeout 0  
E1 Data          Normal  
E1 Clocking      Network
```

E1 Framing	CRC4
E1 Coding	HDB3
E1 Channels	Full

! Note that S2 configuration is set FULL

! Interface S2 is *automatically* assigned the bandwidth not utilized by S1

IPRIP Off

Example 5: IP•Express XL-T1 - Leased Line to an ISP

Scenario

This sample configuration details an IP•Express connection to an Internet Service Provider (ISP) with a leased fractional T1 (fT1) connection running PPP. The hardware in this example is the IP•Express XL with internal T1 DSU/CSU configured for fractional T1 at 512 Kbps.

The TCP/IP configuration in this example has the following addressing:

- ISP assigns User a full Class C for LAN: 205.1.1.0/24
- ISP assigns User serial port IP addr: 10.223.10.18/30
- ISP has as its serial port IP addr: 10.223.10.17/30

Configuration File Name

XL-T1.txt

Command Line Listing

```
Router Name "Anders Corp"  
Router Contact "Bob Smith"  
Router Location "1st St"
```

```
! Specify the default router, here the ISP serial port IP addr  
IP Default-router 10.223.10.17  
IP Cost 1
```

```
! One static route is included to the default router. Access to default router  
! is through serial port 1. DLCI is blank since connection is not frame relay.  
# Static Routes: Network      Next Hop    Cost Interface  DLCI  
IP Route      10.223.10.16/30  10.223.10.17  1    S1
```

```
! Router Ethernet Interface parameters:  
Interface E1  
IP Address 205.1.1.1/24  
IPRIP On
```

```
! Router Serial Interface 1 parameters:  
Interface S1  
Type T1  
Protocol PPP  
Poll-CD Off
```

Wait-CD Off
DTR On
Timeout 0

T1 Data	Normal		
T1 Clocking	Network		
T1 LBO	CSU	0dB	
T1 Framing	ESF		
T1 Coding	B8ZS		
T1 Speed	64K		
T1 Spacing	Contiguous		
#	START CHANNEL	NUMBER OF CHANNELS	
T1 Channels	Fractional	1	8

! If using full T1, that command reads:
! T1 Channels Full

IP Address 10.223.10.18/30
IP RIP Off
! ISP will not be running RIP over the serial interface

Example 6: IP•Express XL-E1**Scenario**

This sample configuration details an IP•Express connection over a leased E1 connection running PPP. The hardware in this example is the IP•Express XL-E1 with internal E1 DSU/CSU configured for full E1.

Configuration File Name

XL-E1.txt

Command Line Listing

```
Router Name "IPEXpress XL-E1"  
Router Contact "Francois"  
Router Location "HQ"
```

```
IP Default-router 205.1.34.1  
IP Cost 1
```

```
# Static Routes: Network Next Hop Cost Interface DLCI  
IP Route 209.23.44.0/24 10.223.10.17 1 s1
```

```
! Router Ethernet Interface parameters:  
Interface E1  
IP Address 205.1.34.2/24  
IP RIP On
```

```
! Router Serial Interface1 parameters:
```

```
Interface S1  
Type E1  
Protocol Engage  
Poll-CD Off  
Wait-CD Off  
DTR On  
Timeout 0
```

```
E1 Data Normal  
E1 Clocking Network  
E1 Framing CRC4  
E1 Coding HDB3  
E1 Channels Full
```

```
IP Address 10.223.10.18/30  
IP RIP Off
```

Example 7: Network and Port Address Translation

Scenario

This sample configuration shows an Engage IP Express router translating private network addresses to a global IP address. The NAT function performs IP Port Address Translation (PAT) on a single Global IP address. The NAT also provides a type of firewall by only allowing communication to those connections that are established from the internal side of the network. NAT enables users to create networks with large blocks of internal addresses without being restricted to a very limited supply of global addresses. NAT simplifies network administration by permitting more flexible internal addressing schemes.

- Internal, private address range: 192.168.1.0/24
- External globally routable address: 200.100.50.1/32

Configuration File Name

NAT.txt

Command Line Listing

```
Router Name "Corp Router"  
Router Contact "James"  
Router Location "Cook Rd."
```

```
IP Default-router 10.10.10.2  
IP Cost 1
```

```
NAT ON  
NAT GLOBAL ADDRESS 200.100.50.1
```

```
!Static Routes:      Network          Next Hop Cost    Interface DLCI
```

```
Interface E1  
IP Address 192.168.1.1/24  
IP Broadcast ONES, address 255.255.255.255  
IPRIP On
```

Interface S1
Type T1
Protocol PPP
Poll-CD Off
Wait-CD Off
DTR On
Timeout 0

IP Address 10.10.10.1/30
IP RIP Off

Example 8: IP • Express QT1/QE1*Scenario*

This sample configuration shows a four port IP•Express QT1/QE1 which has one static route, pointing to a single IP network. All of the four WAN ports are active. When the inverse multiplex option is on as in this example, and the WAN ports are configured to run PPP the IP•Express QT1/QE1 will run multilink PPP.

Configuration File Name

QT1/QE1.txt

Command Line Listing

```
RouterName "Receiver"  
Router Contact "No contact specified"  
Router Location "No location specified"  
  
IP Default-router  
IP Cost 1  
  
Inverse-Mux On  
  
Interface LAN1  
  
IP Address 192.68.10.1/24  
IP Broadcast ONES, address 255.255.255.255  
IP RIP On
```

Interface TEL1
Type T1
Protocol PPP

T1 Data	Normal	
T1 Clocking	Network	
T1 LBO	CSU	0dB
T1 Framing	ESF	
T1 Coding	B8ZS	
T1 Channels	Full	

IP Address
IP RIP On

Interface TEL2
Type T1
Protocol PPP

T1 Data	Normal	
T1 Clocking	Network	
T1 LBO	CSU	0dB
T1 Framing	ESF	
T1 Coding	B8ZS	
T1 Channels	Full	

IP Address
IP RIP On

Interface TEL3

Type T1

Protocol PPP

T1 Data	Normal	
T1 Clocking	Network	
T1 LBO	CSU	0dB
T1 Framing	ESF	
T1 Coding	B8ZS	
T1 Channels	Full	

IP Address

IP RIP On

Interface TEL4

Type T1

Protocol PPP

T1 Data	Normal	
T1 Clocking	Network	
T1 LBO	CSU	0dB
T1 Framing	ESF	
T1 Coding	B8ZS	
T1 Channels	Full	

IP Address

IP RIP On

Chapter 3

IP Network Planning

This chapter provides basic information on network planning for IP internetworks. Included are descriptions of IP addressing conventions as well as rules for connecting IP networks with IP•Express routers to form internetworks.

TCP/IP and Wide Area Networks

TCP/IP identifies a suite of protocols used in internetworks. In addition to the TCP and IP protocols, well-known protocols in the suite include FTP, a file transfer protocol; ICMP, a control message protocol which includes ping packets; RIP, a routing protocol; and several others.

Wide Area Networking is primarily concerned with the IP protocol and the proper routing of IP packets between different physical locations. IP, the internet protocol, is the lowest level protocol of the TCP/IP suite. It operates at layer 3 - the Network Interface layer - of the ISO 7-layer Reference Model.

IP Addressing

Every device or host on an IP network must be assigned a unique IP address. Hosts include workstations, servers, printers, and routers. An IP address is a 32 bit binary value. When writing an IP address, each byte of the address is converted into a decimal number and the numbers are separated by dots. e.g. 192.168.1.5

The IP address contains both the network address (Net ID) and the local address (Host ID). To determine which portion of the IP address is the Net ID and which portion is the Host ID another 32 bit value, the subnet mask, is required. The subnet mask is written in the same four byte fashion as the IP address. e.g. 255.255.255.0. or it may be represented in a shorthand fashion indicating the number of ones. e.g. /24. In this way a typical IP address for a host on a network would be written:

192.168.1.5/24.

In this example the Net ID is the first three bytes: 192.168.1 and the Host ID is the last byte: 5. Possible values for the Host ID in a /24 subnet range from 1 to 254.

The Net ID is a unique identifier for the network to which the Host is attached - it must not conflict with any other Net ID on the internet. The Host ID is a unique identifier for the device on that network - it must not conflict with any other Host ID on that physical network.

An IP network is typically identified by the lowest order Host ID. Thus the above network would be identified as 192.168.1.0/24. Not that this is not a valid IP address - instead it specifies a valid IP network.

Global vs. Private IP Addresses

IP addresses on the global Internet must be unique. For any connection to the Internet, the user should obtain IP address space from their ISP or directly from ARIN, the American Registry for Internet Numbers (www.arin.net), or other international registering bodies.

An autonomous network, not connected to the Internet, is not restricted to the use of globally unique addresses. For enterprise users not connecting to the Internet, it is advised they utilize IP addresses from the following three blocks of IP address space which are reserved for private internets:

10.0.0.0 to 10.255.255.255

172.16.0.0 to 172.31.255.255

192.168.0.0 to 192.168.255.255

An enterprise that utilizes the reserved IP addresses above can do so without coordinating with an Internet registry.

Network Address Translation (NAT) permits conservation of public IP addresses. For a simple enterprise application connecting a network of users to the Internet, a single public (globally unique) IP address can serve a network of users who have been assigned private (reserved) IP addresses.

Routing between Networks

The primary rules for creating internets are:

1. The IP Net ID for every physical network must be unique;
2. The IP Host ID for all devices within a net/subnet must be unique.

Routers provide interconnections between IP networks. A simple LAN router with two ethernet ports could connect two different IP networks:

192.168.1.0/24

and

192.168.2.0/24

The router would ensure that communication between workstation 192.168.1.45 and server 192.168.2.101, for example, can occur.

Wide area network routers, such as the IP•Express, route between their respective ethernet networks in the same way. A connection between two IP•Express units, one with ethernet 192.168.1.1 and the other with ethernet 192.68.2.1 provides connectivity between the networks. Note that the IP networks on the two ethernets must be different, in compliance with rule 1 above.

Chapter 4

Installation of the IP • Express Router

This chapter provides details on the physical connections required to form wide area connections using Engage IP•Express routers. Also covered is the initial communication with the router.

References are made to the configuration and operation of the routers as well as to the Command Line Interface. These topics are covered in detail in their respective chapters.

Installation Requirements

The use of Engage IP•Express routers to create a wide area network requires one router at each side of a synchronous connection. Any Engage router, whether an ExpressRouter or IP•Express, can be connected to any other Engage router. Engage routers, with support for the Point-to-Point Protocol (PPP) and Frame Relay interoperability standards, can also connect to any other manufacturer's routers which support these WAN protocols.

A standard IP•Express router package includes:

- One Engage IP•Express router
- One or more installed WAN interfaces (V.35, T1 DSU/CSU, etc.)
- Console port adapter
- RJ45 or other cables for optionally installed WAN interfaces
- An appropriate power converter (110 or 220 VAC input)
- Engage documentation floppy disk (Windows & Mac)
- Owner registration card

Router Installation Steps

The process of installing an IP•Express router on the network involves the following steps:

1. Planning for network configuration and security
2. Installing the router hardware
3. Configuring the router for the local area network (LAN)
4. Connecting and configuring any external data comm equipment (DCE)
5. Connecting and verifying the WAN connection

Planning for Network Configuration & Security

To avoid conflicts with network addressing as well as unauthorized access to sensitive areas of your network, it is advisable to have complete network address information available to verify that your new network address(es) are unique. Determine in advance which networks/subnetworks you wish to filter - to block from access by remote network users.

For more information on network security, please see Chapter 6: Network Security.

Installing the Hardware

Locating the Engage router

Site consideration is important for proper operation of the IP•Express router. The user should install the router in an environment providing:

- A well-ventilated indoor location
- Access within six feet of a power outlet
- Two feet additional clearance around the unit to permit easy cabling connection

As an option, the IP•Express router can be mounted in a standard 19 inch

equipment rack (rack mounts are available from Engage)

Powering the IP•Express

Engage IP•Express routers utilize an external power adapter, available in 110 VAC and 220 VAC versions, providing either AC or DC output.

The appropriate power adapter is provided with each unit. IP•Express XL models utilize an AC power adapter providing 24 Vac output while IP•Express Hub models utilize a 15-26 Vdc adapter.

AC Power

- Ensure the power adapter is not connected to power.
- Plug the AC adapter into the circular rear panel POWER connector.

DC Power

- Ensure the power adapter is not connected to power.
- Remove 1/2 inch (1 cm) of insulation from the end of each power lead.
- Insert the stripped end of the "+" lead into the **VDC (+)** terminal and tighten the screw above the terminal.
- Insert the stripped end of the "-" lead into the **GND (-)** terminal and tighten the screw above the terminal.
- Make sure there are no exposed wires.

Caution: To avoid equipment damage, ensure that the power adapter leads are connected to the proper terminals. This may require verifying polarity of the power adapter leads with a voltmeter.

- Secure one end of a ground wire (18 AWG - user-supplied) to the **FRM** (identified by the "fork" ground symbol) terminal and the other end of the ground wire to either a grounded rack or to earth ground.

Power On

Connect the power adapter to an appropriate AC power outlet and check

the POWER LED on the front panel of the Engage router. The POWER LED will be GREEN when the internal diagnostics have completed successfully. If the internal diagnostics have failed, it is YELLOW.

The function of the other LED indicators is detailed in the hardware description of the specific models.

Ethernet Interface

Engage IP•Express routers with the exception of the IP•Express QT1/QE1 router utilize 10BaseT Ethernet to connect to the Local Area Network.

IP•Express QT1/QE1 routers utilize a 10/100BaseT Ethernet to connect to the Local Area Network.

IP•Express XL models provide a **10BaseT** connector on the rear panel for connection to an Ethernet switch or hub using a straight-thru Ethernet patch cable. For direct connection to a PC or other LAN device, the user should obtain a 10BaseT crossover cable.

IP•Express Hub models have an integrated four-port Ethernet hub, eliminating the need for additional Ethernet equipment in basic installations. A PC or other LAN client can be connected to any of the **10BaseT Hub** ports using a straight-thru Ethernet patch cable. If the IP•Express Hub model is to connect to another hub or an Ethernet switch, a crossover cable will be required unless the hub/switch provides an Uplink port.

On connection, the **Ethernet** or **LAN** LED provides a simple verification of the connection of the Engage router to its network segment:

- The ETHERNET/LAN LED will blink GREEN during normal packet transmission.
- If, after power-on, the Engage router is unable to acquire a unique network address on the LAN, it will show a steady RED.
- If the ETHERNET/LAN LED is a steady GREEN or AMBER, then the network interface is faulty - the Engage router is unable to complete a packet transmission.

The IP•Express QT1/QE1 models provide specific information, with TD and RD indicators providing status on packet transmission and receipt, respectively, on the Ethernet interface. In addition, FDX and LNK

indicators provide status on Duplex and connectivity, respectively, on the Ethernet interface.

- The RD and TD will flash Green on transmission of packets out of the router's Ethernet interface.
- When in Full Duplex mode, FDX will show a steady GREEN. No light indicates Half Duplex.
- When connected to an Ethernet Network, LNK will show a steady GREEN.

Configuring the Engage Router for the LAN

The Engage router needs to be configured with a number of parameters which determine the router's operation in the network including:

- IP address and subnet mask
- Default router IP address
- Security options: passwords and/or packet filtering

The configuration procedure depends on the network environment in which the Engage router is to be installed.

Note: It is strongly suggested that you configure your router with its unique network identity **before** making any Wide Area Connection.

Initial Communication with the Router in a TCP/IP environment

There are two methods for configuring the IP address of an “unknown” router for use on an IP network. Either method can be employed when configuring a new router or a router with an unknown address.

The first method consists of communication through the router's **Console** port. The console port utilizes the same command line interface as Telnet

and an IP address can be directly assigned. See Chapter 4 for a hardware description and Chapter 5 for Command Line Interface.

A second method employs telnet to *assign* an IP address to the router. The user should power up the router and immediately attempt a Telnet connection to the desired IP address. If the Telnet session returns a timeout failure, the user should retry immediately - without restarting the router. Repeat these retries for up to two minutes.

When the sequence is successful, the **login:** prompt will appear. Enter the username **root** to open the Telnet session. The user will be asked to confirm that the router should adopt the new IP address.

If the method does not work the first time, the router should be restarted and the procedure retried, as timing constraints may not have been met.

Connecting and Configuring WAN Interfaces

Engage IP•Express models are available with a variety of WAN and Serial interfaces. Many models integrate digital telecommunication interfaces into the router, such as the internal 56/64 Kbps and T1/fracT1 DSU/CSUs. Other models provide synchronous serial interfaces for use with external Data Communication Equipment (DCE).

Serial Interface Connections

For those IPExpress models providing serial interfaces, such as V.35, RS-530 or RS-232, the connection to external telecom equipment is made using standard synchronous, male-to-male, one-to-one cables.

- Male-to-male refers to the connectors at each end of the cable.
- Straight (one-to-one) means that each of the signals of the interface used by the Engage router is connected directly from its pin number at one end of the cable to the same pin number at the other end of the cable.
- Synchronous means that the cable has a connection for the transmit data clocking signal(s), external transmit data clocking signal(s), and receive data clocking signal(s). Asynchronous cables do not utilize the clocking signals.

A simple way to handle the synchronous clocking signal connections is to use cables that interconnect all of the connector pins to the corresponding pins at the other end.

WAN Interface Connections

The WAN connection of an IPEXpress with integrated DSU/CSU is made utilizing a straight-thru RJ45 cable. The cable terminates in the SmartJack or other interface installed by the telecommunication service provider. For bench testing, a connection between two IPEXpress units can be made using a crossover cable. See the Appendices for DSU/CSU cabling pinouts and crossover cables.

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

Note: Connection of an unconfigured router to a T1 line can overload the router with framing errors, making communication with the router over the LAN difficult. Always configure the router's T1 interface prior to connection to the live T1 line.

Verifying the WAN Connection

The Engage router's connection to a remote router can be verified by the active port interface LEDs. Although the port LEDs are specific to the Engage router model used (and are detailed in the Configuration and Operation chapter) they do share common characteristics.

- If, after an initial power-up period, the IPEXpress router does not negotiate a layer 2 protocol, including PPP, Frame Relay or Engage Proprietary, the port LED will remain RED.
- When the IPEXpress negotiates a layer two protocol with the remote router, the port LED turns GREEN, and remains GREEN as long as communication with the remote router continues.
- When the Engage router detects reception of its own transmitted HELLO packet, as is the case in a Loopback condition, the LED will turn AMBER.

Chapter 5

Configuration and Operation

Engage IP•Express routers are available with a variety of WAN and LAN interface options. This chapter describes the specific interfaces and features, and outlines their configuration and operation details.

Numerous examples include Command Line Interface commands. Consult the Command Line Interface chapter for a complete listing of available configuration and query commands.

Interfaces and Features

The IP•Express family of WAN routers provides a wide variety of configurations to suit specific user requirements. Models range from the IP•Express XL, with a single Ethernet interface and a single WAN interface, to the IP•Express QT1/QE1 providing a single Ethernet interface and four WAN interfaces.

Engage routers are fully interoperable with other vendors' routers through the use of the Point-to-Point (PPP) and Frame Relay WAN protocols.

Contact Engage Communication Sales for specific model numbers and configuration options.

Console Port

IPExpress routers provide a **Console** port for configuring the router. The Console port may be used to communicate with the router locally through a terminal, or remotely by dialing in through a modem.

IPExpress router models utilize an RJ45 jack for the Console port. The Console port is configured as a DTE (data terminal equipment) port. This allows direct connection to a DCE (data communication equipment) device such as a modem. For connection to other DTE, such as a terminal or PC,

a Null Modem adapter is required.

An RJ45/db9 adapter is provided with the router which, in addition to providing a physical interface, performs the null modem operation permitting direct connection to other DTE equipment, such as a PC.

Pinouts for the Console port, as well as Engage supplied adapters, are provided in the Appendices.

Terminal communication to the console port should be set as:

9600 baud, 1 stop bit, no parity, 8 bit fixed

Login

When a connection is made to the router the **login:** prompt will appear. Enter the default username **root** to open the CLI session.

LAN Interfaces

IP•Express routers provide a 10BaseT Ethernet LAN connections with the exception of the IP•Express QT1/QE1 router. Basic IP•Express models include a single 10BaseT port while IP•Express Hub versions contain an integrated four port Ethernet hub.

The IP•Express QT1/QE1 models include a single 10/100BaseT Ethernet LAN connection. The 100BaseT interface introduces new configuration parameters for interface lan1.

Autonegotiate on - Interface determines speed and duplex mode.

Autonegotiate off - Speed and duplex are set manually.

Speed 10 or 100 - 10Mbps or 100Mbps

Duplex - half or full.

Single 10BaseT Interface

The 10BaseT interface connects via an Ethernet patch cable to an external Ethernet switch or hub. Configuration of the port involves setting the IP address and subnet mask, as well as broadcast address and other parameters. Examples of CLI commands:

```
ip address 192.168.1.1/24
```

```
ip broadcast ones
```

Single 10/100BaseT Interface (IP•Express QT1/QE1 router)

The 10/100BaseT interface connects via an Ethernet patch cable to an external Ethernet switch or hub. Configuration of the port involves setting the IP address and subnet mask, as well as broadcast address and other parameters. Examples of CLI commands:

```
ip address 192.168.1.1/24
```

```
ip broadcast ones
```

Four Port 10BaseT Hub

The integrated four port hub eliminates the need for an external Ethernet switch or hub in a basic installation. The router's Ethernet port can be viewed as connected to an internal, fifth port of this hub. Up to four workstations or other network devices can be connected to the hub.

The IP•Express Ethernet interface configuration involves setting the IP address and subnet mask, as well as broadcast address and other parameters. Examples of CLI commands:

```
ip address 192.168.1.1/24
```

```
ip broadcast ones
```

Ethernet Physical Address

The Ethernet physical (MAC) address can be obtained by issuing the command **show router**.

Serial Port Interfaces

Engage IP•Express routers may be configured with up to four ports for Wide Area Network (WAN) connections.

Interface LEDs

Front panel LEDs provide status on router functions.

The Power LED is normally green, although at startup it briefly turns amber as internal memory devices are loaded.

IP•Express Hub models, with integrated four port Ethernet hub, provide an Ethernet Hub link status LED for each of the four Ethernet ports.

The Ethernet or LAN LED flashes green on transmission of packets out the router's Ethernet interface.

The WAN Port LEDs, identified on different models as Port, Telco and DS1, have three states. If no valid data is received on the active port, the interface LED displays a solid red. If the Engage Router detects reception of its own serial HELLO packets, such as occurs in a loopback condition, the LED turns amber.

When the Engage Router receives layer two protocol packets from a remote router, the interface LED turns green and remains green as long as the layer two protocol remains up and active.

IP•Express QT1/QE1 Model

Ethernet

The IP•Express QT1/QE1 models provide specific information, with TD and RD indicators providing status on packet transmission and receipt, respectively, on the Ethernet interface. In addition, FDX and LNK indicators provide status on Duplex and connectivity, respectively, on the Ethernet interface.

- The RD and TD will flash Green on transmission of packets out of the router's Ethernet interface.
- When in Full Duplex mode, FDX will show a steady GREEN. No light indicates Half Duplex.
- When connected to an Ethernet Network, LNK will show a steady GREEN.

WAN

There are four indicators, Tel1 through Tel4 indicators providing status on valid framing to the T1/E1 device to which the IP•Express QT1/QE1 is connected.

- The RD and TD will flash Green on transmission of packets out of the router's WAN interface

- If the IP•Express QT1/QE1 is unable to receive valid frames from other equipment it is connected to via the T1/E1 line, the RD will be off.
- When connecting to the T1/E1 link, ST will show no color for a positive link and YELLOW for a link down.
- When the communication processor recognizes the port, ENA will show a steady GREEN.
- For correct framing status, LNK will indicate a steady GREEN.

Internal DIP Switches.

The IP•Express has internal DIP switches accessible by powering the unit OFF, removing both screws on the rear panel and sliding the printed circuit assembly out the rear of the unit.

Sw 1 - Turn to ON position to force router to key factory default settings. The primary effect is that any downloaded upgrade will be erased. The router configuration is not changed.

Sw 3 - In the ON position, the router will use IEEE 802.3 Ethernet format for IP broadcasts. When in the OFF position the router will use DIX Ethernet format. Factory Setting is OFF.

Sw 4 - Clears any IP filters which have been configured for the Engage router. When the router is reset or powered up with this switch set to the ON position, all filters will be cleared. This provides a means for clearing any improperly defined filter rules which may lock out administrator access.

T1/fractionalT1 DSU/CSU Option

The internal T1/fracT1 DSU/CSU permits direct connection to a T1/fracT1 interface provided by the telecommunications service provider. This connection uses a rear panel RJ48 jack and accepts 8 pin modular plugs. T1/fracT1 circuits use pins 1&2 for RxData and 4&5 for TxData. See

Appendices for T1 pinout.

The T1/fracT1 interface can be set to run at rates from 56Kbps up to full T1 at 1.544 Mbps.

Note: fracT1 running at 56Kbps is not interoperable with 56Kbps DDS service.

All configurations items, including Line Coding, Framing and TxData timing, are configurable using the Command Line Interface.

Two Engage routers with internal T1/fracT1 DSU/CSU interfaces can be connected “back-to-back” for bench testing. A crossover cable is required (see Appendices). Additionally, one of the two units should be set for Internal, rather than Network, timing. This provides a master-slave timing scheme.

Note: Always configure the T1 DSU/CSU before connecting to a T1 line, as improperly configured T1 circuitry can result in excessive serial errors which can impair communication to the router, even over Ethernet.

E1/fracE1 DSU/CSU Option

The internal E1/fractional E1 DSU/CSU permits direct connection to a E1/fracE1 interface as provided by the telecommunications service provider. This connection uses a rear panel RJ48 jack and accepts 8 pin modular plugs. E1/fracE1 circuits use pins 1&2 for RxData and 4&5 for TxData. An RJ48/db15 adapter cable is available if the E1 line is terminated in a 15 pin "D" connector. See Appendices for E1 pinout and cable specification.

The E1/fracE1 interface can be set to run at rates from 64Kbps up to full E1 speed of 2.048 Mbps.

All configurations items, including Line Coding and Clock Source, are configurable using the Command Line Interface.

Two Engage routers with internal E1/fracE1 DSU/CSU interfaces can be connected “back-to-back” for bench testing. A crossover cable is required (see Appendices). Additionally, one of the two units should be set for Internal, rather than Network, timing. This provides a master-slave timing scheme.

Inverse Multiplexor Option

The Inverse Multiplexor Option is available on dual port T1, E1 and QT1/QE1 IP•Express models. A proprietary inverse multiplexing technology provides a highly efficient utilization of two T1 or E1 connections, yielding an aggregate bandwidth of 3 Mbps for T1, 4 Mbps for E1.

Connection between the two IP•Express routers must ensure that Port 1 on one unit connects to Port 1 on the other - likewise Port 2 connects to Port 2.

The Inverse Multiplexor Option must be enabled with the CLI command

```
INVERSE-MUX[ON|OFF]
```

See *Chapter 6: Command Line Interface* for details on the configuration and status query for Inverse Multiplexing.

Drop and Insert Mux Option

Engage IP•Express MLDI models provide a Drop and Insert Mux capability to permit the utilization of a single T1 or E1 line for both IP data traffic and PBX voice traffic.

The customer data network (LAN) connects to any of the Ethernet hub ports and data traffic is routed between the IP•Express Ethernet interface (designated interface **e1** in the CLI) and the TELCO interface (designated interface **s1**).

The customer voice network, typically a connection to a PBX, connects to the DS1 port. In most cases a Crossover T1 cable is required for this interconnection. See *Appendices* for Crossover T1 specifications. PBX voice traffic is carried between the DS1 interface (interface **s2**) and the TELCO interface (interface **s1**).

Configuration of the Drop and Insert Mux option requires defining the T1 or E1 bandwidth division between data and voice traffic, with selected TELCO channels utilized for data and the remainder of the channels utilized for voice.

Note the following configuration highlights:

- Bandwidth configuration is required for interface s1 only. The remain-

ing bandwidth is **automatically** assigned to interface s2. If interface s2 is allocated partial bandwidth, idle characters are transmitted out the unallocated channels, disrupting the IP data routing path.

- In contrast, the PBX which connects to the DS1 interface (s2) must be configured for just the channels of the E1 interface which it will utilize.
- The T1 or E1 clock source must be synchronous between the TELCO interface (s1) and the DS1 interface (s2). This is accomplished by setting the T1 Clocking to **Network** for interfaces s1 and s2.
- One potential issue for T1 applications involves the use by some PBX systems of the 24th channel for "D" signalling. This can result in the PBX mistakenly interpreting IP data on that channel as voice calls. The PBX should be configured so as to not designate this 24th channel as signalling.

56/64 Kbps DSU/CSU Option for DDS

Engage routers can be configured with 1, 2 or 3 internal 56/64 Kbps DSU/CSU ports. This configuration allows direct connection to a 4-Wire DDS or Clear Channel interface using rear panel RJ48 jacks.

The RJ48 jack uses the same 8 pin modular phone connector used in 10BaseT Ethernet, but care must be taken not to mix the cables as the pinout is different.

DDS circuits use pins 1&2 for TxData and 7&8 for RxData. See Appendices for DDS pinout. The correct cable for DDS connection provides for 1 to 1 pin connection on, at a minimum, pins 1, 2, 7 and 8.

EngageView settings allow inverting the data. DDS data **must** be inverted when the router is to communicate with a SyncRouter or an older model of the ExpressRouter running version 2.XX or 3.XX firmware (beige, "shoebox" models).

Two Engage routers with internal 56/64Kbps DSU/CSU interfaces can be connected "back-to-back" for bench testing. A crossover cable connecting pin 1 to 8, 2 to 7, etc. is required. Additionally, one of the two units should be set for Internal, rather than Network, timing. This provides a master-slave timing scheme.

BERT Test and Loopback Features

IP•Express Hub models provide powerful E1 and T1 troubleshooting features including a number of Loopback tests and a built-in Bit Error Rate Tester (BERT). These test features enable the user to verify the functionality of the IP•Express and to pinpoint external problems with their E1 or T1 services.

Loopback Tests

The TEST commands are used to verify the operation of the built-in T1 and E1 interfaces. These loopback functions are typically used in conjunction with a BERT test, generated by the IP•Express or externally, to verify individual segments of a router-to-router connection.

There are four loopback configurations, allowing the user to loop the IP•Express data back to itself or to provide a loop facing the external network. The loopbacks are configurable for both the DS1 and the Telco interfaces of the MLDI models. These tests are fully described in the Test section of *Chapter 6: Command Line Interface*.

BERT Pattern Generation/Detection

The built-in Bit Error Rate Tester (BERT) allows the user to generate a variety of standard BERT test patterns on the T1 or E1 transmit path, and to monitor and measure errors on those patterns in the receive path. The BERT patterns can be transmitted on a single DS0 or across multiple contiguous DS0s - including the full T1 or E1.

By configuring an Internal or Framer loopback on the IP•Express, which loops its Tx Data back into its Rx Data path, the user can verify the operation of the IP•Express T1 or E1 interface.

By configuring a loopback on the far end of the T1/E1 circuit - at the remote DSU/CSU - the user can verify the quality of the T1 or E1 connection itself.

The commands used to generate a BERT test pattern and to monitor the received pattern are described in detail in the BERT section of *Chapter 6: Command Line Interface*.

Chapter 6

Command Line Interface

Configuration of IP•Express routers is accomplished using the Engage Command Line Interface (CLI). Command Line access to the router may be made through the Ethernet port, across a WAN connection or via the Console port.

For communication through Ethernet or across a WAN, Telnet is used. Telnet, part of the TCP/IP Protocol Suite, provides a general communications facility defining a standard method of interfacing terminal devices to each other. Any standard Telnet application can be used to communicate to an Engage router provided there is IP connectivity between the User Host and the router.

For communication through the Console port, standard serial communication software is used. The console port may be used to communicate with the router locally through a terminal, or remotely by dialing in through a modem.

Communication to the console port should be set as:

9600 baud, 1 stop bit, no parity, 8 bit fixed

The console port is an RJ45 jack and an appropriate cable and adapter are provided with the IP•Express for use with standard 9 pin COM ports

The RJ45 console port is configured as a DTE (data terminal equipment) port, as are all the router WAN ports. This allows direct connection to a DCE (data communication equipment) device such as a modem. For connection to other DTE, such as a terminal, a Null Modem adapter is required. The adapter provided with the router also serves this null modem function.

Initial IP Address Assignment with Telnet

Telnet can be used to assign an IP address to an “unknown” router - one in which IP is not enabled or has an unknown IP address.

The user should power up the router and immediately attempt a Telnet connection to the desired IP address. If the Telnet session returns a connection failure, the user should retry immediately - without restarting the router. Repeat these retries for a total of two minutes.

When the sequence is successful, the user will be asked to confirm that the router should adopt the new IP address. If the response is yes, the router adopts the new address permanently and restarts. If the response is no, the router ends the Telnet session and reverts to the previously configured IP address. If there was no IP address configured, IP will become unavailable.

Once the address assignment is complete, the user will need to assign further IP parameters including the subnet mask.

If the method does not work the first time, the router should be restarted to initiate the procedure again, as certain timing constraints may not have been met. This method relies on the Telnet workstation broadcasting repeated ARP requests for the desired IP address and the router, in the brief period after powerup, observing those requests go unanswered. It may be helpful to restart the workstation to clear its ARP cache.

Addressing conventions:

IP Address and Subnet Mask

The Engage command line interface makes use of a compact IP Address/Subnet Mask format which defines the subnet mask by its integer number of “1’s”. Examples:

<u>IP Address</u>	<u>Subnet Mask</u>	<u>No. of “1’s”</u>	<u>Addr/Mask format</u>
157.22.23.41	255.255.0.0	16	157.22.23.41/16
202.55.33.50	255.255.255.0	24	202.55.33.50/24
204.11.39.18	255.255.255.192	26	204.11.39.18/26
207.22.88.92	255.255.255.248	29	207.22.88.92/29

The long form of the subnet mask is also accepted:

207.22.88.92/255.255.255.248

If no mask is entered, the subnet mask for the address class is used.

Below is a list of standard Class C Subnets:

<u>4 Byte Representation</u>	<u>Number of 1's</u>
255.255.255.0	24
255.255.255.128	25
255.255.255.192	26
255.255.255.224	27
255.255.255.240	28
255.255.255.248	29
255.255.255.252	30

IP Network Representation

The Engage command line interface identifies a Network or Subnet by using the first (the “zero”) address of the subnet. Examples of this convention:

<u>Address Range</u>	<u>Mask</u>	<u>Representation</u>
202.55.33.0 to 202.55.33.255	255.255.255.0	202.55.33.0/24
204.99.13.64 to 204.99.13.127	255.255.255.192	204.99.13.64/26
207.22.88.8 to 207.22.88.15	255.255.255.248	207.22.88.8/29

Establishing a Telnet session

A Telnet session is opened by providing the IP address of the router. On opening a Telnet session with an Engage router, the **login** prompt requires entry of a User ID. The default User ID: **root**.

Engage routers are shipped with no password set. Passwords are set or modified with the **passwd** command, detailed below.

Overview of the Engage CLI

A full description of the Engage command line interface follows. Additionally, the entire list is provided in the Appendices section.

Categories

The command set can be divided into four categories:

- General
- Show
- Config
- Config Interface

Help

Included in the General commands is the HELP command, providing information on the entire command set.

Configuration Modes

For the Config and Config Interface commands, Engage employs a modal approach. The user enters the Configuration mode, makes changes, then Saves those changes. On Saving the changes the user leaves the Configuration mode.

A further mode, within the Configuration mode, is used to set parameters for a specified interface. Once in the Configuration mode, the user enters the Interface command. All subsequent commands apply to the specified interface.

The Telnet prompt indicates the mode of operation as follows:

routename# the single “#” indicates standard Telnet mode

routename## double “#” indicates Configuration mode

routename(S1)## router is in Interface Config mode, Serial Port 1

To move up one level, from Interface Config mode to Config mode, enter the **interface** with no argument. To change between interfaces when in

Interface Config mode, specify the new interface. For example:

```
routername(S1)## interface e1
```

Syntax for Command Parameters (Arguments)

{} == one of the parameters in set is required

[] == one of the parameters in set is allowed (optional)

Show Config All

The SHOW CONFIG ALL command, outlined below, provides the means to store and replay an entire configuration. Using a cut and paste operation, configurations may be edited off-line and stored.

General Commands

PASSWD

Allows setting or modifying the login password. The router ships with no password set. On entering the **passwd** command, the user is prompted to enter, and confirm, the new password. This password is equivalent to the Admin password set in EngageView.

BYE | QUIT | LOGOUT

Any of these commands will terminate the Telnet session. If you have unsaved configuration changes, you will be prompted to save or discard the new configuration.

RESET

Resets the Engage router.

HELP [HELP | ALL | CONFIG | SHOW]

Provides Help information on a selected list of topics. Typing **help** with no argument provides the Help summary screen which is the top-level list of commands.

CLEAR {E1 | S1 | S2}

Clears the port statistics on the selected port: Ethernet, Serial Port 1, Serial Port 2.

QT1/QE1 Models Only

CLEAR {Lan1|Tel1|Tel2|Tel3|Tel4}

Clears the port statistics on the selected port: Ethernet, Serial Port 1, Serial Port 2, Serial Port 3, Serial Port 4.

TERM NN

Allows the user to tailor the number of display lines to their terminal screen size

PING {dest.address} [src.address] [{number}] |spray]

Sends an ICMP ECHO message to the specified address. Any source address from an interface on the router can be used. This can be useful to test routes across a LAN or WAN interface.

By default, only 1 message (packet) is sent. A numeric value can be entered to send more than one message. Also, SPRAY can be used to continually send messages until the ESC key is pressed.

UPGRADE {TFTP SERVER} [DNS Address] [Filename]

TFTP (trivial file transfer protocol) provides a means for upgrading Engage router firmware in a TCP/IP environment. A TFTP upgrade may be accomplished over the Internet from Engage Communication's TFTP site, or the user can configure their own local TFTP server.

To upgrade over the Internet, obtain the filename for the latest version from Engage (support@engage.com), then issue the command from within a Telnet session:

UPGRADE TFTP.ENGAGE.COM [Filename]

In the event this is unsuccessful, it may be necessary to specify the IP address of your local Domain Name Server as follows

UPGRADE TFTP.ENGAGE.COM 157.22.1.1 [Filename]

To upgrade locally, obtain the upgrade file from Engage Tech Support or ftp.engage.com. Configure a local TFTP server with this file and upgrade with the local server's address as:

UPGRADE {TFTP SERVER} [Filename]

Note that a router which is running an upgrade must go through two resets when performing an upgrade. This may cause a Telnet connection to drop. If this does occur, simply re-establish the Telnet connection.

SHOW Commands

SHOW [INTERFACE [E1|S1|S2]] {INFO|STATISTICS} FRAME-RELAY-DLCI}

QT1/QE1 Model Only

SHOW [INTERFACE [Lan1|Tel1|Tel2|Tel3|Tel4]] {INFO|STATISTICS} FRAME-RELAY-DLCI}

Provides details on any LAN or serial interface. If no interface is specified, either the current interface per “interface” command will be used, or all interfaces will be shown.

INFO details the port type, port state, etc.

STATISTICS lists the packets transmitted, received, etc.

FRAME-RELAY-DLCI lists all active DLCIs on the specified port, and their status.

SHOW ROUTER provides general configuration and status information, including the ethernet hardware address and the firmware version.

SHOW IP ROUTES [LOCAL|RIP|STATIC] lists IP routes. If no argument is provided, all IP route types are listed. The IP Route type indicates the source from which the router learned the route.

Local routes are those to networks to which the router is directly at-

tached.

If RIP, the Routing Information Protocol, is enabled in the router configuration, routes learned through the exchange of RIP packets will be listed.

Static routes are those defined explicitly in the router configuration.

SHOW FILTERS provides a listing of all filters on all interfaces.

SHOW IP STATISTICS provides more detailed statistics on IP packets only.

SHOW CONFIG ALL provides a list of all configuration parameters. No argument is the same as ALL. This list provides the basis for storing a router configuration into a local text file. The full configuration can be edited offline.

SHOW CONFIG INTERFACE {E1|S1|S2}

QT1/QE1 Model Only

SHOW CONFIG INTERFACE [Lan1|Tel1|Tel2|Tel3|Tel4]

If no interface is specified, either the current interface per the “interface” command will be used, or all interfaces will be shown.

SHOW CONFIG IP [ALL|ROUTES]

Details the IP configuration. No argument is the same as ALL, which provides routes as well as IP configuration items which don't pertain to a specific port, i.e. default router, routing cost, etc.

SHOW CONFIG ROUTER

Provides overall router configuration information including hardware configuration, ethernet MAC address, uptime, etc.

CONFIGURATION Commands

The Engage CLI employs a modal approach to Telnet router configuration. The user enters the Configuration mode, makes changes, then Saves those changes. On Saving the changes the user leaves the Configuration mode.

A further mode, within the Configuration mode, is used to set parameters for a specified interface. Once in the Configuration mode, the user enters the Interface command. All subsequent commands apply to the specified interface.

The Telnet prompt indicates the mode of operation as follows:

routename# the single “#” indicates standard Telnet mode

routename## double “#” indicates Configuration mode

routename(S1)## router is in Interface Config mode, Serial Port 1

To change between interfaces when in Interface Config mode, simply specify the new interface. For example:

```
routename(S1)## interface e1
```

CONFIG

Enter the Configuration mode, at which point the following commands may be used:

SAVE

Save the changes and exit Configuration mode

END [SAVE]

Exit Configuration mode. The optional SAVE instructs the router to save configuration changes.

RESTORE

Restores the current router configuration, ignoring any changes which have been made during the current Telnet CONFIG session.

ROUTER NAME namestring

ROUTER CONTACT contactstring**ROUTER LOCATION locationstring**

These three text fields allow the user to assign site specific information which would be used by SNMP network management applications.

IP DEFAULT-ROUTER address

Enter the IP address of the default router or gateway.

IP COST NN

Enter the routing cost, in hops, to the default gateway. Typically set to 1.

IP ROUTE addr[/mask] next-hop cost port dlcI

Static Routes are entered using the IP Route command. The address convention used provides the first (the “zero”) address of the subnet. The Subnet mask convention uses the integer number of 1’s in the subnet mask. Examples of this addr/mask convention:

<u>IP Address Range</u>	<u>Subnet Mask</u>	<u>addr/mask value</u>
202.55.33.0 through .255	255.255.255.0	202.55.33.0/24
204.99.13.64 through .127	255.255.255.192	204.99.13.64/26
207.22.88.8 through .15	255.255.255.248	207.22.88.8/29

- The next-hop entry is the IP address of the next-hop router/gateway.
- Routing cost is an integer value.
- Valid port entries include e1, s1, s2.
- DLCI is left blank if the route is not a Frame Relay connection

Examples of valid static route entries:

```
ip route 202.55.33.0/24 202.55.33.50 1 s1 19
```

```
ip route 204.99.13.64/26 204.99.13.65 1 s2 103
```

```
ip route 207.22.88.8/29 207.22.88.9 1 e1
```

Note: All Static Routes require an explicit IP Network Address. User should configure a route to the IP network in which the Default Router resides, if not on a directly connected network..

A route to 0.0.0.0 is not permitted, instead the default router's IP address is specified.

IP DELETE addr

Delete a static route. Example of format:

```
ip delete 157.22.234.0
```

CONFIG INTERFACE Commands

INTERFACE [E1|S1|S2]

QT1/QE1 Model Only

INTERFACE [Lan1|Tel1|Tel2|Tel3|Tel4]

Places router in the Interface Configuration mode for a specific Interface, or Port. Once in this mode, the following commands are available:

IP ADDRESS addr[/mask]

Used to configure the IP address and subnet mask for the selected interface, whether ethernet or serial.

IP RIP {OFF|ON|LISTEN|SEND}

Sets the Routing Information Protocol configuration for the selected port. IP•Express routers support RIP v1 .

- | | |
|---------------|---|
| OFF | RIP not enabled |
| ON | Router will transmit RIP information out the selected port and will process RIP information received through the port |
| LISTEN | Router will process incoming RIP packets, but will not transmit RIP. |
| SEND | Router will transmit RIP information but ignore received |

RIP packets.

Note: RIP v1 has limitations relating to subnetting and variable length subnet masks. Because subnet mask information is not included in RIP v1 updates, it will not route properly to networks which have been subnetted. Therefore it is only useful when using full, "classful" IP networks. The following table defines IP address classes A, B and C, and the subnet mask that must be applied for RIP v1 to work properly

Class	Lower Addr	Upper Addr	Required Subnet Mask
A	1.0.0.0	126.255.255.255	/8 (255.0.0.0)
B	128.0.0.0	191.255.255.255	/16 (255.255.0.0)
C	192.0.0.0	223.255.255.255	/24 (255.255.255.0)

For example, the Class C network 192.168.1.0 must utilize a 255.255.255.0 subnet mask in order for RIP v1 to route properly, while the Class A network 10.1.1.0 must utilize a 255.0.0.0 subnet mask.

TYPE {RS232|RS449|RS530|56K|64K|DDS|T1|E1|V.35}

Sets the port type. Port types 56K, 64K DDS, T1 and E1 are only available with models which have the internal DSU/CSU installed.

PROTOCOL {ENGAGE|PPP|FRAME-RELAY}

Selects the Engage proprietary WAN protocol, or one of two standards-based WAN protocols.

POLL-CD {ON|OFF}

Applicable only to serial interfaces including RS-232 and RS-530, this defines whether the carrier detect (CD) signal must be active to bring the WAN connection up.

WAIT-CD {ON|OFF}

Applicable only to serial interfaces. Set ON to specify that the serial interface will operate in synchronous mode only when CD is asserted, otherwise it is in asynchronous mode.

DTR {ON|OFF}

Applicable only to serial interfaces and used for dialup connections, such as ISDN, this asserts the DTR control signal for the external DCE.

TIMEOUT NN

Used for dialup connections, such as ISDN, this permits setting a timeout after which the connection will be brought down in the absence of data.

Ethernet Interface**AUTONEGOTIATION {ON | OFF}**

Enable or disable IEEE 802.3 Auto-negotiation on the Ethernet interface. Warning: If the device connected to LAN1 uses Auto Negotiation and LAN1 is configured to use full duplex without Auto-Negotiation, the other device may operate in half duplex mode by default and successful operation cannot be guaranteed.

DUPLEX {HALF | FULL}

Sets the duplex mode for the Ethernet interface. This command only takes effect when Auto-negotiation is configured to OFF. Warning: If the device connected to LAN1 uses Auto-Negotiation and LAN1 is configured to use full duplex without Auto-Negotiation, the other device may operate in half duplex mode by default and successful operation cannot be guaranteed.

SPEED {10 | 100}

Sets the line rate in Mbps for the Ethernet interface. This command only takes effect when Auto-negotiation is configured to OFF.

IP ADDRESS address[/mask]

The interface IP address and subnet mask are required for configuration with telnet or connectivity tests with ping. The subnet mask can be entered in long or

short form. Examples:

```
IP ADDRESS 192.168.1.1/255.255.255.0
```

```
IP ADDRESS 192.168.1.1/24
```

IP BROADCAST [ONES | ZEROS | DIRECTED]

Assigns IP broadcast address for the Ethernet port. ONES assigns a broadcast address of 255.255.255.255, which is the default on most networks. ZEROS assigns a broadcast address of 0.0.0.0. DIRECTED assigns a broadcast address which is a multicast of the network address for the Ethernet port. For example, if the network address is 10.x.x.x, a directed broadcast address would be 10.255.255.255. Example:

IP BROADCAST ONES

The interface IP address and subnet mask are the only parameters required for the Ethernet interface. The subnet mask can be entered in long or short form. Examples:

```
IP ADDRESS 192.168.1.1/255.255.255.0
```

```
IP ADDRESS 192.168.1.1/24
```

BROADCASTRCV {OFF | ON}

The Ethernet interface can be configured to disable the reception of Broadcast and Multicast packets. The IP protocol uses broadcast packets to resolve the Ethernet MAC Address of the destination IP.

BROADCASTRCV OFF requires that the Destination IPTube or the Default Router and any local device that wants to communicate with the IPTube needs to be configured with the MAC address of the IPTube in its ARP table. Due to the complexity involved in setting up the IP Address to Ethernet MAC addresses manually it is recommended that BroadcastRCV is set to ON unless broadcast storms are expected on the network where the IPTubes reside. For the Ethernet interface, first specify INT lan1.

Typically if BroadcastRCV is set to OFF the Tube Ether ARP and Tube Ethernet Address needs to be configured with the MAC address of the IPTube packet's Ethernet destination, refer to Interface S1. Since the destination for the IPTube packet will have its broadcast receive turned off also.

T1 Port Configuration Commands:**T1 DATA {NORMAL|INVERTED}**

Can be set for Normal or Inverted and must match the setting of the DSU/CSU on the other end.

T1 CLOCKING {NETWORK|INTERNAL}

Determines the source of Transmit Clock (TxCk). When set to Network, the DSU/CSU derives its transmit timing from the received data (RxD) and is therefore synchronized with the telco (the phone network). This is generally used when connecting through commercial carriers and is also referred to as Slave timing.

When set to Internal, the DSU/CSU transmits data at a rate set by an internal clock. This mode is also referred to as Master timing and is used when testing on the bench - one unit set to Master, the other to Slave.

T1 LBO {CSU {0dB|-7.5dB|-15 dB|-22.5dB}|DSX-1 NN}

This setting determines the transmitted data (TxD) waveform to compensate for attenuation on the T1 line. Typically Line Build Out is set to the CSU mode, where the build out is specified in dB. In applications where the T1 cabling is short - the ExpressRouter is within 20 feet of the network termination - set for 0 dB.

T1 FRAMING {ESF|D4}

Selects whether Extended Super Frame (ESF) or D4 framing is to be used. Typically the T1 service provider specifies.

T1 CODING {B8ZS|AMI}

Selects whether B8ZS or Alternate Mark Inversion line coding is used. Typically the T1 service provider will specify.

T1 SPEED {56k|64k}

Sets the DS0 speed. If set to 56K the maximum full T1 speed is 1.344 Mbps. Typical setting is for 64K channels

T1 SPACING {ALTERNATE|CONTIGUOUS}

Associated only with fractional T1, this specifies whether the channels are contiguous (adjacent) or alternating (every other channel).

T1 CHANNELS {FULL | FRACTIONAL {NN XX}}

Full will utilize all channels. When Fractional is selected, additional options are presented:

Start Channel: Enter the location of the first channel, or DS0, of the fractional service. Minimum entry is “1”.

Total Channels: Enter the total number of channels used

For example, 384 Kbps fractional T1 typically uses channels 1 through 6. Set Spacing: Contiguous, Start Channel: 1 and Total Channels: 6. where NN defines the Start Channel; XX is the total number of channels

E1 Port Configuration Commands:

E1 DATA {NORMAL | INVERTED}

Can be set for Normal or Inverted and must agree with the setting of the DSU/CSU on the other end.

E1 CLOCKING {NETWORK | INTERNAL}

Determines the source of Transmit Clock (TxCk). When set to Network, the DSU/CSU derives its transmit timing from the received data (RxD). This is also referred to as Slave timing.

When set to Internal, the DSU/CSU transmits data at a rate set by an internal clock. This mode is also referred to as Master timing and is often used when testing E1 connections on the bench.

E1 FRAMING {CRC4 | FAS}

Selects whether CRC4 Framing is enabled.

E1 CODING {HDB3 | AMI}

Selects whether HDB3 or Alternate Mark Inversion line coding is used.

E1 CHANNELS {FULL | FRACTIONAL {NN XX}}

Select Full or Fractional E1 and configure for fractional, where NN is first E1 channel (1 - 31), XX is the number of channels.

Timeslot Usage: FULL utilizes all channels. When Fractional is selected, additional options are presented:

Start: Enter the location of the first channel, or DS0, of the fractional service. Minimum entry is "1".

Total Channels: Enter the total number of channels used.

Frame Relay Configuration Commands:

FRAME-RELAY T391 NN

FRAME-RELAY N391 NN

FRAME-RELAY MANAGEMENT {ANNEX-D|LMI}

Frame Relay configuration commands. The T391 timer specifies the time between Status Enquiries sent to the Frame Relay switch, i.e. a status enquiry is sent every T391 seconds. The default value is 10 seconds. The N391 counter sets the frequency of Full Status Enquiries, i.e. every N391 Status Enquiries a Full Status Enquiry is sent. Default N391 is 6.

Management interface should be set to that used by the Frame Relay service provider.

Config Filter Commands

Filter commands are detailed in Chapter 8: Network Security

FILTER [IN|OUT]

PERMIT|DENY [INTERFACE {E1|S1|S2}]

QT1/QE1 Model Only

PERMIT|DENY [INTERFACE [Lan1|Tel1|Tel2|Tel3|Tel4]]

DELETE ALL

Config Inverse Multiplexor Commands

Inverse Multiplexing provides commands to enable/disable and to query the status. If the Inverse Multiplexor option is not enabled on the IP•Express router, these commands will result in an "invalid command" response.

INVERSE MUX [ON|OFF]

Used to enable the inverse multiplexing mode

SHOW INVERSE

Provides the status of the inverse multiplexing operation on each of the two ports. A sample response:

Inverse-Mux On

Serial Port 1 Inverse Mux Status: ACTIVE

Serial Port 2 Inverse Mux Status: ACTIVE

Status: ACTIVE occurs when both ports have successfully Inverse Multiplexed.

Note: Inverse Multiplexing requires the connection of Port 1 to Port1 and Port 2 to Port 2 on the connected IP•Express routers.

Config NAT Commands

Network Address Translation provides commands to enable/disable the feature as well as for querying status. An "invalid" response will be returned if the NAT option is not installed.

NAT [ON|OFF]

Used to enable NAT

NAT GLOBAL ADDRESS *addr*

Used to enter the global address to which the IP•Express router is to respond.

SHOW NAT

Responds with the NAT enable/disable status and the configured NAT global

address.

TEST Commands for Loopback

IP•Express Hub models provide advanced troubleshooting features which enable the user to verify the functionality of the IP•Express T1/E1 interfaces and to pinpoint external problems with their T1/E1 services.

IP•Express TEST commands allow the user to configure loops between the Transmit and Receive data paths and are used to verify the operation of the built-in T1 and E1 interfaces. These loopback configurations are typically used in conjunction with BERT test patterns, generated by the IP•Express or externally, to verify individual segments of a router-to-router connection.

The TEST commands allow setting one of four loopback configurations, allowing the user to loop the IP•Express data back to itself or to provide a loop facing the external network.

TEST loops are configured on a per-interface basis. The user must first specify the interface on which the loop is to be configured:

INTERFACE [S1|S2]

The TEST command has five arguments

TEST LOOP {OFF | INTERNAL | NETWORK | PAYLOAD | FRAMER }

To clear any configured loopback and return to normal operation, use the OFF command:

TEST OFF

Note that any configured loopback is cleared by a unit RESET or power cycling.

Loop towards the Network

Two of the TEST commands configure the IP•Express to loop its Receive Data back to its Transmit Data path. This is useful if the T1/E1 service provider or the remote site DSU/CSU sends a BERT pattern to test the connection to the IP•Express site:

TEST LOOP NETWORK

When a NETWORK loop is configured, the selected interface's Receive Data will be loop backed to the Transmit Data path. Receive Data will continue to pass through the Receive side framer as it would normally, while the data from the Transmit side formatter is ignored.

TEST LOOP PAYLOAD

When a PAYLOAD loop is configured, the selected interface's Receive Data input will be loop backed to the Transmit Data path as in the NETWORK loop. Data in the Receive path will continue through the Receive framer. But, in contrast to the NETWORK loop, Transmit Data will be transmitted synchronously with the Receive Clock rather than Transmit Clock.

For T1 interfaces the PAYLOAD loop is normally enabled when ESF framing is being performed, but can be enabled also in D4 framing applications. In a PAYLOAD loop situation, the T1/E1 Circuit will loop the 192 bits of payload data (with BPVs corrected) from the receive section back to the transmit section. The FPS framing pattern, CRC6 calculation, and the FDL bits are not looped back, they are reinserted by the T1 circuitry.

For E1 interfaces the PAYLOAD configuration will loop the 248 bits of payload data (with BPVs corrected) from the receive section back to the transmit section. The transmit section will modify the payload as if it was normal Transmit Data. The FAS word, Si, Sa and E bits, and CRC4 are not looped back, they are reinserted by the E1 Circuitry.

Loop IP•Express Tx Data Back on to Rx Data Path

The remaining TEST commands configure the IP•Express to loop its Transmit Data back to its Receive Data path. This is useful for testing the IP•Express T1/E1 interfaces. After configuring the INTERNAL or the FRAMER loopback, the user would initiate a BERT test to prove the IP•Express transmit and receive data paths.

TEST LOOP INTERNAL

With INTERNAL loopback configured, data will continue to be transmitted as normal. Data being received at RTIP and RRING will be replaced with the data being transmitted. Data in this loopback will pass through the Jitter attenuator.

TEST LOOP FRAMER

The FRAMER loopback is useful in testing and debugging. The selected T1/E1 will loop data from the transmit side back to the receive side. When FRAMER loop is enabled, the following will occur:

- Interface Receive Data is ignored.
- Receive side data will take on timing synchronous with TxClk instead of RxClk.
- T1 Mode: An unframed all ones code will be transmitted.
- E1 Mode: Normal data will be transmitted.

BERT Pattern Generation/Detection

The built-in Bit Error Rate Tester (BERT) allows the user to generate a variety of standard BERT test patterns on the T1 or E1 transmit path. Once a test pattern is configured for transmission out the interface, the STATUS of the receive path signal can be queried for the quality of the received test pattern.

The BERT function is assigned on a per-channel basis for both the transmitter and receiver. The allows configuration of BERT tests on a single DS0 or across multiple contiguous DS0s - up to and including the full T1 or E1.

By configuring an INTERNAL or FRAMER loopback, which loops IP•Express Tx Data back into its Rx Data path, then performing a BERT test, the user can verify the functionality of the IP•Express T1 or E1 interface.

By configuring a loopback on the far end of the T1/E1 circuit - at the remote DSU/CSU - and performing a BERT test, the user can verify the quality of the T1 or E1 connection itself.

Note: BERT Test patterns are Framed.

BERT tests are configured on a per-interface basis. The user must first specify the interface on which the BERT test is to be configured:

INTERFACE [S1|S2]

There are nine BERT test arguments:

BERT [OFF | ON | DIRECTION | CHANNEL | PATTERN | RESYNC | ERROR | STATUS | CLEAR]

BERT OFF

Returns selected interface put back to configured state

BERT ON

Turns on BERT for selected serial interface. Note that any BERT test is turned off after an IP•Express RESET or power cycle.

BERT DIRECTION [IN | OUT]

Configured for OUT, the BERT test pattern is transmitted out the selected Serial interface. This is the typical test mode. The IN configuration sends the BERT pattern into the system and is only valid for serial interface 2 (S2) in Drop and Insert configurations.

BERT CHANNELS [NN XX]

Configure the DS0(s) across which the BERT test pattern is transmitted and monitored. NN is the first channel to put the BERT Pattern into and XX is the number of channels to be used. T1 interfaces have DS0s numbered 1-24, while available DS0s for an E1 interface are 1-31.

BERT PATTERN [2E07 | 2E11 | 2E15 | QRSS]

Select the desired pseudorandom test patterns. QRSS is the most common.

- 2E07: $2^7 - 1$
- 2E11: $2^{11} - 1$
- 2E15: $2^{15} - 1$
- QRSS: A $2^{20} - 1$ pattern with 14 consecutive zeros

Note: BERT parameter changes take effect immediately on entering them. BERT configurations must be saved if they are to be retained after a RESET or power cycle.

BERT RESYNC

Forces the receive BERT synchronizer to resynchronize to the incoming data stream. This command should be issued as needed to acquire synchronization on a new pattern.

BERT ERROR

Injects a single bit error in the pattern. Useful for confirming pattern detect.

BERT CLEAR

Clears Bits Transmitted and Bit Error counters for the selected port.

BERT STATUS

Queries the IP•Express for information on BERT configuration and test results. The BERT STATUS will report SYNC when the incoming pattern matches for 32 consecutive bit positions. The BERT STATUS will lose sync after receiving six errored bits out of 64 bits. Once synchronization is achieved, this bit will remain set until read.

An example of the results displayed with the BERT STATUS command:

Bert S1 Status

```

|                                     Start End
| Turned: On      Direction: Out    Channels:  1  12
| Pattern: QRSS   Pattern Synch: Yes  Pattern Synch Lost: No
|
| Receive All Ones: No           Receive All Zeros: No
| Bits Transmitted: 3735398      Bit Errors:      0

```

In the above example note that

- A BERT test is enabled on interface Serial 1 (S1).
- The BERT pattern is applied in the outbound direction of S1.
- The BERT pattern is applied only on DS0s 1 through 12, not the entire T1.
- QRSS is the BERT pattern in use.
- The Receive circuitry has Synched (locked) on to the incoming BERT pattern.
- The Receive circuitry has no lost Sync since BERT statistics were last cleared.

Chapter 7

Network Security

Engage routers provide a number of network security options. For TCP/IP networks, Engage's IP Packet Filtering allows creation of highly selective filters to permit or deny access in any direction through any router port.

IP Packet Filtering

Engage IP packet filtering allows the creation of rule sets which selectively block TCP/IP packets on a specified interface. Filters are applied independently to all interfaces, ethernet and serial, as well as independently to interface direction: input (packets coming in to the router) or output (packets transmitted out of the router).

Packet filtering is used to prevent unauthorized access to your internal network as well as to limit internal user access to services across the WAN. Complex filters can be constructed. One example would be a filter which prevents external users from establishing Telnet sessions to any internal hosts while permitting selected internal users to establish Telnet sessions to external hosts.

Improperly constructed filters can yield unexpected results. Example filters are provided, but it is recommended that users completely familiarize themselves with the filtering rules in the next section before applying filters to their own routers.

Basic Filtering Rules

WAN Router Filters

Filters are often applied to WAN routers by a network administrator via the internal LAN. To avoid inadvertently restricting the administrator's own access to the router, it is advisable to apply all filters to the serial (WAN) port rather than the ethernet (LAN) port.

Default Packet Deny

Filters are applied to an interface and direction, for example to **s1 out**. If a single filter command is applied to an interface-direction, **all** packets not explicitly permitted will be denied.

If no filter is applied to an interface-direction, all packets are permitted.

Filter Rule Ordering

- a. Filter rules are applied in the order in which they were entered by the user.
- b. A packet will be checked against the rules until a match, either a permit or deny, is encountered. No further rules are checked.
- c. If possible, place filters which will apply to the largest number of packets at the beginning of the list. This increases efficiency.

Ramifications of these rules

- a. Generally the user will place Permit filters before Deny filters
- b. One exception is a wild card Permit rule placed at the end of the rule list which will Permit all packets not explicitly denied:

Permit all *or* Permit 0.0.0.0 0.0.0.0

Clearing Filters

Filters may be cleared through the use of the **delete** command, outlined below.

Additionally, power cycling the Engage router with DIP Switch 4 turned ON will delete all filters, useful if users lock themselves out.

Command Format

Filter Entry Mode

Filter entry is accomplished through a Command Line session with the router. The default login is `root` after which the router responds with the prompt:

```
RouterName#
```

To enter filters, you must be in Configuration mode by typing **config**. The prompt changes to:

```
RouterName##
```

An interface must be selected using the command:

```
interface [e1 |s1 |s2].
```

QT1/QE1 Models Only

```
interface [Lan1|Tel1|Tel2|Tel3|Tel4]
```

The next prompt indicates selected interface:

```
RouterName(S2)##
```

The filter command is used to define the direction of filters.

```
filter [in | out]
```

filter in - Begin command entry for input filters. Input filters apply to packets received IN to the router through the specified port. The Command Line prompt indicates a left arrow:

```
RouterName(S2)##<
```

filter out - Begin command entry for output filters. Output filters apply to packets transmitted OUT of the router through the specified port.

Command Line prompt indicates a right arrow:

```
RouterName(S2)##>
```

Filter Command Format

The format for the filter command:

```
permit|deny [interface{e1|s1|s2}] [in|out][src-addr[dest-addr]] [type]  
[options]
```

QT1/QE1 Model Only

```
permit|deny [interface{Lan1|Tel1|Tel2|Tel3|Tel4}] [in|out][src-addr[dest-addr]] [type]  
[options]
```

permit or **deny** designates what action should be performed on the packet

[interface]{e1|s1|s2|s3} is used to define the rule for a given port. If an interface is not explicitly defined, the default will be the current interface defined via the **interface** command. If no interface is current, an error is displayed.

[in|out] is used to define the direction of the filter. If not used, the direction defined in the **filter** command will be used. If no interface is current, an error is displayed.

[src-addr[dest-addr]] src-addr and dest-addr define the source and destination IP address(es) to be filtered. These addresses can be either discrete host IP addresses or network addresses in the format a.b.c.d/x, where x is the number of bits for the network mask.

Source and destination addresses are optional. If neither is specified, the rule applies to all source and destination addresses - same as the wild card IP address 0.0.0.0. If only one address is specified it is interpreted as the source address.

type is the protocol to be acted on. Valid choices are TCP, UDP, ICMP and IP. If no protocol type is specified, the filter applies to all protocols.

options allows more specific filtering on protocols. If no expression is specified, all ports and protocol flags are filtered. Valid expressions depend on the protocol selected as follows:

- TCP expressions are used to filter on TCP source/destination ports as well as control flags and have the format:

```
TCP [SRC <op><value>] [DST <op><value>] [<tcp-flags>]
```

where

op is a relational operator of the following set:

=, !=, >, >=, <, <=

value indicates the protocol port to be filtered. Common TCP ports include:

ftp-data	20	File Transfer (Default Data)
ftp-control	21	File Transfer (Control)
telnet	23	Telnet
smtp	25	Simple Mail Transfer (email)
nicname	43	Who Is
domain	53	Domain Name Server
gopher	70	Gopher
finger	79	Finger
www-http	80	World Wide Web HTTP

tcp-flags can be one or more of the following:

ACK|URG|PSH|RST

- UDP expressions are identical to TCP expressions, though the values of Protocol Ports differ:

```
UDP [[SRC <op> <value>][DST <op> <value>]]
```

Common UDP ports include:

nickname	43	Who Is
domain	53	Domain Name Server
tftp	69	Trivial File Transfer
gopher	70	Gopher
finger	79	Finger

- ICMP expressions are used to filter on ICMP datagram types and have the format:

```
ICMP [TYPE <op> <value>]
```

where

op is a relational operator of the following set:

```
=, !=, >, >=, <, <=
```

value is an integer ICMP type. Examples include:

0 ICMP Echo Reply

8 ICMP Echo Request

- IP expressions are used to filter on IP fragments and options and include

```
FRAGMENTS
```

```
SOURCE-ROUTE
```

```
RECORD-ROUTE
```

Other Commands

```
delete [interface{e1|s1|s2|s3}] [in|out][src-addr[dest-addr]] [type]
[options] [all]
```

QT1/QE1 Model Only

```
delete [interface{Lan1|Tel1|Tel2|Tel3|Tel4}] [in|out][src-addr[dest-
addr]] [type] [options] [all]
```

This command is used to delete a packet filter. The arguments are similar to the **permit/deny** commands.

By default, filters will only be deleted if they match the arguments exactly. If ALL is used, then the arguments are used as a wildcard and filters will be deleted if they match the arguments as entered.

For example, **delete ip all** would delete the filters permit in ip and deny out ip fragments.

```
show filter [all | [interface <interface>]] [in|out]
```

This will show the packet filters for the router. The format of the display will match the syntax of the configuration command.

For example:

Interface: S1

Direction: In

	Source	Destination	Protocol	Protocol
Action	Address	Address	Type	Options
Permit	0.0.0.0	0.0.0.0	ICMP	Type = 1
Deny	0.0.0.0	0.0.0.0	ICMP	Type = 8
Permit	0.0.0.0	0.0.0.0	TCP	Src >= 1024Dst = 23
Deny	128.14.0.0/16	0.0.0.0	TCP	Dst = 21

If an interface and filter direction is defined, then filters will only be shown for that interface and direction. Otherwise, filters for all directions and interfaces will be shown. ALL or an explicit interface/direction can also be entered to show filters from an interface/direction other than what's current.

Examples

Included are examples of common filters which might be created for Wide Area routers.

Note: Filter examples are provided for sample purposes only. The design of IP packet filters is a complex process and requires a solid familiarity with the TCP/IP protocol. It is STRONGLY suggested that the user fully tests the security of any filters applied to Engage routers prior to placing them into secured locations.

Example 1

IP Spoofing is best prevented by applying an input filter to your WAN port which denies incoming packets whose source address matches your own internal IP network. For example, if you have a Class C IP network 156.22.235.0/24, apply the following filter

```
interface s1 or Tel1 for QT1/QE1 Models
filter in
deny 156.22.235.0/24 0.0.0.0 ip
permit 0.0.0.0 0.0.0.0 ip
```

Example 2

This example shows how a user can set up input filters on the ethernet port to allow only incoming FTP and Telnet packets but reject incoming FTP packets from network 128.14.0.0.

```
interface e1 or Lan1 for QT1/QE1 Models
filter in
permit tcp dst=21
permit tcp dst=23 src>=1024
deny 128.14.0.0/16 tcp dst=21
```

Example 3

This example shows a complex filter permitting *only*:

- a. One host to FTP out: 157.22.234.114
- b. Only FTP server 157.22.234.115 is accessible from the Internet:
- c. All users on subnet 157.22.234.112/28 can Telnet out, but no outside user may Telnet in:

interface S1 or Tel1 for QT1/QE1 Models

! configure to permit .114 to ftp out

filter out

permit 157.22.234.114 0.0.0.0 tcp dst = 21

permit 157.22.234.114 0.0.0.0 tcp src > 1023 dst = 20 ack

filter in

permit 0.0.0.0 157.22.234.114 tcp src = 21 ack

permit 0.0.0.0 157.22.234.114 tcp src = 20 dst > 1023

! configure to permit Internet access to .115

filter in

permit 0.0.0.0 157.22.234.115 tcp src > 1023 dst = 21

permit 0.0.0.0 157.22.234.115 tcp src > 1023 dst = 20 ack

filter out

permit 157.22.234.115 0.0.0.0 tcp src = 21 dst > 1023 ack

permit 157.22.234.115 0.0.0.0 tcp src = 20 dst > 1023

! configure so those on 157.22.234.112 can Telnet out

filter in

permit 0.0.0.0 157.22.234.112/28 tcp src = 23 dst > 1023 ack

filter out

permit 157.22.234.112/28 0.0.0.0 tcp src > 1023 dst = 23

Example 4

This filter, applied to serial port input of a router on the 204.22.233/24 network, permits HTTP, DNS and SMTP. By default, all other services, including, FTP and Telnet, are denied. The standard anti-spoofing filter is also present. Note that since there are no filters on serial port out, all packets in that direction are allowed.

interface s1 or Tel1 for QT1/QE1 Models

filter in

! prevent spoofing

deny 204.22.233.0/24 0.0.0.0 ip

! permit HTTP

permit 0.0.0.0 204.22.233.0/24 tcp src > 1023 dst = 80

permit 0.0.0.0 204.22.233.0/24 tcp src = 80 dst > 1023

! permit DNS

permit 0.0.0.0 204.22.233.0/24 udp src > 1023 dst = 25

permit 0.0.0.0 204.22.233.0/24 udp src = 25 dst > 1023

permit 0.0.0.0 204.22.233.0/24 tcp src > 1023 dst = 25

permit 0.0.0.0 204.22.233.0/24 tcp src = 25 dst > 1023

! permit SMTP

permit 0.0.0.0 204.22.233.0/24 tcp src > 1023 dst = 25

permit 0.0.0.0 204.22.233.0/24 tcp src = 25 dst > 1023

Chapter 8

Troubleshooting

Wide Area Network system are subject to problems from a variety of sources. Fortunately, an organized troubleshooting approach usually leads to the area of the problem in short order. It is essential to distinguish between problems caused by the LAN (network system), the WAN equipment (communication equipment), the digital phone service and the Engage IP•Express configuration.

This troubleshooting chapter is structured with symptoms in the order the user might encounter them.

Unable to Communicate with the Local Router

Most installations first require communication with a local router, usually from the same network as the router itself. Proceed through the following symptoms if you are unable to communicate with the local router using the Console Port, Telnet, Ping, etc.

Ethernet/General

Cause: Network Cabling is faulty

Solution: Verify cabling is good by swapping router cabling with a known good connection. Check the status LEDs on the 10BaseT hub to confirm a good connection. If necessary, create a stand-alone LAN with just a workstation and the router.

Cause: User has connected the Engage router model w/ internal T1 DSU/CSU to the T1 line prior to configuration.

Solution: Improper T1 configuration or a large T1 error count can generate errors which so overload the processor that communication to the router is slowed or stopped. Unplug the router from the T1 line. The router should immediately recover. Configure the T1 DSU/CSU properly for T1 line parameters.

Cause: Router ethernet LED on solid or not flashing

Solution: Normally, the ethernet LED flashes each time a packet is transmitted on to the ethernet. If no activity is observed, router may be defective. If LED is on solid, the router may have difficulty completing a transmission. In either case, a good test is to remove the router to a stand-alone network and retest.

Cause: Can not connect to a hub at 100 Mbps with autonegotiate turned on. Connection drops to 10 Mbps at half duplex.

Solution: For **Models QT1/QE1**, change interface to match what the hub is configured for.

Can't Communicate with Router - TCP/IP

Cause: IP address is not set properly on the router

Solution: A variety of methods exist for assigning an IP address to an Engage router with an unknown IP address. Telnet, BootRouter and DHCP rely on powering up the router on a LAN with a workstation ready to assign a new address. The application EngageView can assign the IP address directly (a non-IP version of EngageView), or the user can configure directly through the Console port. These methods are described in *Chapter 2: QuickStart* and *Chapter 6: Command Line Interface*.

Cause: Workstation not on the same subnet as the router

Solution: During an initial configuration of a router, communication should come from within the same net/subnet. With no default router, the IP•Express router will not be able to reply to communication off its own net.

Cause: IP stack on the workstation not configured

Solution: Ensure that other devices on the same LAN can be pinged, or otherwise 'seen'

Can't communicate to the router - Console Port

Cause: Baud Rate, Stop Bits, etc. set wrong on communication application

Solution: Ensure the communication software is configured for a fixed, asynchronous data rate of 9600 bps, 1 stop bit, no parity, 8 bit fixed

Cause: Transmit and Receive Data swapped

Solution: The console port is configured as a DTE (data terminal equipment) port. For connection to other DTE, such as a terminal, a Null Modem adapter is required. A 25 pin female/25 pin male null modem adapter is provided with the router.

High Ethernet Error Count

Cause: Bad cabling

Solution: Check all cabling. Swap ports on 10BaseT hub to troubleshoot.

Solution: Use alternate ethernet type on the router to prove its ethernet interface.

Unable to Communicate with the Remote Site

Local Router Port LED Stays Red

All equipment has been configured and connected, and the digital phone service has been "turned up", yet the port LED remains Red, rather than turning Green. On a leased or dedicated link, Green indicates reception of good data from a remote router. On a Frame Relay link, it indicates successful handshake with the telco.

Proceed through the following steps in sequence:

IP • Express T1/E1 Port Not Functional

Use the IP•Express test features to prove the functionality of the IP•Express T1/E1 port by disconnecting the port from any T1/E1 line,

configuring either a TEST LOOP INTERNAL or a TEST LOOP FRAMER, then initiate a BERT test. If the BERT STATUS indicates that the receive circuitry locks on to the transmitted BERT pattern, the IP•Express port functionality is proven. See *Chapter 5: Configuration and Operation* as well as *Chapter 6: Command Line Interface* for specific commands.

T1/E1 Circuit is Not Fully Functional

Use the IP•Express test features to test the T1/E1 circuit. By configuring either a TEST LOOP NETWORK or a TEST LOOP PAYLOAD, the IP•Express will loop its receive data back to its transmit path. A BERT test towards the IP•Express, initiated by the T1/E1 service provider or the remote DSU/CSU, should run clean.

Alternatively, setting the remote DSU/CSU into a loop and initiating a BERT test from the IP•Express will prove the T1/E1 circuit from the local side. If the BERT STATUS indicates that the receive circuitry locks on to the transmitted BERT pattern, and the error count remains 0 over an extended period, the user can be confident of the T1/E1 circuit. See *Chapter 5: Configuration and Operation* as well as *Chapter 6: Command Line Interface* for specific commands.

No Serial Port Transmit Data

Check whether the Serial Port Transmit Packet count is increasing by repeatedly issuing the command

```
SHOW INTERFACE S1 (or S2) STATISTICS.
```

QT1/QE1 Model Only

```
SHOW INTERFACE Tel1|Tel2|Tel3|Tel4 STATISTICS
```

Solution: Router is configured to transmit data only when the Carrier Detect (CD) signal is active. Ensure that the DCE does supply CD (or DCD) *or* turn off the Engage router's sensitivity to Carrier Detect. CD parameters are found in EngageView's Port menu, under Port Configuration - Advanced Options. Command line uses POLL-CD and WAIT-CD, both of which would be set to OFF.

Note: CD is an important control signal and *should* be monitored for dial-up connections.

Solution: Router is not receiving a Transmit Clock (TxCk) signal from the DCE. Verify the cabling between the router and DCE. If using V.35, ensure the use of an Engage cable since there are multiple standards for implementing V.35 signaling through db25 connectors. Ensure the DCE does supply TxCk - a modem only supplies TxCk when configured to operate in Synchronous mode.

No Serial Port Receive Data

Check whether the Serial Port Receive Packet count is increasing by selecting the Serial Port in EngageView and monitoring "Packets Received" or by repeatedly issuing the command

```
SHOWINTERFACE S1 (or S2) STATISTICS.
```

QT1/QE1 Model Only

```
INTERFACE Tel1|Tel2|Tel3|Tel4 STATISTICS
```

Solution: Router is not getting a Receive Clock (RxCk) signal from the DCE. Verify the cabling between the router and DCE. If using V.35, ensure the use of an Engage cable since there are multiple standards for implementing V.35 signaling through db25 connectors. Ensure the DCE does supply RxCk.

Solution: Router is not getting Receive Data (RxD) from the DCE. Same cabling issues as previous item on RxCk.

Solution: Remote router is not transmitting data. Have a user at remote site verify the router is transmitting data.

Solution: Telco path is not complete. Have the telephone company perform loop tests to ensure their connection to both end points is working. On leased lines, this simply involves breaking the link and performing Loop Tests to the DSU/CSU or other customer equipment in each direction. Frame Relay involves more parties, but the local loop to the customer router equipment can be "looped up" and tested.

Solution: All Receive Data (RxD) is arriving in error. Receive Packet count is not moving, but the Total Error Count is increasing, and all are

Receive Errors. Quality of the line is very poor - have the telco test it out.

Solution: All Receive Data (RxD) is arriving in error. Receive Packet count is not moving, but the Total Error Count is increasing, and all are Receive Errors. DSU/CSU is improperly configured for the line - usually only the case in T1/fractional T1 lines. Unplug from T1 line and confirm the line coding, framing, etc. with the T1 provider.

Received Data is of a Different Protocol

Receive Packet count is increasing, but the port LED remains Red.

Solution: Check that the WAN protocol agrees between the Engage router and the remote unit: Engage, PPP or Frame Relay.

Inverse Mux Connection Down

Cause: The two WAN interfaces, E1 or T1, are not connected one-for-one with the remote site.

Solution: Swap the WAN interfaces on one side to ensure Port 1 connects to Port 1 and Port 2 to Port 2.

Drop & Insert Mux Path not passing PBX data.

Cause: PBX not configured to utilize only the T1 or E1 channels designated for the DS1 path.

Solution: PBX must be configured to utilize only the T1 or E1 channels which are not being utilized by the IP•Express for IP data. For example, if MLDI interface S1 is configured to utilize T1 channels 1-8, the PBX must be configured to use only the remaining channels 9-24.

Cause: IP•Express MLDI serial port 2 (DS1 port for PBX connection) is configured for fractional T1 or E1.

Solution: Interface S2 (the DS1 serial interface) should be configured for CHANNELS: FULL in all cases. It is automatically assigned the channels not assigned to S1.

Cause: Improper connection between PBX and IP•Express MLDI. A

crossover T1 cable is typically required to connect the PBX to the IP•Express MLDI. See *Appendices* for crossover T1 cable specifications.

Test Suggestion: Local DTE Loop

If using the IP•Express with external DCE, configure the external DCE for a Local (or DTE) Loop. When configured in Local Loop, a data communication device will loop back the router's Transmit Data to its Receive Data port. If connected to a device providing loop, the router will show TxD and RxD packets incrementing at the same rate, and the Port LED should turn to amber (yellow). Successful Local Loop testing proves the router's TxD, RxD, TxC and RxC circuitry, the cable to the external DCE, and the DTE interface circuitry of the DCE.

Note: Temporarily set WAN Configuration to Engage for DCE loop tests

Note: DCE must supply TxC and RxC during Local Loop for the test to pass.

Port LED Goes Amber (Yellow)

As noted in Local DTE/DCE Loop section, the router Port LED will go amber or yellow when it detects a loop somewhere on its WAN connection. If the Port LED goes Amber during normal operation, suspect a loop somewhere in the circuit, whether at the local data communication equipment, somewhere in telephone company equipment, or at the remote data communication equipment.

Port LED Alternates Green/Red

Cause: The external DCE is not supplying Carrier Detect (CD)

Solution: Set the router to ignore the CD signal through EngageView or the commands POLL-CD and WAIT-CD, both of which would be set to OFF.

Port LED Green on One Router, Red on the Other

This situation arises when data is transferred properly in one direction, but not in the reverse. Data in each direction is somewhat independent and, for example, a bad RxD circuit on a DSU/CSU can cause this effect. The fact that data is transferring properly in one direction helps narrow

the troubleshooting. Using the points mentioned earlier regarding No Tx/D and/or no Rx/D, the user should be able to examine the "bad" data direction and narrow down the problem.

Port LED Green, but Cannot Communicate across WAN

Leased/Dedicated Circuit - If the Port LED on the local router is Green and the remote router indicates it also has a good connection (Port LED Green if an Engage router), you may assume data is flowing in both directions.

Cause: A poor quality connection may provide sufficient data exchange to turn Port LEDs green, but not permit real traffic. Check the errors on the serial port of each router. Total Errors should not exceed 1-2% of either Receive or Transmit Packets. If there are many errors, actions include having line tested for quality and verifying configuration of the DSU/CSU or other DCE for items such as Tx/Ck Source (usually Network vs. Internal)

Frame Relay - A green Port LED in a Frame Relay environment only indicates the router is exchanging status packets properly with the local Frame Relay switch. It provides no indication of a connection across the Frame "Cloud" to another router.

Cause: No router on the other end. Ensure the router(s) which are part of your frame network are up and connected.

Cause: PVCs (Permanent Virtual Circuits) not in place. Ensure that the telco really has "turned up" all of the necessary PVCs.

Cause: Router on the other end not running IETF Frame Relay. Ensure that no proprietary Frame Relay protocol is in use.

TCP/IP Connection

An IP Ping program is the best tool for troubleshooting TCP/IP connectivity. As a sanity check, *first* ensure you can ping the local router. If unsuccessful, go back to "Can't Communicate with the Local Router" section.

Can't IP Ping Remote Router

Cause: Ping workstation does not have Default Gateway (or Router) set. In the workstation's IP configuration, alongside workstation's own IP address and subnet mask, you must provide the IP address of the device (a router) to which all packets destined off the local net should be sent. If the Engage router is the only router on the IP network, use its IP address for Default Gateway. If there is another router on the net, see next item.

Cause: Another router on the net, serving as Default Gateway for all net workstations, does not know about the remote IP nets the new Engage router brings to the picture. This device must be provided with static route(s), through the local Engage router, to the remote IP nets/subnets.

Cause: Engage router improperly configured to use RIP. Engage routers support one routing protocol, RIP v1, which automates the exchange of routing information between routers and is suitable for simple IP network configurations. RIP v1 is not suitable for subnetted IP networks, in which case Static Routes must be used. Further information is available in the description of RIP provided in *Chapter 6: Command Line Interface*.

Cause: Static Route(s) are not entered properly. Each router vendor's approach to Static Route entry is different. Ensure that each static route has its six components: destination network (the starting or "0" address), subnet mask at that dest. network, address of next router in path to destination, number of hops to dest. network, port of *local* Engage router to go out to reach destination network and DLCI (leave blank if not a Frame Relay network).

Cause: Frame Relay DLCI in static route is improper - telco provided wrong DLCI or user entered DLCI for *other* end of the PVC. Connect via the command line interface and issue the command

show interface s1 frame-relay-dlci

will provide a list of all active DLCIs into that telco port.

Cause: Remote router does not have a route, whether through RIP or static routes, back to this network. Verify that the remote router is configured with routing information for the local IP network.

**Able to Ping Remote Router, but
not other devices on the Remote
IP net**

Cause: Devices on the remote net do not have their IP Gateway defined. Use the IP address of the Engage router if it is the only router at that site. If there are other routers, they may be used as the Default Gateway, but they must have a route, through the remote Engage router, back to this network.

Appendices

IP • Express Router Specifications

Ethernet Port

- 10 Mbps fixed transmission speed

LAN Protocol

- TCP/IP

WAN Protocols

- Engage Proprietary
- Point-to-Point Protocol (PPP)
- Frame Relay

Available WAN Interfaces

- RS-232/RS-530/RS-449/V.35: DB-25 female
- Internal 56/64 Kbps DSU/CSU
- Internal T1/fracT1 DSU/CSU
- Internal E1/fracE1 DSU/CSU

Power Supply

- Non-Hub Models - External 24 Volts AC, 1 Amp, with standard AC plug. International power supplies available.
- Hub Models - External 15-26 Volts DC, 1 Amp terminal block connection. International power supplies available.

Physical

- Standard 19 inch rack mount kit available
- Hub model dimensions: 9.45 x 7.2 x 1.63 inches
- Non-Hub model dimensions: 8.75 x 5.50 x 1.63 inches
- Weight: approximately 2 lbs., excluding external power adapter.

IP • Express QT1/QE1 Router Specifications

Ethernet Port

- 10/100 BaseT Full/Half Duplex Ethernet
- Autonegotiation or configurable speed and Duplex

Quality of Service Support

- Interoperability with RFC 1717

LAN Protocol

- TCP/IP

WAN Protocols

- Engage Proprietary
- Point-to-Point Protocol (PPP)
- Frame Relay

T1/Fractional T1 Specifications:

- One to Four Port Models
- Connects directly to T1 Line or to a DS1 interface with a Crossover Cable.
- Framing - ESF or D4
- Coding - B8ZS or AMI
- Supports DS0 assignments from 1 to 24

Up to four Available WAN Interaces

- RS-232/RS-530/RS-449/V.35: DB-25 female
- Internal 56/64 Kbps DSU/CSU
- Internal T1/fracT1 DSU/CSU
- Internal E1/fracE1 DSU/CSU

Power Supply

- External 24 Volts AC, 1Amp, with standard AC plug. International power supplies available.

FTP Online Upgrade Capable FLASH ROMs)

- IP Express QT1/QE1 is fully operational during upgrade

Management:

- Telnet support with Edit and Paste Template Files
- Console Port for Out of Band Management
- SNMP support (MIB I, MIB II)
- Remote configuration & monitoring

Physical

- Standard 19 inch rack mount kit available
- Dimensions: 8.75 x 5.50 x 1.63 inches
- Weight: approximately 3 lbs., excluding external power adapter.

IP • Express Switch Settings

IPExpress models have a four position DIP switch accessible by removing the router rear panel and sliding out the motherboard.

The default setting for all DIP switches is **OFF**.

Switch 1

Powering the router up when DIP Switch 1 is ON forces the router to revert to certain default settings, including operation from Base Flash, deleting any download upgrades, and setting AppleTalk seeding ON.

Switch 3

When DIP Switch 3 is OFF, the router uses DIX Ethernet for IP broadcasts. When ON the router uses IEEE 802.3 Ethernet.

Switch 4

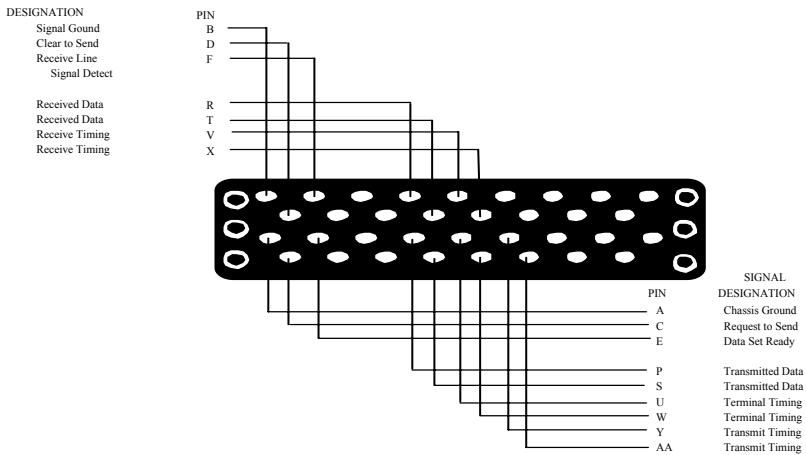
DIP Switch 4 is used to clear IP filters. When the unit is powered on with DIP Switch 4 set ON, all configured TCP/IP filters will be deleted, a good method for recovering from filter configuration errors. Return the switch to OFF to ensure subsequent filter configurations are retained.

RS-530 Port Specification

RS530A Connector Specification

RS530-A db25 Male	Signal	I/O TO DC
1	Shield	I/O
2	TD-A	I
3	RD-A	O
4	RTS-A	I
5	CTS-A	O
6	DSR-A	O
7	Gnd	I/O
8	CD-A	O
9	RC-B	O
10	CD-B	O
11	ETC-B	I
12	TC-B	O
13	CTS-B	O
14	TD-B	I
15	TC-A	O
16	RD-B	O
17	RC-A	O
18	nc	
19	RTS-B	I
20	DTR-A	I
21	nc	
22	DSR-B	O
23	DTR-B	I
24	ETC-A	I
25	nc	

V.35 Interface Specifications

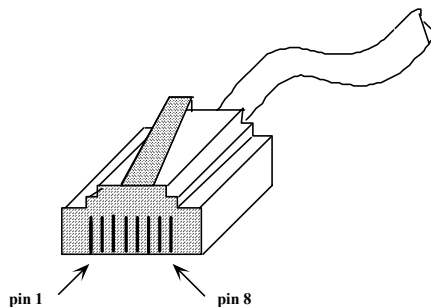


V.35 Interface Specifications (cont'd)

Cable p/n: 091-3200
 Name: "V.35, db25 vers."
 Connector 1: db25, Male
 Connector 2: 34 pin "M" block, male
 Length: 3 feet

Connector 1 (db25)	Connector 2 (34 pin "M")	Signal Name	Cabling note
2	P	TxD A	<- twisted
14	S	TxD B	<- pair
3	R	RxD A	<- twisted
16	T	RxD B	<- pair
17	V	RxCk A	<- twisted
9	X	RxCk B	<- pair
15	Y	TxCk A	<- twisted
12	AA	TxCk B	<- pair
24	U	ExtCk A	<- twisted
11	W	ExtCk B	<- pair
6	E	DSR	
20	H	DTR	
4	C	RTS	
5	D	CTS	
8	F	RLSD	
18	K	LT	
7	B	SG	
nc	A	FG	

T1 and E1 Port Specification with Crossover Pinouts



T1/fracT1 DSU/CSU Pin numbering

1	RxRing
2	RxTip
4	TxRing
5	TxTip

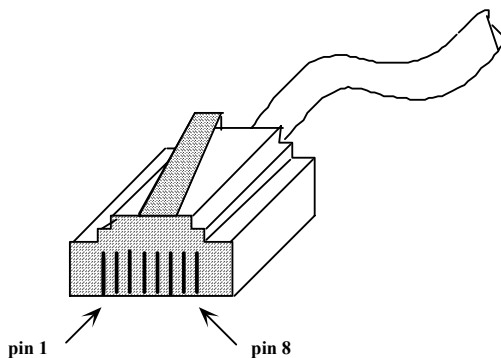
For T1 Crossover (allowing connection directly between two T1/fracT1 DSU/CSU devices) wire:

(TxTip)	Pin 5	to	Pin 2	(RxTip)
(TxRing)	Pin 4	to	Pin 1	(RxRing)
(RxRing)	Pin 1	to	Pin 4	(TxRing)
(RxTip)	Pin 2	to	Pin 5	(TxTip)

E1 RJ45 to db15 Cable

Signal	RJ45	db15Male
TxD Tip	5	1
RxD Tip	2	3
TxD Ring	4	9
RxD Ring	1	11
Frame Ground	7	2

56 & 64 Kbps DSU/CSU Port Specification (w/ Crossover cable pinout)



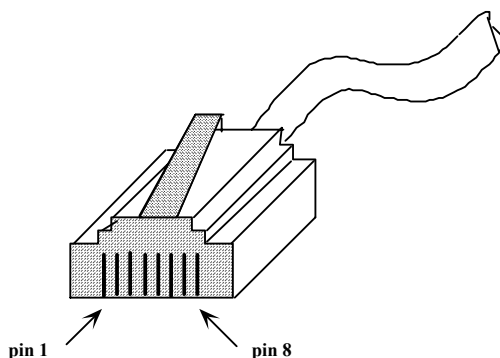
56 Kbps DSU/CSU (DDS) Pin numbering

1	TxRing
2	TxTip
7	RxTip
8	RxRing

For DDS Crossover (allowing connection directly between two 56Kbps DSU/CSU devices) wire:

<u>Signal</u>	<u>Conn 1</u>	<u>Conn 2</u>	<u>Signal</u>
TxTip	2	7	RxTip
TxRing	1	8	RxRing
RxTip	7	2	TxTip
RxRing	8	1	TxRing

10BaseT Port Specification (w/ Crossover cable pin out)



10BaseT Plug pin numbering

Pin 1	TxD+
Pin 2	TxD-
Pin 3	RxD+
Pin 6	RxD-

For 10BaseT Crossover (allowing connection directly between two 10BaseT devices) wire:

(TD+)	Pin 1	to	Pin 3	(RD+)
(TD-)	Pin 2	to	Pin 6	(RD-)
(RD+)	Pin 3	to	Pin 1	(TD+)
(RD-)	Pin 6	to	Pin 2	(TD-)

Console Port Information

XL Model Console Port: RJ45

RJ45 Console Port Pinout

RJ45 pin Signal Name

3	TxData
6	RxData
1	RTS
8	CTS
4	Gnd
2	DTR

RJ45/db9F Null Modem Adapter

RJ45 pin db9pin

3	2
6	3
1	8
4	5
2	6

Glossary

Terms and Concepts

Before using the Engage Router, you should be familiar with the terms and concepts that describe TCP/IP. If you are experienced with internet routers, these terms may already be familiar to you.

General Networking Terms

Network

A network is a collection of computers, server devices, and communication devices connected together and capable of communication with one another through a transmission medium.

Internet

An internet is any grouping of two or more networks connected by one or more internet routers.

Network Services

Network services are the capabilities that the network system delivers to users, such as print servers, file servers, and electronic mail.

Addresses

Transmitting information in a network system is made possible by an addressing scheme that identifies the sender and destination of the transmission, using network and node addresses. Data is transmitted to and from these addresses in the form of packets.

Routing Table

A routing table is maintained in each router. This table lists all networks and routers in the internet and enables routers to determine the most

efficient route for each packet. The routing table serves as a logical map of the internet, specifying the address of the next router in the path to a given destination network and the distance in hops. The router uses the routing table to determine where and whether to forward a packet.

Each router periodically broadcasts its routing table to other routers on each of its directly connected networks, enabling them to compare and update their own tables with the most recent record of connected networks and routes. In this way, routing tables are kept current as changes are made on the internet.

Hop

A hop is a unit count between networks on the internet. A hop signifies “one router away.”

Node

Device on the network

TCP/IP Networking Terms**FTP**

File Transfer Protocol gives users the ability to transfer files between IP hosts. It uses TCP to provide connection initiation and reliable data transfer.

Host

A computer with one or more uses that can act as an endpoint of communication if it has TCP/IP.

ICMP

Internet Control Message Protocol provides a means for intermediate gateways and hosts to communicate. There are several types of ICMP messages and they are used for several purposes including IP flow control, routing table correction and host availability.

IP

Internet Protocol which routes the data.

IP Datagram

The basic unit of the information passed across and IP Internet. It

contains address information and data.

PING

Packet InterNet Groper is a program which uses ICMP echo request message to check if the specifies IP address is accessible from the current host.

Port

A Destination point used by transport level protocols to distinguish among multiple destinations within a given host computer.

RIP

Routing Information Protocol provides a means for routers to exchange routing information. RIP's messages are encapsulated in UDP datagrams.

SubNet Address

An extension of the IP addressing scheme which enables an IP site to use a single IP address for multiple physical networks. Subnetting is applicable when a network grows beyond the number of hosts allowed for the IP address class of the site.

TCP

Transmission Control Protocol ensures reliable, sequential, delivery of data. TCP at each end of the connection ensures that the data is delivered to the application accurately, sequential, completely and free of duplicates. The application passes a stream of bytes to TCP which breaks it into pieces, adds a header, forming a segment, and then passes each segment to IP for transmission.

Telnet

The TCP/IP standard protocol for remote terminal connection service. A user can telnet from the local host to a host at a remote site.

UDP

User Datagram Protocol provides simple, efficient protocol which is connectionless and thus unreliable. The IP address contained in the UDP header is used to direct the datagram to a specific destination host.

Well-Known Port

Any set of port numbers reserved for specific uses by transport level

protocols (TCP & UDP). Well-known ports exist for echo servers, time servers, telnet and FTP servers.

Communication Link Definitions

Data Communication Equipment (DCE)

This interfaces to the communication service's transmission/reception medium, and includes T1 Voice/Data Multiplexors, 64/56 Kilobit DSU/CSUs, and Fiber Optic Modems. The DCE provides the transmit and receive data pathways, along with their synchronous clocking signals, that are used by the Engage Router's DTE interface for full duplex communication between the remotely interconnected networks.

Data Terminal Equipment (DTE)

This equipment, such as an Engage Router, attaches to the terminal side of Data Communication Equipment.

Data Carrier Detect (DCD)

A signal that indicates to the DTE that the DCE is receiving a signal from a remote DCE.

Data Terminal Ready (DTR)

Prepares the DCE to be connected to the phone line, then the connection can be established by dialing. Enables the DCE to answer an incoming call on a switched line.