IP • Tube User's Guide

Engage Communication, Inc.

9565 Soquel Drive
Aptos, California 95003
Ph 831.688.1021
Fax 831.688.1421
www.engagecom.com

Rev. 050304

Product Warranty

Seller warrants to Buyer that any unit shipped to Buyer, under normal and proper use, be free from defects in material and workmanship for a period of 24 months from the date of shipment to Buyer. This warranty will not be extended to items repaired by anyone other than the Seller or its authorized agent. The foregoing warranty is exclusive and in lieu of all other warranties of merchantability, fitness for purpose, or any other type, whether express or implied.

Remedies and Limitation of Liability

A. All claims for breach of the foregoing warranty shall be deemed waived unless notice of such claim is received by Seller during the applicable warranty period and unless the items to be defective are returned to Seller within thirty (30) days after such claim. Failure of Seller to receive written notice of any such claim within the applicable time period shall be deemed an absolute and unconditional waiver by buyer of such claim irrespective of whether the facts giving rise to such a claim shall have been discovered or whether processing, further manufacturing, other use or resale of such items shall have then taken place.

B. Buyer's exclusive remedy, and Seller's total liability, for any and all losses and damages arising out of any cause whatsoever (whether such cause be based in contract, negligence, strict liability, other tort or otherwise) shall in no event exceed the repair price of the work to which such cause arises. In no event shall Seller be liable for incidental, consequential, or punitive damages resulting from any such cause. Seller may, at its sole option, either repair or replace defective goods or work, and shall have no further obligations to Buyer. Return of the defective items to Seller shall be at Buyer's risk and expense.

C. Seller shall not be liable for failure to perform its obligations under the contract if such failure results directly or indirectly from, or is contributed to by any act of God or of Buyer; riot; fire; explosion; accident; flood; sabotage; epidemics; delays in transportation; lack of or inability to obtain raw materials, components, labor, fuel or supplies; governmental laws, regulations or orders; other circumstances beyond Seller's reasonable control, whether similar or dissimilar to the foregoing; or labor trouble, strike, lockout or injunction (whether or not such labor event is within the reasonable control of Seller)

Copyright Notice

Copyright ©2001-2004 Engage Communication, Inc.

All rights reserved. This document may not, in part or in entirety, be copied, photocopied, reproduced, translated, or reduced to any electronic medium or machine-readable form without first obtaining the express written consent of Engage Communication. Restricted rights legend: Use, duplication, or disclosure by the U.S. government is subject to restrictions set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause in DFARS 52.227-7013 and in similar clauses in the FAR and NASA FAR Supplement.

Information in this document is subject to change without notice and does not represent a commitment on the part of Engage Communication, Inc.

FCC Radio Frequency Interference Statement

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

NOTE - Shielded Telecommunication (T1 or E1) and ethernet cables must be used with the Engage IP•Tube to ensure compliance with FCC Part 15 Class A limits.

CAUTION – To reduce the risk of fire, use only No. 26 AWG or larger listed Telecommunication cables.

Equipment Malfunction

If trouble is experienced with an IP•Tube, 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:

Phone (U.S.)	831-688-1021
Fax	831-688-1421
Email	support@engagecom.com
Web	www.engagecom.com

Table of Contents

Chapter 1

Introduction

The IP•Tube User's Guide provides the information users require to install and operate the IP•Tube family of products developed and manufactured by Engage Communication, Inc.

IP • Tube Family

IP•Tube T1/E1 models encapsulate full and fractional T1 or E1 TDM circuits, along with their framing and signaling bits, into IP packets.

The IP•Tube QT1/QE1 models encapsulate from one to four full and fractional T1 or E1 and TDM circuits, along with their framing and signaling bits, into IP packets.

The IP•Tube's TDM Over IP connection provides for the transparent interconnection of PBXs, Telecom Switches and T1/E1 based communication systems via LANs, WANs, MANs, and Wireless Ethernet interconnects.

The IP•Tube RS530 and IP•Tube V35 models encapsulate synchronous serial data from Data Terminal Equipment (DTE) or Data Communication Equipment (DCE) such as Encryptors, Terminal Servers, Video Codecs, and WAN Routers into IP packets. The IP connection provides for the transparent interconnection of DTEs and DCEs via LANs, WANs, MANs, Satellite and Wireless Ethernet. The size and frequency of the IP packets can be controlled, yielding data rates ranging from 2.4 Kbits/sec to 2.048 Mbits/sec.

The following IP•Tube models are equipped with built-in data compression.

IP•Tube T1•C

IP•Tube E1•C

IP•Tube QT1•C

IP•Tube QE1•C

This lossless data compression can greatly reduce bandwidth consumption over the IP connection, particularly during periods of idle traffic, yielding reductions in bandwidth utilization as great as 56 to 1.

The compression ratio is based upon the frames per packet setting of the IPTube's T1/E1 interface. The available compression ratios for each of the models is as follows:

IP•Tube T1•C -56:1.

IP•Tube E1•C - 40:1.

IP•Tube QT1•C - 8:1 to 56:1.

IP•Tube QE1•C - 8:1 to 40:1.

For interoperability with the IP•Tube T1•C and IP•Tube E1•C models, the IP•Tube QT1•C and QE1•C models must match the frames per packet setting of the models being connected to.

Note: Round trip delays in excess of 30 milliseconds require echo cancellation. The amount of delay can be calculated based on the TUBE FPP setting and the TUBE BUFFERS setting. See *Chapter 5: IP•Tube T1/E1 Configuration and Operation* for a detailed analysis of how the IP•Tube settings and the LAN/WAN interconnection contribute to the overall round trip delay or latency.

Table 2 highlights the features available with different models within the IP tube family.

Model	Serial	Comp
IP•Tube- QT1	T1	N
IP•Tube- QE1	E1	N
IP•Tube- QT1C	T1	Y
IP•Tube- QE1C	E1	Y
IP•Tube-T1	T1	N
IP•Tube-E1	E1	N
IP•Tube-T1C	T1	Y
IP•Tube-E1C	E1	Y
IP•Tube-RS530.DCE	RS-530	N
IP•Tube-RS530.DTE	RS-530	N
IP•Tube-V35.DCE	V.35	N
IP•Tube-V35.DTE	V.35	N

Table 1 - IP•Tube Family Features

LAN Interface

All IP•Tube with the exception of the The IP•Tube QT1/QE1 models provide a 10BaseT Ethernet interface for connection to an IP interconnect. The IP•Tube QT1/QE1 models feature a 10/100Base T full/half duplex Ethernet interface for connection to an IP interconnect.

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.
- **RS-530** synchronous serial interface for interconnection to routers, encryptors, video codecs, etc. via a db25 connector.
- **V.35** synchronous serial interface for interconnection to routers, encryptors, video codecs, etc. via db25 connector.

About this Guide

Organization

Chapter 1 - Introduction provides an overview of the *IP•Tube User's Guide* as well as feature descriptions for the T1, E1, RS-530 and V.35 models which make up the IP•Tube family.

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

Chapter 3 - Installation covers the physical environment and connections required when first installing the IP•Tube.

Chapter 4 - Command Line Reference provides a command-by-command description of the Engage CLI.

Chapter 5 - Configuration and Operation T1/E1 discusses the initial configuration and ongoing operation of the IP•Tube T1 and E1 models. A discussion on bandwidth and data rate issues is included.

Chapter 6 - .Configuration and Operation RS-530/V.35 discusses the initial configuration and ongoing operation of the IP•Tube models with

RS-530 or V.35 synchronous serial interfaces. A discussion on bandwidth and data rate issues is included.

Chapter 7 - Troubleshooting common problems occurring during installation and normal operation.

Appendices - IP•Tube specifications, connector pinouts and crossover wiring details.

Glossary - Routing, Telecommunication and TCP/IP terminology.

Intended Audience

This manual is intended for administrators of network and telecommunication systems. The technical content is written for readers who have basic computer, telecommunication and networking experience.

It is important that any administrator responsible for the installation and operation of Engage IP•Tube products be familiar with IP networking and data communication concepts, such as network addressing and synchronous serial interfaces. These terms are central to an understanding of IP•Tube functionality, and are covered in the Glossary section.

Chapter 2

Installation QuickStart

This QuickStart Chapter is intended for users who understand how they want their IP•Tube configured and only require the mechanics of performing that configuration.

Communication with the IP•Tube

Console Port

Initial communication with the IP•Tube is made through the Console port, utilizing the Command Line interface detailed in *Chapter 4: Command Line Interface*. Communication to the Console port should be set as: 9600 baud, 1 stop bit, no parity, 8 bit fixed.

The Console port on the IP•Tube is an RJ45 jack. The Console port is configured as a DTE port. An RJ45/db9 adapter is provided with the IP•Tube which, in addition to providing a physical interface, performs the null modem operation permitting direct connection to other DTE equipment, such as the COM1 connection of a PC.

Once a serial connection between a workstation and the IP•Tube Console port is established and a carriage return <CR> is entered, a Login prompt will appear.

The default login is: **root**.

Telnet

Once an IP address has been assigned to the IP•Tube Ethernet interface, the user can telnet into the IP•Tube and continue configuration using the Command Line Interface.

Editing & Pasting Configurations

Users of the Command Line Interface have the option of editing standard IP•Tube configurations in text-only mode and pasting that configuration to the IP•Tube. Each example in this chapter includes the name of a configuration file found on the shipping disk as well as at Engage's Web site.

Edit the desired configuration listing using a simple text editor. Connect to the IP•Tube through Telnet or the Console port, then enter the configuration mode with the command: **config**

Paste the edited text, comments and all, to the IP•Tube, then issue the command: **save**. The IP•Tube will reset and come up with the new configuration.

To save an IP•Tube configuration, issue the command: **show configuration all** and save the response listing to a file.

IP Tube Cabling

The IP•Tube uses standard 10BaseT Ethernet cabling to connect to an Ethernet switch or hub. The IP•Tube QT1/QE1 uses standard 10/100BaseT Ethernet cabling to connect to an Ethernet switch or hub. A crossover 10BaseT cable can be used for direct connection to a single router, wireless radio or other Ethernet device.

The cabling used to connect the IP•Tube T1/E1 Port to the T1/E1 interface to be extended depends upon whether it is connecting to T1/E1 equipment (PBX, Phone System, Multiplexor) or directly to a T1/E1 line.

In the case of a connection to the T1/E1 interface of T1/E1 equipment, a crossover cable is required. The IPTubeT1/E1 is shipped with a T1/E1 Crossover Cable that uses yellow cabling Refer to the Appendices for the details of the wiring of this cable. Connections to T1/E1 lines are made with a standard, straight-through T1/E1 cable.

IP • Tube Configuration Parameters

The setup of the IP•Tube involves configuration of the:
• IP•Tube System Parameters
• IP•TubeData Conversion Parameters
• Interface Specific (T1/E1/RS530/V.35) parameters

Examples are provided in this QuickStart and a complete description of all commands is available in *Chapter 4: Command Line Interface.*

IP•Tube System Parameters

System parameters include the IP•Tube Hostname, the Ethernet IP address and the default router. Examples:

IP•Tube Host Name

Provide a unique name for the IP•Tube.

Note: Earlier versions of the IP•Tube software use ROUTER NAME.

HOST NAME DallasIPTube

Ethernet IP address

IP address applied on a per-interface basis. For the Ethernet interface, use either e1 or lan1 depending on the tube model. Use lan1 for the IP•Tube QT1/QE1 and e1 for the IP•Tube T1/E1.

IP ADDRESS aaa.bbb.ccc.ddd

Ethernet Broadcast Reception

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. If BroadcastRCV is set to OFF the Tube Ether ARP and Tube Ethernet Address needs to be configured with the MAC address. Note 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. .

BroadcastRCV ON/OFF

IP•Tube Default Router

If the Remote IP•Tube, whose IP address is configured with TUBE

ADDRESS, resides on a different IP network from the Local IP•Tube, a default router must be specified. The Default Router is typically the local IP WAN Router.

IP DEFAULT-ROUTER aaa.bbb.ccc.ddd

IP•Tube Data Conversion Parameters

The IP•Tube has an enable/disable command as well as control of Protocol, Framing Encapsulation, Tube Destination Address, Destination UDP Port, IP Type of Service (TOS), Buffers, Frames per Packet (FPP) and Compression (optional).

These parameters appear within the Serial Interface Configuration(s).

Protocol

The interface protocol controls the packetization format of the IP•Tube. The options are IPTUBE, CESoIP and HDLCoIP.

IPTUBE Protocol encapsulates the data bits selected into UDP packets.

CESoIP Protocol encapsulates the data bits selected into UDP packets with an RTP header.

HDLCoIP Protocol encapsulates HDLC frames into UDP packets with an RTP header. This protocol is used to interconnect data networks that utilize WAN protocols such as PPP, Frame Relay, HDLC and SDLC.

Type

The interface type lan1/E1/T1/RS530/V35 is defined by the IP•Tube model purchased. Do not change the Interface Type as it is hardware dependent.

IP•Tube Enable

The IP•Tube is enabled by the command TUBE ON.

IP•Tube Framing

The IP•Tube parameter TUBE FRAMING is set to either: Transparent or T1/E1 Framed. Transparent framing encapsulates the DS0 data without the T1/E1 framing information. T1 Framed encapsulates the T1 framing bits along with the DS0 data. E1Framed encapsulates the E1 framing byte along with the DS0 data.

NOTE1: A DS0 is a 64 Kbps Voice/Data circuit. T1 frames have 24 DS0s and a framing bit for a total of 193 bits per frame. E1 frames have 31 DS0s and a Framing/Signaling Byte for a total of 32 bytes per frame.

NOTE2: Tube Framing only applies to T1 or E1 IPTubes.

IP•Tube Destination Address

TUBE ADDRESS specifies the IP address of the receiving IP•Tube.

NOTE: Loopback of the T1/E1/RS530 data occurs when the destination address is the same as the IP address of the Ethernet interface of the IP•Tube.

TUBE ADDR aaa.bbb.ccc.ddd

IP•Tube Destination UDP Port

TUBE UDPPORT specifies the UDP port source and destination address. The IPTube only accepts packets that match its UDP Port configuration.

TUBE UDPPORT nnnn

NOTE: Engage has registered with the IANA UDP port 3175 decimal. For the IP•Tube QT1/QE1 use the following UDP port numbers depending on which ports are activated.

Port 1 UDP port 3175

Port 2 UDP port 3176

Port 3 UDP port 3177

Port 4 UDP port 3178

IP•Tube IP Packet Type of Service

The TUBE TOS command is used to set the Type of Service byte in the IP packets in which is encapsulated the T1/E1 frames. The setting of the TOS byte can be used to ensure that the real time TDM data from the IP•Tube is ensured high priority. The Quality of Service support is required within each router or switch that is within the interconnect between the IP•Tubes. A TOS setting of 0x08 "maximizes throughput".

TUBE TOS 0x08

An alternative to the use of the TOS byte is the configuration for QoS based on UDP port number. Engage has registered UDP port assignment 3175 (reference www.iana.org/assignments/port-numbers). QoS configuration to prioritize UDP packets destined for port 3175 can be setup.

Communication between IP•Tube systems uses packets destined for a configurable UDP port number. The IPTube defaults to UDP port 3175.

IP•Tube Buffers

As IP/UDP packets are received at the IP•Tube Ethernet interface, they are buffered prior to the enabling of the E1 transmitter. This provides for elasticity. The TUBE BUFFERS setting permits the user to configure the number of packets buffered - with valid settings from 4 to 30.

A large value provides greater elasticity but can introduce significant delay. The amount of delay can be calculated from the E1 data rate, the TUBE FPP setting (below) and the TUBE BUFFERS setting. See *Chapter 5: IP•Tube T1/E1 Configuration and Operation* for an analysis of how IP•Tube settings contribute to the overall round trip delay or latency.

Note: Round trip delays in excess of 20 milliseconds require echo cancellation.

TUBE BUFFERS 5

IP•Tube Frames Per Packet

TUBE FPP specifies the number of frames received on the T1/E1/RS530/V35 interface to be encapsulated in a single IP/UDP packet. The size of the serial interface frame depends on the interface provided in the IP•Tube.

- T1 frame size is 192 bits + 1 framing bit (depends on T1Framing config)

- E1 frame size is 256 bits

- RS530/V.35 frame size is 512 bits (64 bytes)

Low latency applications, such as voice, require minimum Frames Per Packet. The recommended configuration for low latency for T1 is FPP = 8, for E1 recommended FPP = 12.

NOTE: When Compression is enabled on C models, FPP is automatically forced to its maximum. There is no restriction on FPP for the QT models.

IP•Tube Compression Enable

TUBE COMPRESSION ON enables compression on IP•Tube C models.

IP•Tube Ethernet ARP

TUBE Ethernet ARP OFF uses the Ethernet MAC address specified by the TUBE Ethernet Address.

TUBE Ethernet ARP ON uses the Ethernet MAC address obtained automatically by the IPTube's IP to Ethernet MAC Address Resolution Protocol.

NOTE: Unless Broadcast storms are suspected it is highly recommended that the automatic resolution of the IP address to Ethernet MAC address is utilized by setting TUBE ETHERNET ARP ON (Default)

IP•Tube Ethernet Address

TUBE ETHERNET ADDRESS allows the user to specify the Ethernet MAC address for the IPTube IP packet. The TUBE Ethernet MAC Address needs to match the MAC address of the destination IPTube or the Default Router.

Interface Specific (QT1,QE1,T1/E1/RS530/V.35) Parameters

T1 Configuration Parameters

The IP•Tube-T1 serial interface number 1 is configured for T1 operation. The following T1 parameters must match the configuration of the DS1/T1 interface to which it is connected. The T1 clock setting is dependent upon the source of the T1 Clock.

Interface S1
Type T1
T1 Data {Normal | Invert}
T1 Clocking {Internal | Network | PLL}
T1 LBO CSU {0dB | -7.5 | -15 | -22.5}
T1 Framing {ESF | D4}
T1 Coding {B8ZS | AMI}
T1 IdleCharacter value
T1 Channels {Full | Fractional: Starting DS0 - Number of DS0s}

E1 Configuration Parameters

The IP•Tube-E1 serial interface number 1 is configured for E1 operation. The following E1 parameters must match the configuration of the E1 interface to which it is connected. The E1 clock setting is dependent upon the source of the E1 Clock.

Interface S1
Type E1
E1 Data {Normal | Invert}
E1 Clocking {Internal | Network | PLL}
E1 Framing {CRC4 | FAS | UNFRAMED}
E1 Coding {HDB3 | AMI}
E1 IdleCharacter value
E1 Channels {Full | Fractional: Starting DS0 - Number of DS0s}

Note: Improper configuration of the T1/E1 clocking will result in an overrun or underrun condition which causes T1/E1 periodic frame losses. One of the IP•Tubes must be the master clock source or locked onto a master and the remote end unit uses a Phase Lock Loop circuit to match the master's T1 clock frequency. In the case where an IP•Tube is being connected to a T1 line from the Telephone company, the IP•Tube connected to the Telco T1 line must be set to T1 Clocking Network and the remote unit set to T1 Clocking PLL.

RS-530/V.35 Configuration Parameters

The configuration parameters for IP•Tube RS-530 and IP•Tube V.35 models differ slightly from those for IP•Tube T1/E1. TUBE FRAMING is not used, while the following commands are unique to these synchronous, serial interfaces:

IP•Tube Serial Clock Control

The IP•Tube RS-530 and V.35 models provide DCE (data communication equipment) interfaces. The DCE interface supplies both the Transmit Clock (serial clock transmit, or SCT) and Receive Clock (SCR) to the connected DTE (date terminal equipment) interface. The IP•Tube RS-530 and V.35 models allow the user to configure these clocks to normal mode or to inverted mode. The DTE to which the IP•Tube connects may require inverted clock.

SCR NORMAL

SCT INVERTED

SCRCLOCK is used to clock the receive Ethernet packet data from the buffer memory into the DTE.

SCTCLOCK is used to clock data from the DTE into IP packets that are sent to the TUBE ADDRESS.

IP•Tube Clock

The TUBE CLOCK command is used to set the source of the Serial Clock Receive and Transmit Timing signals. When SCRCLOCK needs to match the SCTCLOCK exactly with a smooth non gapped clock, TUBE INTERVAL = 0, then one of the IPTUBERS530/V.35s needs to have its TUBE CLOCK to INTERNAL and the other needs to be set to PLL and TUBE BUFFERing needs to be utilized.

TUBE CLOCK INTERNAL

TUBE CLOCK PLL

IP•Tube SCxCLOCK MODE

NX2K4, NX56K AND NX64K

IP•Tube SCxCLOCK FACTOR

TUBE SCxCLOCK MODE NXxxx is multiplied by SCxCLOCK FACTOR to produce the SCxCLOCK.

NX2K4 2.4k times factor. Maximum factor is 20.
Data rate from 2.4K to 44.8K.

NX56K 56k times factor. Maximum factor is 32.
Data rate from 56K to 1792K.

NX64K 64k times factor. Maximum factor is 32.
Data rate from 64K to 2048K.

IP•Tube SCRCLOCK MODE

TUBE SCRCLOCK MODE NX2K4,/NX56K /NX64K

IP•Tube SCRCLOCK FACTOR NN

TUBE SCRCLOCK FACTOR NN

IS THE N THAT MULTIPLIES THE MODE NX2K4, NX56K AND NX64K

IP•Tube SCTCLOCK MODE

TUBE SCTCLOCK MODE NX2K4/NX56K /NX64K

IP•Tube SCTCLOCK FACTOR

TUBE SCTCLOCK FACTOR NN

IS THE N THAT MULTIPLIES THE MODE NX2K4, NX56K AND NX64K

IP•Tube Interval

The TUBE INTERVAL command is used to control the gapping of the transmit (SCT) and receive (SCR) clocks. Permitted values are 0 to 63.

Example Configurations

IP•TubeT1 and E1 configurations are detailed in this section. The command line configuration listing is shown for each example. The configuration commands are defined in Chapter 4: Command Line Interface as well as in a detailed discussion provided in *Chapter 5: IP•Tube T1/E1 Configuration & Operation.*

Example 1: IP•Tube-T1 Full 24 DS0s with T1 Framing Bits

Scenario

This sample configuration details an IP•Tube interconnect of a Full T1 with framing bits. Note that the IP•Tube adds overhead in its conversion of T1 to IP packets so that the full T1 frame rate of 1.544 Mbps requires 1.906 Mbps of interconnect bandwidth on the ethernet side. See *Chapter 5: T1/E1 Configuration and Operation* for a complete description of the overhead associated with encapsualtion of T1/E1 frames into IP packets.

Config File Name

IPTT1FullwFramingPLL.txt

Command Line Listing

```
HostName IPTube T1
IP Default-router

Interface E1
# IP Address of this IP•Tube:
 IP Address 192.168.1.1/24
# Ethernet Broadcast/Multicast Reception Control
 BroadcastRCV ON

Interface S1
Type T1
# Tube Parameters
Protocol IPTube
Tube On
Tube Framing T1Framed
#    IP Address of remote IP•Tube:
Tube Address 192.168.1.2
# Tube Destination Ethernet Address Resolution
Tube TOS 08 Hex
TubeUDPPORT 3175

Tube Buffers  5
Tube FPP 8
Tube Compression Off
Tube Ethernet Arp On
Tube Ethernet Address

# T1 Parameters
T1 Data          Normal
#     T1 Transmit timing set to Phase Lock Loop:
T1 Clocking      PLL
T1 LBO           CSU          0dB
T1 Framing       ESF
T1 Coding        B8ZS
T1 IdleCharacter 0x7F
T1 Channels      Full
```

Example 2: IP•Tube Fractional T1: 8 DS0s without T1 Framing Bits

Scenario

This sample configuration details an IP•Tube interconnect of a fractional T1 without framing bits. DS0 1 through 8 are transported. This IP•Tube is set to internal timing as the master clock of the IP•Tube's T1 connection. The remote IP•Tube must be set to use its Phase Lock Loop to match this frequency. Note: the remote IP•Tube is across a WAN whose IP address range is 192.168.2.x. The WAN router address is 192.168.1.4 this is the address for the Default Router.

Config File Name

IPTT1fracwanINT.txt

Command Line Listing

```
Host Name IP•Tube-T1 Master Clock

IP Default-router 192.168.1.4

Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.1/24
# Ethernet Broadcast/Multicast Reception Control
BroadcastRCV ON

Interface S1
 Type T1
# Tube Parameters
 Protocol IPTube
 Tube On
 Tube Framing Transparent
# IP Address of remote IP•Tube
 Tube Address 192.168.2.1
Tube UDPPort 3175
 Tube TOS 0x08
 Tube Buffers   5
 Tube FPP   8
# Tube Destination Ethernet Address Resolution
 Tube Ethernet ARP On
 Tube Ethernet Address


# T1 Parameters
 T1 Data          Normal
# T1 Transmit timing set to Internal
 T1 Clocking      Internal
 T1 LBO           CSU           0dB
 T1 Framing       ESF
 T1 Coding        B8ZS
 T1 IdleCharacter 0x7F
#                           START CHANNEL   NUMBER OF CHANNELS
 T1 Channels      Fractional       1             8
```

Example 3: IP•Tube T1 Compression: 24 DS0s with 56 to 1 Compression

Scenario

This sample configuration details an IP•Tube interconnect of a Full T1 with compression enabled. Note: T1 compression must be without framing bits. DS0 1 through 24 are transported. This IP•Tube is set to internal timing as the master clock of the IP•Tube's T1 connection. The remote IP•Tube must be set to use its Phase Lock Loop to match this frequency. Note: the remote IP•Tube is across a WAN whose IP address range is 192.168.2.x. The WAN router address is 192.168.1.4 this is the address for the Default Router.

Config File Name

IPTT1fullCompressionINT.txt

Command Line Listing

```
Host Name IP•Tube-T1 Compression Master Clock

IP Default-router 192.168.1.4

Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.1/24
# Ethernet Broadcast/Multicast Reception Control
BroadcastRCV ON

Interface S1
 Type T1
# Tube Parameters
 Protocol IPTube
 Tube On
 Tube Framing Transparent
# IP Address of remote IP•Tube
 Tube Address 192.168.2.1
 Tube TOS 0x08
 Tube Buffers   10
# Note Echo Cancellation Required
 Tube FPP   56
 Tube Compression ON
# Tube Destination Ethernet Address Resolution
 Tube Ethernet ARP ON
 Tube Ethernet Address

# T1 Parameters
 T1 Data          Normal
# T1 Transmit timing set to Internal
 T1 Clocking      Internal
 T1 LBO           CSU          0dB
 T1 Framing       ESF
 T1 Coding        B8ZS
 T1 IdleCharacter 0x7F
 T1 Channels      Full
```

Example 4: IP•Tube-E1 Full 31 DS0s with E1 Framing Byte

Scenario

This sample configuration details an IP•Tube-E1 interconnect of a full E1 with framing bits. All 31 DS0s are transported. Note: the IP•Tube adds overhead in its conversion of E1 to IP packets so that the full E1 frame rate of 2,048,000 requires 2,250,000 bits per second of interconnect bandwidth.

Config File Name

IPTE1FullwFramingPLL.txt

Command Line Listing

```
Host Name IP Tube E1

IP Default-router
IP Cost 1

Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.1/24
# Ethernet Broadcast/Multicast Reception Control
 BroadcastRCV ON

Interface S1
 Type E1

# Tube Parameters
 Protocol IP•Tube
 Tube On
 Tube Framing E1Framed
# IP Address of Remote IP•Tube
 Tube Address 192.168.1.2
Tube UDPPort 3175
 Tube TOS 08 Hex
Tube Buffers 5
 Tube FPP 12
Tube Compression Off
# Tube Destination Ethernet Address Resolution
 Tube Ethernet ARP On
 Tube Ethernet Address


# E1 Interface Configuration Parameters
 E1 Data         Normal
# E1 Transmit timing set to Phase Lock Loop
 E1 Clocking     PLL
 E1 Framing      CRC4
 E1 Coding       HDB3
 E1 IdleCharacter 0x7F
 E1 Channels     Full
```

Example 5: IP•Tube Fractional E1: 8 DS0s without E1 Framing Byte

Scenario

This sample configuration details an IP•Tube interconnect of a fractional E1 without framing byte. E1 framing is generated locally. DS0 1 through 8 are transported. This IP•Tube is set to internal timing as the master clock of the IP•Tube's E1 connection. The remote IP•Tube must be set to use its Phase Lock Loop to match this frequency.
Note: the remote IP•Tube is across a WAN whose IP address range is 192.168.2.x. The WAN router address is 192.168.1.4 and is the address for the Default Router.

Config File Name

IPTE1fracwanINT.txt

Command Line Listing

```
Host Name IPTube E1 Master Clock
IP Default-router 192.168.1.4

Interface E1
# IP Address of this IP•Tube
IP Address 192.168.1.1/24

Interface S1
Type T1
Protocol IPTube
Tube On
Tube Framing Transparent
# IP Address of remote IP•Tube
 Tube Address 192.168.1.2
Tube UDPPort 3175
 Tube TOS 08 Hex
Tube Buffers 5
 Tube FPP 12
Tube Compression Off
# Tube Destination Ethernet Address Resolution
 Tube Ethernet ARP On
 Tube Ethernet Address

E1 Data         Normal
# E1 Transmit timing set to Internal
E1 Clocking     Internal
E1 Framing      CRC4
E1 Coding       HDB3
 E1 IdleCharacter 0x7F
#                          START CHANNEL   NUMBER OF CHANNELS
E1 Channels     Fractional      1              8
```

Example 6: IP•Tube E1 Compression: 32 DS0s with 40 to 1 Compression

Scenario

This sample configuration details an IP•Tube interconnect of a Full E1 with compression enabled. Note: E1 compression does not need to bebe without framing bits. DS0 1 through 32 are transported. This IP•Tube is set to internal timing as the master clock of the IP•Tube's T1 connection. The remote IP•Tube must be set to use its Phase Lock Loop to match this frequency. Note: the remote IP•Tube is across a WAN whose IP address range is 192.168.2.x. The WAN router address is 192.168.1.4 this is the address for the Default Router.

Config File Name

IPTE1fullCompressionINT.txt

Command Line Listing

```
Host Name IP•Tube-T1 Compression Master Clock

IP Default-router 192.168.1.4

Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.1/24
# Ethernet Broadcast/Multicast Reception Control
BroadcastRCV ON

Interface S1
 Type E1
# Tube Parameters
 Protocol IPTube
 Tube On
 Tube Framing Transparent
# IP Address of remote IP•Tube
 Tube Address 192.168.2.1
 Tube TOS 0x08
 Tube Buffers   10
# Note Echo Cancellation Required
 Tube FPP   40
 Tube Compression ON
```

Tube Destination Ethernet Address Resolution
 Tube Ethernet ARP ON
 Tube Ethernet Address

E1 Parameters
 E1 Data Normal
E1 Transmit timing set to Internal
 E1 Clocking Internal
 E1 Framing CRC4
 E1 Coding HDB3
 E1 IdleCharacter 0x7F
 E1 Channels Full

An interval of 0 does not gap the clock. An interval consists of the period defined by the Frames Per Packet times the Bytes Per Frame times the bits per byte divided by the SCxCLOCK setting. The Bytes Per Frame is set to 64. The FPP is user configurable and the bits per byte is 8.

TUBE INTERVAL is used to regulate the packet rate. Regulation of the packet rate provides for a mechanism to control the data rate of the IPTubeRS530/V.35. The Interval setting can be utilized to clock data out of the DTE into a packet at its maximum clocking rate so as to minimize latency.

There are 2 methods of controlling the IPTube data rate. One method is to set the SCxCLOCK rates to the data rate required. This method can double the delay if in the IPTube network connection there is a WAN link. The other method is to set the SCxCLOCK to the DTE's maximum clocking rate and regulating the packet rate with the interval setting.

TUBE INTERVAL xx

IP•Tube Percentage

The TUBE PERCENTAGE parameter, in conjunction with the

SCxCLOCK MODE/FACTOR and TUBE INTERVAL setting, controls the transmit (SCT) and receive (SCR) clocking on the RS-530/V.35 serial interface. A detailed discussion of data bandwidth and clock rate, and how TUBE FPP, TUBE INTERVAL and TUBE PERCENTAGE settings affect them is provided in *Chapter 5: IP•Tube T1/E1 Configuration & Operation.*

Example 7: IP•Tube RS530 at 2.048 Mbps

IP•Tube RS530/V.35 configurations are detailed in this section. The command line configuration listing are shown for each example. The configuration commands are defined in Chapter 4: Command Line Interface as well as in a detailed discussion provided in *Chapter 6: IP•TubeRS530/V35 Configuration & Operation.*

Scenario

This sample configuration details an IP•Tube RS530 model which connects to a data encryption device via RS-530 at a clocking rate of 2.048 Megabits per second. The IPTubes Ethernet interconnection has a committed information rate that is much greater than the IPTube maximum data rate. Therefore the Ethernet bandwidth available is relatively unlimited.

The SCRCLOCK will be set to run at 64Kilobits faster than the SCTCLOCK 1.984 Mbps so that Tube Buffering is not required and the latency is minimized to the time required to load up the IP packet.

For this example, the user will select Frames-Per-Packet = 10. With this TUBE FPP setting, the Overhead Table in Chapter 6 indicates an approximate 7% (ratio is 1.069) overhead. IPTube Ethernet Data rate is 1.069 times 1.984 Mbps

Config File Name

IPT530_nbft.txt

Command Line Listing

Host Name IPTube-530

IP Default-router

```
Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.1/24

Interface S1
Type RS-530
SCR Normal
SCT Normal
Protocol IPTube
Tube On
# IP Address of the Remote IP•Tube
Tube Address 192.168.1.2
Tube TOS 0x08
Tube FPP 10
Tube Clock Internal
Tube SCRCLOCK MODE NX64K
Tube SCRCLOCK FACTOR 32
Tube SCTCLOCK MODE NX64K
Tube SCTCLOCK FACTOR 31
Tube Buffer 0
Tube Interval 0
Tube Percentage 100
```

Example 8: IP•Tube RS530 at 64 Kbps

Scenario

This sample configuration details an IP•Tube RS530 model which connects to a data encryption device via RS-530. The Ethernet bandwidth must be limited to 64 Kbps due to its path over an ISDN WAN Router connected to a 64Kilobit satellite link. Therefore the user must calculate the desired RS-530 clock rate which will yield a 64 Kbps bandwidth usage on Ethernet, taking into consideration the overhead added with encapsulation of RS-530 data into IP/UDP packets and the ISDN WAN Router's PPP overhead.

For this example, the user will select Frames-Per-Packet = 10. With this TUBE FPP setting, the tables in Chapter 6 indicate an approximate 7% (ratio is 1.069) overhead. The WAN Point to Point Protocol overhead is off set with the Ethernet MAC addresses not being transported accross the WAN link although the HDLC framing does bit stuffing that could bump the data bandwidth by 8%. So the total overhead is 7% for the IP/UDP plus 8% for bit stuffing.

Therefore the desired clock rate on RS530 is 64Kbps/1.15 = 55Kbps. In order to minimize the latency involved in clocking the data from the encryptor's serial interface the encryptor will be clocked at its maximum rate and the Tube Interval setting will be used to hold off clocking the next packet of data until the ISDN WAN router has been able to transmit the prior packet.

To determine the Tube Interval setting take the maximum clocking rate of the DTE divide it by the data rate and subtract one. The Encryptors maximum clocking rate is 2.048Mbps.

Divisor = 2,048,000/55,000 = 37.2.
Round down 2,048,000/37 = 55,351
note: slightly greater clocking rate is ok since bit stuffing of
8% is worst case of every data byte being stuffed.
Interval = Divisor minus 1 = 36

Note: the time of clock gapping equals
((FPP * BytePerFrame* BitsPerByte)/2.048Mbps) times Interval.
FPP = 10; BPP = 64; SCRCLOCK = 55,351; Interval = 36.
(10 * 64*8)/ 2,048,000 * 36 = 0.09 = 90 milliseconds.
This amount of gap can result in synchronization mode limitations. The clock gapping delay can be reduced by reducing the FPP (overheaed impact) and the SCTCLOCK base rate (latency impact) which is set to maximum in this example.

Config File Name

IPT530_interval.txt

Command Line Listing

```
Host Name IPTube-530

# IP Address of the ISDN WAN Router
IP Default-router 192.168.1.1

Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.5/24

Interface S1
Type RS-530
SCR Normal
SCT Normal
Protocol IPTube
Tube On
# IP Address of the Remote IP•Tube
Tube Address 198.168.2.5
Tube TOS 0x08
Tube FPP 10
Tube Clock Internal
# SCRCLOCK = 2.048 Mbps
Tube SCRCLOCK MODE NX64K
Tube SCRCLOCK FACTOR 32
# SCTCLOCK = 2.048 Mbps
Tube SCTCLOCK MODE NX64K
Tube SCTCLOCK FACTOR 32
Tube Buffer 0
Tube Interval 36
Tube Percentage 100
```

Example 9: IP•Tube RS530 Video

IP•Tube RS530/V.35 configurations are detailed in this section. The command line configuration listing are shown for each example. The configuration commands are defined in Chapter 4: Command Line Interface as well as in a detailed discussion provided in *Chapter 6: IP•TubeRS530/V35 Configuration & Operation.*

Scenario

This sample configuration details the interconnection of a synchronous serial Video Encoder to a Video Decoder via IPTubeRS530s that are providing smooth clocking at a rate of 1.536 Megabits per second. The IPTube's Ethernet interconnection has a committed information rate that is much greater than the IPTube's maximum data rate. Therefore the Ethernet bandwidth available is relatively unlimited.

The Tube Clock on one of the IPTubeRS530s need to be set to Internal and the other to PLL. The SCRCLOCK will be set to run at the same speed as the SCTCLOCK without gapping so that buffering of packets is required and the Frames Per Packet is set to the maximum for maximum efficiency.

For this example, the user will select Frames-Per-Packet = 20. With this TUBE FPP setting, the Overhead Table in Chapter 6 indicates an approximate 3.4% (ratio is 1.034) overhead. IPTube Ethernet Data rate is 1.034 times 1.536 Mbps.

Config File Name

IPT530_video.txt

Command Line Listing

```
Host Name IPTube-530

IP Default-router

Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.1/24

Interface S1
Type RS-530
SCR Normal
SCT Normal
Protocol IPTube
Tube On
# IP Address of the Remote IP•Tube
Tube Address 192.168.1.2
Tube TOS 0x08
Tube FPP 20
Tube Clock Internal
Tube SCRCLOCK MODE NX64K
Tube SCRCLOCK FACTOR 24
Tube SCTCLOCK MODE NX64K
Tube SCTCLOCK FACTOR 24
Tube Buffer 10
Tube Interval 0
Tube Percentage 100
```

Example 10: IP•Tube V35 HDLC

Scenario

This sample configuration details the interconnection of a WAN Routers running Point to Point Protocol via IPTubeV35s that are providing smooth clocking at a rate of 128 Kilobits per second. The IPTube's Ethernet interconnection has a committed information rate that is much greater than the IPTube's maximum data rate. Therefore the Ethernet bandwidth available is relatively unlimited.

The Tube Clocks on one of the IPTubeV35s are both set to Internal. The SCRCLOCK will be set to run at the same speed as the SCTCLOCK without gapping. Buffering of packets is not required and the Frames Per Packet is set low minimize latency.

For this example, the user will select Frames-Per-Packet = 2. With this TUBE FPP setting, the Overhead Table in Chapter 6 indicates an approximate 34% (ratio is 1.34) overhead. IPTube Ethernet Data rate is 1.34 times 128Kbps which equals 171.52 Kilobits per second.

Config File Name

IPTV35_HDLC.txt

Command Line Listing

```
Host Name IPTube-V35

IP Default-router

Interface E1
# IP Address of this IP•Tube
 IP Address 192.168.1.1/24

Interface S1
Type V35
SCR Normal
SCT Normal
Protocol HDLCoIP
Tube On
# IP Address of the Remote IP•Tube
Tube Address 192.168.1.2
Tube TOS 0x08
Tube FPP 2
Tube Clock Internal
Tube SCRCLOCK MODE NX64K
Tube SCRCLOCK FACTOR 2
Tube SCTCLOCK MODE NX64K
Tube SCTCLOCK FACTOR 2
Tube Buffer 0
Tube Interval 0
Tube Percentage 100
```

Example 11: IP•Tube-QT1 Full 24 DS0s with T1 Framing Bits

Scenario

This sample configuration details an IP•Tube interconnect of a Full T1 with framing bits. Note that the IP•Tube adds overhead in its conversion of T1 to IP packets so that the full T1 frame rate of 1.544 Mbps requires 1.906 Mbps of interconnect bandwidth on the ethernet side. See *Chapter 5: T1/E1 Configuration and Operation* for a complete description of the overhead associated with encapsualtion of T1/E1 frames into IP packets.

Config File Name

IPTQT1.txt

```
Host Name "IPTube QT1"
Host Contact "No contact specified"
Host Location "No location specified"
IP Default-router
Interface LAN1
 Auto Negotiation:  On
 IP Address 192.168.1.2/24
 IP State: RUNNING

Interface S1
 Type T1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3175
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
```

Tube Ethernet Address 00:00:00:00:00:00

T1 Data	Normal	
T1 Clocking	Internal	
T1 LBO	CSU	0dB
T1 Framing	ESF	
T1 Coding	B8ZS	
T1 IdleCharacter	7E Hex	
T1 Channels	Full	

Config File Name

IPTQT1.txt

```
Interface S2
 Type T1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3176
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
 Tube Ethernet Address 00:00:00:00:00:00

 T1 Data          Normal
 T1 Clocking      Internal
 T1 LBO                  CSU        0dB
 T1 Framing       ESF
 T1 Coding        B8ZS
 T1 IdleCharacter 7E Hex
 T1 Channels      Full
```

Config File Name

IPTQT1.txt

```
Interface S3
Type T1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3177
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
 Tube Ethernet Address 00:00:00:00:00:00

 T1 Data          Normal
 T1 Clocking      Internal
 T1 LBO                     CSU        0dB
 T1 Framing        ESF
 T1 Coding        B8ZS
 T1 IdleCharacter 7E Hex
 T1 Channels      Full
```

Config File Name

IPTQT1.txt

```
Interface S4
 Type T1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3178
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
 Tube Ethernet Address 00:00:00:00:00:00

 T1 Data          Normal
 T1 Clocking      Internal
 T1 LBO                   CSU      0dB
 T1 Framing       ESF
 T1 Coding        B8ZS
 T1 IdleCharacter 7E Hex
 T1 Channels      Full
```

Example 12: IP•Tube-QE1 Full 31 DS0s with E1 Framing Byte

Scenario

This sample configuration details an IP•Tube-E1 interconnect of a full E1 with framing bits. All 31 DS0s are transported. Note: the IP•Tube adds overhead in its conversion of E1 to IP packets so that the full E1 frame rate of 2,048,000 requires 2,250,000 bits per second of interconnect bandwidth.

Config File Name

IPTQE1.txt

```
Host Name "IP Tube QE1"
Host Contact "No contact specified"
Host Location "No location specified"
IP Default-router
Interface LAN1
 Auto Negotiation:  On
 IP Address 192.168.1.2/24
IP State: RUNNING
Interface S1
 Type E1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3175
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
 Tube Ethernet Address 00:00:00:00:00:00

 E1 Data           Normal
 E1 Clocking       Internal
 E1 Framing        CRC4
 E1 Coding         HDB3
 E1 IdleCharacter  7E Hex
 E1 Channels       Full
```

Config File Name

IPTQE1.txt

```
Interface S2
 Type E1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3176
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
 Tube Ethernet Address 00:00:00:00:00:00

 E1 Data            Normal
 E1 Clocking        Internal
 E1 Framing         CRC4
 E1 Coding          HDB3
 E1 IdleCharacter   7E Hex
 E1 Channels        Full
```

Config File Name

IPTQE1.txt

```
Interface S3
 Type E1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3177
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
 Tube Ethernet Address 00:00:00:00:00:00

 E1 Data             Normal
 E1 Clocking         Internal
 E1 Framing          CRC4
 E1 Coding           HDB3
 E1 IdleCharacter    7E Hex
 E1 Channels         Full
```

```
Interface S4
 Type E1
 Protocol IPTube
 Tube On
 Tube Framing Transparent
 Tube Address 192.168.1.1
 #Destination Address of Remote Tube
 Tube UDPPORT  3178
 Tube TOS  4F Hex
 Tube Buffers 5
 Tube FPP 16
 Tube Duplicates 0
 Tube Compression Off
 Tube Ethernet Arp On
 Tube Ethernet Address 00:00:00:00:00:00

 E1 Data            Normal
 E1 Clocking        Internal
 E1 Framing         CRC4
 E1 Coding          HDB3
 E1 IdleCharacter   7E Hex
 E1 Channels        Full
```

Chapter 3

Installation of the IP•Tube

This chapter provides details on the physical connections required for the installation of Engage IP•Tube equipment. Also covered is the initial communication with the IP•Tube.

References are made to the Configuration and Operation of the IP•Tube as well as to the Command Line Interface. These topics are covered in detail in later chapters.

Installation Requirements

The use of Engage IP•Tube systems to create a TDM-over-IP or SynchronousData-over-IP connection requires one IP•Tube at each side of the IP connection.

A standard IP•Tube package includes:

- IP•Tube unit - with installed WAN interface: QT1/QE1/T1, E1, RS-530, or V.35
- Console port adapter and cable
- One cross-over T1/E1 cable (QT1/QE1/T1/E1 models only)
- RJ45 to DB15 male adapter for 120 ohm balanced (QE1/E1 only)
- Power Converter (110 or 220 Vac input/24 Vac or 24 Vdc output)

Note: power supply not supplied with negative 48 volt models.

- Documentation floppy disk with *IP•Tube User's Guide*

Installing the Hardware

Locating the IP•Tube

Site consideration is important for proper operation of the IP•Tube. The user should install the unit 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•Tube can be mounted in a standard 19 inch equipment rack (rack mounts are available from Engage)

Powering the IP • Tube

Engage IP•Tube units utilize an external power adapter, available in 110 VAC and 220 VAC versions, providing AC output.

The appropriate power adapter is provided with each unit.

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

Connect the power adapter to an appropriate AC power outlet and check the POWER LED on the front panel of the Engage IP•Tube. The POWER LED will be GREEN when the internal diagnostics have completed

Console Port

All IP•Tube models include a Console port for configuration. The Console port may be used for serial communication from a local workstation, or for remote connection via a modem.

IP•Tube 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 to db9 adapter is provided with the IP•Tube which, in addition to providing a physical interface, performs the null modem operation permitting direct connection to other DTE equipment, such as the COM1 interface of a PC.

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

Communication to the console port should be set for:

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

Once a serial connection between a workstation and the IP•Tube Console port is established and a carriage return <CR> is entered, a Login prompt will appear.

The default login is: **root**.

Configuring the Engage IP•Tube for the LAN

The IP•Tube needs to be configured with a number of parameters for proper operation in the network including:

- Ethernet IP address and subnet mask
- IP data target unit IP address and subnet mask
- Default gateway if the IP data target is on another IP network

The configuration procedure depends on the network environment in which the IP•Tube is to be installed.

Note: It is strongly suggested that you configure the IP•Tube with its unique network identity **before** making any Ethernet or Wide Area connections.

Ethernet Interface

Engage IP•Tube systems with the exception of the IP•Tube QT1/QE1 models utilize 10BaseT Ethernet to connect to the Local Area Network. The QT1/QE1 uses a 10/100Base T to connect to the Local Area Network. Each system provides a 10BaseT interface on the rear panel for connection to an Ethernet switch or hub using a straight-thru Ethernet cable. For direct connection to a PC or other LAN device, the user should obtain a 10BaseT crossover cable.

10BaseT Ethernet cabling and crossover pinouts are provided in the Appendices.

IP•Tube Serial Interface Options

T1/fractional T1 Interface

The internal T1/fracT1 interface is used for T1 over IP connectivity. The interface connects to the T1 interface of T1 based telecommunication equipment such as a PBX or a T1 Multiplexer. This connection uses a 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 the T1 interface pinout.

The T1/fracT1 interface can be configured to operate at rates from 64Kbps to full T1 at 1.544 Mbps. The IP•Tube can be configured to transport T1 Framing bits.

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

E1/fractionalE1 Interface

The internal E1/fractional E1 DSU/CSU permits direct connection to the E1 interface of E1 based telecommunication equipment such as a PBX or an E1 Multiplexer. This connection uses a 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 male "D" connector. See Appendices for E1 pinout and cable specification.

Note: The E1 interface is 120 ohm, balanced. The E1 RJ45 interface is converted to the E1 120 balanced db15 Male interface via an RJ45 to DB15 male adapter.

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

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

RS-530 Interface

The IP•Tube-RS530 model provides a standard RS-530 synchronous serial interface for connection to Data Terminal Equipment (DTE) or Data

Communication Equipment (DCE) such as Encrypters, Terminal Servers, Video Codecs, and WAN Routers. The IP•Tube-RS530 encapsulates the serial data into IP packets for transmission over Ethernet.

The RS-530 interface is provided via a 25 pin "D" connector on the rear panel. See the Appendices for pinouts, signal names and directions. The RS-530 interface on the IP•Tube can be ordered as a Data Communication Equipment (DCE) interface or as a Data Terminal Equipment (DTE) interface. As a DCE it provides TxClk and RxClk to the connected DTE.

The DCE model needs to have a configured data rate through the IP•Tube-RS530 by setting timing parameters which control the TxClk and RxClk. The size and frequency of the IP packets can be controlled, yielding data rates ranging from 8 Kbits/sec to 1.544 Mbits/sec. *Chapter 6: Configuration and Operation of IP•Tube-RS530/V35* provides an explanation of the commands and their effect.

V.35 Interface

The IP•Tube-V35 model provides a V.35 synchronous serial interface for connection to Data Terminal Equipment (DTE) or Data Communication Equipment (DCE) such as Encrypters, Terminal Servers, Video Codecs, and WAN Routers. The IP•Tube-V35 encapsulates the serial data into IP packets for transmission over Ethernet.

The V.35 interface is provided via a 25 pin "D" connector on the rear panel, though this pinout differs from that of the IP•Tube-RS530. See the Appendices for pinouts, signal names and directions. The V.35 interface on the IP•Tube is a Data Communication Equipment (DCE) interface or as a Data Terminal Equipment (DTE) interface. As a DCE it provides TxClk and RxClk to the connected DTE.

The DCE model needs to have a configured data rate through the IP•Tube-V.35 by setting timing parameters which control the TxClk and RxClk. The size and frequency of the IP packets can be controlled, yielding data rates ranging from 8 Kbits/sec to 1.544 Mbits/sec. *Chapter 6: Configuration and Operation of IP•Tube-RS530/V35* provides an explanation of the commands and their effect.

Status LEDs

Front panel LEDs provide Power, Ethernet and Serial Interface status.

All Models.

Power - The Power LED is normally green, although at power-on it will briefly display amber if a firmware upgrade (TFTP upgrade stored in the FLASH ROM) is being loaded.

IP•Tube T1 model.

Ethernet

The IP•Tube T1 provides specific information, with EthRX and EthTX indicators providing status on packet transmission and receipt, respectively, on the Ethernet interface.

- When receiving, the EthRX will show a steady GREEN.
- When transmitting, the EthTX will show a steady GREEN.
- If, after power-on, the IP•Tube is unable to acquire a unique network address on the LAN, EthTX will show a steady RED or AMBER.

IP•Tube T1 model T1 Interface

The IP•Tube T1 provides specific information, with T1RX and T1TX indicators providing status on valid framing from the T1device or line to which the IP•Tube is connected.

- When receiving, the T1RX will show a steady GREEN.
- When transmitting, the T1TX will show a steady GREEN.
- If, after power-on, the IP•Tube is unable receive valid frames from other equipment it is connected to via the T1 line, the T1RX will show a steady RED or AMBER.

IP•Tube E1 model.

Ethernet

The IP•Tube E1 provides specific information, with EthRX and EthTX indicators providing status on packet transmission and receipt, respectively, on the Ethernet interface.

- When receiving, the EthRX will show a steady GREEN.
- When transmitting, the EthTX will show a steady GREEN.
- If, after power-on, the IP•Tube is unable to acquire a unique network address on the LAN, EthTX will show a steady RED or AMBER

IP•Tube E1 model E1 Interface

The IP•Tube E1 provides specific information, with E1RX and E1TX indicators providing status on valid framing from the E1device or line to which the IP•Tube is connected.

- When receiving, the E1RX will show a steady GREEN.
- When transmitting, the E1TX will show a steady GREEN.
- If, after power-on, the IP•Tube is unable receive valid frames from other equipment it is connected to via the E1 line, the E1RX will show a steady RED or AMBER.

IP•Tube QT1/QE1 model

IND1 - Serves as the heartbeat for the IP•Tube QT1/QE1. LED will be blinking during normal operation.

IND2 - Indicates a fault is detected by the internal diagnostics.

RST - Depressing the RST switch initiates a soft reset of the IP•Tube QT1/QE1

Ethernet

The IP•Tube 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.

- When transmitting, the TD will show a steady GREEN.
- When receiving RD will show a steady GREEN.
- 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.
- If, after power-on, the IP•Tube is unable to acquire a unique network address on the LAN, TD will show a steady RED or AMBER.

IP•Tube QT1/QE1 model T1/E1 Interface

The IP•Tube QT1/QE1 provides specific information, with TD and RD indicators providing status on valid framing from the T1/E1device or line to which the IP•Tube is connected. In addition, ST, ENA and LNK indicators provide status on link status, communication processor and framing, respectively, from the T1/E1device or line to which the IP•Tube is connected.

There are four indicators, Tel1 through Tel4 indicators providing status on valid framing from the T1device or line to which the IP•Tube is connected. Please note that the Tel1 through Tel4 indicators will only show connections for the amount of ports purchased.

- When transmitting, the TD will show a steady GREEN.
- When receiving, the RD will show a steady GREEN. If the IP•Tube 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.

IP•Tube RS530/V.35 models.

Ethernet

IP•Tube RS530 and V.35 models provide specific information, with EthTx and EthRx indicators providing status on packet transmission and receipt, respectively, on the Ethernet interface.

- When receiving, the EthRX will show a steady GREEN.
- When transmitting, the EthTX will show a steady GREEN.
- If, after power-on, the IP•Tube is unable to acquire a unique network address on the LAN, it will show a steady RED or AMBER.

IP•Tube RS530/V.35 model Serial Interface

IP•Tube RS530 and V.35 models provide SerRX and SerTX LEDs which indicate packet receipt and transmission , respectively, on the serial interface.

- When receiving packets, the SerRX will show a steady GREEN.
- When transmitting packets, the SerTXwill show a steady GREEN.

Additionally, a red SerRx LED indicates one of the following configuration/connection problems:

- The IP•Tube is in the process of determining IP communication.
- The IP•Tube is not configured with an IP address on Ethernet.
- The IP•Tube cannot resolve the IP address configured for its Ethernet.
- The DTE to which the IP•Tube RS530.DCE/V.35.DCE is connected is not asserting DTR.
- The DCE to which the IP•Tube RS530.DTE/V.35.DTE is connected is not asserting DSR.

Internal DIP Switches.

IP•Tube systems contain an internal four position DIP Switch which is accessible by removing the unit rear panel and sliding out the motherboard.

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

Switch 1 - Power cycling the unit with DIP Switch 1 ON forces the IP•Tube T1/E1/QT1/QE1/RS530/V.35 to return to factory default settings. Factory settings include operation from Base Flash and deleting any download upgrades. Ensure Switch 1 is returned to the OFF position after clearing an upgrade so future upgrades can be performed successfully.

Also for the IP•Tube T1/E1/QT1/QE1 models, Switch 1 ON allows a login without a password. This is useful when a password is forgotten. Switch 1 OFF retains the previously configured password.

Switch 2 - Applies only to IP•Tube C units - with lossless DS0 compres sion. Setting to ON will disable the compression. Note: this must be done at each IP•Tube and a RESTART or power cycle issued.

Switch 3 - Switch 3 is used during manufacturing to test the Voltage Controlled Crystal Oscillator (VCXO). The switch must be set to OFF for normal operation.

Switch 4 - DIP Switch 4 has two functions. When turned ON, it forces the IP•Tube T1/E1/QT1/QE1/RS530/V.35 into a loopback mode. This is useful for troubleshooting the Telco/Serial connection.

Chapter 4

Command Line Interface

Command Line access to the IP•Tube may be made via a Telnet connection to the Ethernet interface or via a serial connection to the Console port.

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 IP•Tube provided there is IP connectivity between the User Host and the IP•Tube.

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

Console Communication

Serial communication to the console port should be configured for

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•Tube for use with standard 9 pin COM ports

The RJ45 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, a Null Modem adapter is required.

The RJ45 to DB9 adapter which is provided with the IP•Tube serves this null modem function, permitting direct connection to the COM1 interface of most PCs.

Logging in to the IP • Tube

A Telnet session is opened by providing the IP address of the IP•Tube. On opening a CLI session, via Telnet or the Console port, the **login** prompt requires entry of a login ID.

The default login ID: **root.**

The IP•Tube is shipped with no password set. Passwords are set or modified with the **passwd** command, detailed below.

Overview of Commands

The Engage CLI supports shorthand character entry. At most 3 characters are required for the parsing of the commands. For example: **show configuration** can be entered as: **sh con**. The CLI is not case senstive. Description of the commands uses both upper and lower case for syntax definitions and examples.

A full description of the command line interface follows.

Categories

The command set can be divided into four categories:

General
Show
Config
Config Interface

Online 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 Config mode, makes changes, then Saves those changes. On Saving the changes the user leaves the Config mode.

The Config Interface mode, within the Config 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 command prompt indicates the mode of operation:

name# the single "#" indicates standard Telnet mode

name## indicates the IP•Tube is in the Config mode

name(s1)## IP•Tube is in Config Interface mode for 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:

name(s1)## interface lan1

Syntax for Command Parameters

{} == 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.

System Level Commands

PASSWD

Allows setting or modifying the login password. The IP•Tube ships with no password set. On entering the passwd command, the user is prompted to enter, and confirm, the new password.

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 IP•Tube.

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}

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

For the IP•Tube QT1/QE1 use the command:

CLEAR {lan1|S1|S2|S3|S4|All}

TERMNN

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 IP•Tube 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 Addr} {Filename}

TFTP (trivial file transfer protocol) provides a means for upgrading IP•Tube 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 Engage TFTP server address and the upgrade filename for the latest version from Engage Technical Support (support@engagecom.com). Ensure IP connectivity between the IP•Tube and the TFTP server by pinging from one to the other. Then issue the upgrade command. Example:

UPGRADE 157.22.234.129 ML107407.COD

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

Note that an IP•Tube 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] {INFO|STATISTICS}

For the IP•Tube QT1/QE1 use the command:

SHOW INTERFACE [lan1|S1|S2|S3|S4]{INFO|STATISTICS}

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.

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

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 an IP•Tube configuration into a local text file. The full configuration can be edited offline.

SHOW CONFIG INTERFACE [E1|S1]

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 lists IP•Tube Hostname, etc.

CONFIGURATION Commands

Engage employs a modal approach to IP•Tube 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:

name#	the single “#” indicates standard Telnet mode
name##	indicates the IP•Tube is in the Config mode
name (S1)##	IP•Tube is in Config Interface mode for Serial Port 1

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 IP•Tube to save configuration chnages.

RESTORE

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

HOST NAME namestring

Provide a unique name for the IP•Tube. The new host name does not take effect until a save and reset is performed. For example:

HOST NAME Dallas IPTube

Note: Earlier versions of the Engage software use the term ROUTER NAME.

SNMP COMMUNITY NAME

Set or modify Tube SNMP community name. This string is used for authentication for SNMP SetRequests and SNMP traps.

SNMP TRAPS {ON | OFF}

Turns on or off generation of SNMPv1 Traps. The Destination Address for these traps must be configured to be an SNMP management station capable of decoding

SNMPv1 traps.

SNMP TRAPS ADDRESS address

Sets the Destination IP Address to which the Tube will send SNMPv1 Traps.

IP DEFAULT-ROUTER address

Enter the IP address of the default router or gateway. This must be an IP address on the same network as the IP•Tube Ethernet interface.

Config Interface Commands

Configuration of the IP•Tube involves setting parameters for the Ethernet (E1) interface and the Serial (S1) interface, which may be T1, E1, RS-530 or V.35. The user must specify which interface is being configured with the command:

INTERFACE [E1|S1]

Configuration of the IP•Tube QT1/QE1 involves setting parameters for the Ethernet (lan1) interface and the Serial **S1|S2|S3|S4** interface, which may be T1, E1. The user must specify which interface is being configured with the command:

INTERFACE [lan1|S1|S2|S3|S4]

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:

name(s1)## **interface e1**

To move up one level, from CONFIG INTERFACE mode to CONFIG mode, enter the command **INTERFACE** with no argument.

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 Interface

The following Serial Interface commands are applicable to IP•Tube T1 models. The serial interface commands include those which configure T1-over-IP parameters as well as T1 DSU/CSU parameters.

TYPE

The TYPE parameter is factory configured to match the Serial port's hardware and should be set to T1.

PROTOCOL

The interface protocol controls the packetization format of the IP•Tube. The options are IPTUBE, CESoIP and HDLCoIP.

IPTUBE Protocol encapsulates the data bits selected into UDP packets.

CESoIP Protocol encapsulates the data bits selected into UDP packets with an RTP header.

HDLCoIP Protocol encapsulates HDLC frames into UDP packets with an RTP header. This protocol is used to interconnect data networks that utilize WAN protocols such as PPP, Frame Relay, HDLC and SDLC.

TUBE {ON|OFF}
Turning off the IP•Tube stops the conversion of the Serial Port frames into IP packets.

TUBE LOCALLOOP {ON|OFF}

IP•Tube model T1/E1/QT1/QE1 only.

Turning on LOCALLOOP causes the IP•Tube to loop frames on the Serial Port. Frames received on the Serial Port are transmitted back on the Serial Port. Tube packets received on the Ethernet interface are not transmitted on the Serial Port when LOCALLOOP is on. LOCALLOOP takes effect after saving a configuration, but will be set OFF after a subsequent reset.

Turning LOCALLOOP on performs the same function as setting the TUBE ADDRESS the same as the Ethernet interface IP address or setting DIP Switch 4 on.

TUBE REMOTELOOP {ON|OFF}

IP•Tube model T1/E1/QT1/QE1 only

Turning on REMOTELOOP causes the IP•Tube to loop tube packets on the Ethernet interface. Valid tube packets received on the Ethernet interface are transmitted back out the Ethernet interface with the source and destination IP address and UDP ports exchanged. Frames received on the Serial Port are not transmitted on the Ethernet interface when REMOTELOOP is on. REMOTELOOP takes effect after saving a configuration, but will be set OFF after a subsequent reset.

TUBE FRAMING {T1FRAMED|TRANSPARENT}
Set the framing of the T1 data which is encapsulated into IP packets:

T1Framed: The framing bit position 193 of the T1 frame and the selected DS0s are tran sported in the IP packet.
Transparent: Only the data in the selected DS0s is transported in the IP•Tube. T1 framing bits are not encapsulated.

TUBE ADDRESS addr
Used to configure the destination IP address of the IP•Tube (the IP address of the remote IP•Tube). Note: if the TUBE ADDRESS is configured with the same IP address as the IP•Tube Ethernet interface (E1), a loopback of the T1 over IP port S1 will occur.

TUBE UDPPORT value

TUBE UDPPORT specifies the UDP port source and destination address. The IPTube only accepts packets that match its UDP Port configuration.

NOTE: Engage has registered with the IANA UDP port 3175 decimal. For the IP•Tube QT1/QE1 use the following UDP port numbers depending on which ports are activated.

Port 1	UDP port 3175
Port 2	UDP port 3176
Port 3	UDP port 3177
Port 4	UDP port 3178

TUBE TOS value

Sets the Type of Service Byte in the IP packets in which are encapsulated the T1/E1 frames. The setting of the TOS byte can be used to ensure that the real time TDM data from the IP•Tube is ensured high priority, assuming Quality of Service support is provided by each router or switch in the IP path between the IP•Tubes. Alternatively the IP destination address can be used to ensure that the IP•Tube IP packets receive the required priority and bandwidth. IP TOS is defined in the IETF RFC 1349, accessable online at www.ietf.org. A TOS setting of 0x08 maximizes throughput.

TUBE TOS is displayed in hex, with values ranging from 0x00 to 0x08. Preceding the entry with 0x results in a direct Hexidecimal input. Example:

TUBE TOS 0x06

TUBE BUFFERS value

As IP/UDP packets are received at the IP•Tube Ethernet interface, they are buffered prior to the enabling of the T1 transmitter. This provides for elasticity. The TUBE BUFFERS setting permits the user to configure the number of packets buffered with valid settings from 4 to 30.

A large value provides greater elasticity but can introduce significant delay. The amount of delay can be calculated based on the T1 data rate, the TUBE FPP setting (below) and the TUBE BUFFERS setting. See *Chapter 5: IP•Tube T1/E1 Configuration and Operation* for a detailed analysis of how the IP•Tube settings and the LAN/WAN interconnection contribute to the overall round trip delay or latency.

Note: Round trip delays in excess of 30 milliseconds require echo cancellation.

TUBE FPP value

Frames-Per-Packet specifies the number of frames received on the T1 interface to be encapsulated in a single IP/UDP packet. The size of the serial interface frame depends on the interface provided in the IP•Tube. For the T1 interface, the frame size is 192 bits + 1 framing bit (depending on T1Framing config).

T1 FPP is configurable in increments of 8. Proper configuration of FPP is appplication dependent. Low latency applications, such as voice, require minimum Frames Per Packet. The recommended T1 configuration for low latency is FPP = 8.

When Compression is enabled on IP•Tube-T1C models, FPP is automatically forced to 56.

TUBE COMPRESSION {ON|OFF}

Enables and disables compression on IP•Tube C models.

TUBE ETHERNET ARP {ON|OFF}

TUBE Ethernet ARP OFF uses the Ethernet MAC address specified by the TUBE Ethernet Address.

TUBE Ethernet ARP ON uses the Ethernet MAC address obtained automatically by the IPTube's IP to Ethernet MAC Address Resolution Protocol. Note: Default Configuration.

TUBE ETHERNET ADDRESS abcdef

TUBE ETHERNET ADDRESS specifies the Ethernet MAC address for the IPTube IP packet. The TUBE Ethernet MAC Address needs to match the MAC address of the destination IPTube or the Default Router. The MAC address is entered without the | character. Only enter the 6 bytes of MAC address, i.e. 001122334455.

NOTE: Unless Broadcast storms are suspected it is highly recommended that the automatic resolution of the IP address to Ethernet MAC address is utilized.

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|PLL}

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.

When set to PLL, the tube tunes its transmit clock to match the rate of the remote tube. When the remote tube clocking is internal or networking, this tube should be set to PLL.

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 IDLECHARACTER 0xNN

The T1 IDLECHARACTER is used with fractional T1 configuration to specify the value for the non selected T1 channels. The purpose of the IDLECHARACTER is to ensure that ESF framing's CRC is done without errors. The Idle Character setting of the T1 device attached to the Tube's T1 interface needs to be matched when the IPTubeT1 is set to transport the framing bit TUBE FRAMING T1FRAMED and the T1 interface is fractional T1 and the T1 framing is ESF.

T1 CHANNELS {FULL | FRACTIONAL {NN XX | {{NN | Y-Z}[,MM | ,Y-Z]}}}

Indicates if T1 line usage is all channels, or fractional.

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

For Fractional T1 with contiguous channels, NN is the first T1 channel in use (1 - 24) and XX is the number of channels to be used.

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

    T1 FRAC 1 6

Alternatively for channels in use that are not contiguous, NN and MM are single T1 channels in use and Y-Z are a range of T1 channels in use. Single channels and ranges are separated by commas and can be combined on a command line.

For example, an ISDN PRI link uses channels 24 for D Channel signaling and 5-20 for voice circuits.

    T1 FRAC 5-20,24

E1 Interface

The IP•Tube is available with an E1 interface, providing connection speeds up to 2.048 Mbps. The following Serial Interface commands are applicable to IP•Tube E1 models. The serial interface commands include those which configure E1-over-IP parameters as well as E1 DSU/CSU parameters.

TYPE

The TYPE parameter is factory configured to match the Serial port's hardware and should be set to E1.

PROTOCOL

The interface protocol controls the packetization format of the IP•Tube. The options are IPTUBE, CESoIP and HDLCoIP.

IPTUBE Protocol encapsulates the data bits selected into UDP packets.

CESoIP Protocol encapsulates the data bits selected into UDP packets with an RTP header.

HDLCoIP Protocol encapsulates HDLC frames into UDP packets with an RTP header. This protocol is used to interconnect data networks that utilize WAN protocols such as PPP, Frame Relay, HDLC and SDLC.

TUBE {ON|OFF}
Turning off the IP•Tube stops the conversion of the Serial Port frames into IP packets

TUBE LOCALLOOP {ON|OFF}

IP•Tube model QT1/QE1 only.

Turning on LOCALLOOP causes the IP•Tube to loop frames on the Serial Port. Frames received on the Serial Port are transmitted back on the Serial Port. Tube packets received on the Ethernet interface are not transmitted on the Serial Port when LOCALLOOP is on. LOCALLOOP takes effect after saving a configuration, but will be set OFF after a subsequent reset.

Turning LOCALLOOP on performs the same function as setting the TUBE ADDRESS the same as the Ethernet interface IP address or setting DIP Switch 4 on.

TUBE REMOTELOOP {ON|OFF}

IP•Tube model QT1/QE1 only

Turning on REMOTELOOP causes the IP•Tube to loop tube packets on the Ethernet interface. Valid tube packets received on the Ethernet interface are transmitted back out the Ethernet interface with the source and destination IP address and UDP ports exchanged. Frames received on the Serial Port are not transmitted on the Ethernet interface when REMOTELOOP is on. REMOTELOOP takes effect after saving a configuration, but will be set OFF after a subsequent reset.

TUBE FRAMING {E1FRAMED | TRANSPARENT}

Determines whether the E1 framing byte is encapsulated in the IP/UDP packet along with the DS0 data.

E1Framed: encapsulates the framing byte along with the DS0 data.

Transparent: Only the data in the selected DS0s is transported in the IP•Tube. The E1 framing byte is not encapsulated.

Note: The selection of the T1/E1 DS0s starting channel and number of channels is setup by the Serial Interface's T1/E1 configuration commands. A DS0 is a 64 Kbps Voice/Data circuit. E1 frames have 31 DS0s plus a Framing/Signaling Byte for a total of 32 bytes per frame.

TUBE ADDRESS addr
Used to configure the destination IP address of the IP•Tube (the IP address of the remote IP•Tube). Note: if the TUBE ADDRESS is configured with the same IP address as the IP•Tube Ethernet interface (E1), a loopback of the E1 over IP port S1 will occur.

TUBE UDPPORT value

TUBE UDPPORT specifies the UDP port source and destination address. The IPTube only accepts packets that match its UDP Port configuration.

NOTE: Engage has registered with the IANA UDP port 3175 decimal. For the IP•Tube QT1/QE1 use the following UDP port numbers depending on which ports are activated.

Port 1	UDP port 3175
Port 2	UDP port 3176
Port 3	UDP port 3177
Port 4	UDP port 3178

TUBE TOS value

Sets the Type of Service Byte in the IP packets in which are encapsulated the T1/E1 frames. The setting of the TOS byte can be used to ensure that the real time TDM data from the IP•Tube is ensured high priority, assuming Quality of Service support is provided by each router or switch in the IP path between the IP•Tubes.

Alternatively the IP destination address can be used to ensure that the IP•Tube IP packets receive the required priority and bandwidth. IP TOS is defined in the IETF RFC 1349, accessable online at www.ietf.org. A TOS setting of 0x08 maximizes throughput.

TUBE TOS is displayed in hex, with values ranging from 0x00 to 0x08. Preceding the entry with 0x results in a direct Hexidecimal input.

TUBE BUFFERS value

As IP/UDP packets are received at the IP•Tube Ethernet interface, they are buffered prior to the enabling of the E1 transmitter. This provides for elasticity. The TUBE BUFFERS setting permits the user to configure the number of packets buffered - with valid settings from 4 to 30.

A large value provides greater elasticity but can introduce significant delay. The amount of delay can be calculated based on the E1 data rate, the TUBE FPP setting (below) and the TUBE BUFFERS setting. See *Chapter 5: IP•Tube T1/E1 Configuration and Operation* for a detailed analysis of how the IP•Tube settings and the LAN/WAN interconnection contribute to the overall round trip delay or latency.

Note: Round trip delays in excess of 30 milliseconds require echo cancellation.

TUBE FPP value

Frames-Per-Packet specifies the number of frames received on the E1 interface to be encapsulated in a single IP/UDP packet. The size of the serial interface frame depends on the interface provided in the IP•Tube. For the E1 interface, the frame size is 256 bits.

E1 FPP is configurable in increments of 4. Proper configuration of FPP is appplication dependent. Low latency applications, such as voice, require minimum Frames Per Packet. The recommended E1 configuration for low latency is FPP = 12.

When Compression is enabled on IP•Tube-E1C models, FPP is automatically forced to 40.

TUBE COMPRESSION {ON | OFF}

Enables and disables compression on IP•Tube E1-C models.

TUBE ETHERNET ARP {ON|OFF}

TUBE Ethernet ARP ON uses the Ethernet MAC address specified by the TUBE Ethernet Address.

TUBE Ethernet ARP OFF uses the Ethernet MAC address obtained automatically by the IPTube's IP to Ethernet MAC Address Resolution Protocol.

TUBE ETHERNET ADDRESS abcdef

TUBE ETHERNET ADDRESS specifies the Ethernet MAC address for the IPTube IP packet. The TUBE Ethernet MAC Address needs to match the MAC address of the destination IPTube or the Default Router. The MAC address is entered without the | character. Only enter in the 6 bytes of MAC address i.e. 001122334455.

NOTE: Unless Broadcast storms are suspected it is highly recommended that the automatic resolution of the IP address to Ethernet MAC address is utilized.

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 oftenused when testing E1 connections on the bench.

E1 FRAMING {CRC4|FAS|UNFRAMED}

Selects the desired E1 framing format, including unframed. Note that Unframed mode is not permitted with Fractional E1.

E1 CODING {HDB3|AMI}

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

E1 IDLECHARACTER 0xNN

The E1 IDLECHARACTER is used with fractional E1 configuration to specify the value for the non selected E1 channels. The purpose of the IDLECHARACTER is to ensure that CRC4framing's CRC is done without errors. The Idle Character setting of the E1 device attached to the Tube's E1 interface needs to be matched when the IPTubeE1 is set to transport the framing bit TUBE FRAMING E1FRAMED and the E1 interface is fractional E1 and the E1 framing is CRC4.

E1 CHANNELS {FULL|FRACTIONAL {NN XX|{{NN|Y-Z}[,MM|,Y-Z]}}}

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

For Fractional E1 with contiguous channels, NN is the first E1 channel in use (1 - 31) and XX is the number of channels to be used.

For example, 384 Kbps fractional E1 typically uses channels 1 through 6. Start Channel: 1 and Total Channels: 6. where NN defines the Start Channel; XX is the total number of channels.

E1 FRAC 1 6

Alternatively for channels in use that are not contiguous, NN and MM are single E1 channels in use and Y-Z are a range of E1 channels in use. Single channels and ranges are separated by commas and can be combined on a command line.

For example, an ISDN PRI link uses channels 31 for D Channel signaling and 5-20 for voice circuits.

E1 FRAC 5-20,31

RS-530 & V.35 Interface

The following Serial Interface commands are applicable to IP•Tube RS530 and V.35 model

IP•Tube DTR-DSR Sensitivity- AVAILABLE ONLY ON REV. LEVEL 20.85.28 MODELS

The SENSEDTRDSR command is used to configure the RS530 and V.35 models for connection to their respective communication equipment.

The SENSEDTRDSR command determines whether the the IP•Tube is sensitive to the DTR signal in the case of IP•Tube DCE or the DSR signal in the case of IP•Tube DTE. When SENSEDTRDSR is ON, the IP•Tube will send IP packets with encapsulated data only when the DTR (IP•Tube DCE) or DSR (IP•Tube DTE) signal is asserted. When SENSEDTR DSR is OFF, the IP•Tube ignores the DTR or DSR signal and sends IP packets with encapsulated data.

SENSEDTRDSR {ON|OFF}

Enable or Disable DTR Sensitivity on a Serial Port for IP•Tube DCE.
Enable or Disable DSR Sensitivity on a Serial Port for IP•Tube DTE.

TYPE

The TYPE parameter is factory configured to match the Serial port's hardware and should be set to RS530 or V35 depending upon the hardware configuration.

SCR{NORMAL|INVERTED}

SCR{NORMAL|INVERTED}

The IP•Tube RS-530 and V.35 models provide DCE (data communication equipment) or Data Terminal Equipment (DTE) interfaces. The DCE interface supplies both the Transmit Clock (serial clock transmit, or SCT) and Receive Clock (SCR) to the connected DTE (date terminal equipment) interface. The IP•Tube RS-530 and V.35 models allow the user to configure these clocks to normal mode or to inverted mode. The DTE to which the IP•Tube connects may require inverted clock.

PROTOCOL

The interface protocol controls the packetization format of the IP•Tube. The options are IPTUBE, CESoIP and HDLCoIP.

IPTUBE Protocol encapsulates the data bits selected into UDP packets.

CESoIP Protocol encapsulates the data bits selected into UDP packets with an RTP header.

HDLCoIP Protocol encapsulates HDLC frames into UDP packets with an RTP header. This protocol is used to interconnect data networks that utilize WAN protocols such as PPP, Frame Relay, HDLC and SDLC.

TUBE{ON|OFF}
Turning off the IP•Tube stops the conversion of the Serial Port frames into IP packets.

TUBE ADDRESS addr
Used to configure the destination IP address of the IP•Tube (the IP address of the remote IP•Tube). Note: if the TUBE ADDRESS is configured with the same IP address as the IP•Tube Ethernet interface (E1), a loopback of the Serial Data over IP port S1 will occur.

TUBE UDPPORT value

TUBE UDPPORT specifies the UDP port source and destination address. The IPTube only accepts packets that match its UDP Port configuration.

NOTE: Engage has registered with the IANA UDP port 3175 decimal.

TUBE TOS value

Type of Service Byte in the IP packets in which are encapsulated the T1/E1 frames.

The setting of the TOS byte can be used to ensure that the real time TDM data from the IP•Tube is ensured high priority, assuming Quality of Service support is provided by each router or switch in the IP path between the IP•Tubes. Alternatively the IP destination address can be used to ensure that the IP•Tube IP packets receive the required priority and bandwidth. IP TOS is defined in the IETF RFC 1349, accessable online at www.ietf.org. A TOS setting of 0x08 maximizes throughput.

TUBE TOS is displayed in hex, with values ranging from 0x00 to 0x08. Preceding the entry with 0x results in a direct Hexidecimal input.

TUBE FPP value

Frames-Per-Packet specifies the number of frames received on the RS-530 or V.35 interface to be encapsulated in a single IP/UDP packet. The size of the serial interface frame depends on the interface provided in the IP•Tube. For the RS-530 and V.35 interfaces, the frame size is 512 bits (64 bytes).

Proper configuration of FPP is appplication dependent. Low latency applications,

TUBE CLOCK {INTERNAL|PLL}

The TUBE CLOCK command is used to set the source of the Serial Clock Receive and Transmit Timing signals. When SCRCLOCK needs to match the SCTCLOCK exactly with a smooth non gapped clock, TUBE INTERVAL = 0, then one of the IPTUBERS530/V.35s needs to have its TUBE CLOCK to INTERNAL and the other needs to be set to PLL and TUBE BUFFERing needs to be utilized.

TUBE SCRCLOCKMODE {NX2K4|NX56K|NX64K}

The TUBE SCRCLOCKMODE setting in combination with the SCRCLOCK FACTOR controls the frequency of the RS530/V.35 DCE interface's Serial Clock Receive.

TUBE SCRCLOCK FACTOR value

TUBE SCRCLOCK MODE NXxxx is multiplied by SCRCLOCK FACTOR to produce the SCRCLOCK.

NX2K4 2.4k times factor. Maximum factor is 20.
Data rate from 2.4K to 44.8K.

NX56K 56k times factor. Maximum factor is 32.
Data rate from 56K to 1792K.

NX64K 64k times factor. Maximum factor is 32.

Data rate from 64K to 2048K.

TUBE SCTCLOCK MODE {NX2K4|NX56K|NX64K}

The TUBE SCTCLOCKMODE setting in combination with the SCTCLOCK FACTOR controls the frequency of the RS530/V.35 DCE interface's Serial Clock Transmit.

TUBE SCTCLOCK FACTOR value

TUBE SCTCLOCK MODE NXxxx is multiplied by SCTCLOCK FACTOR to produce the SCTCLOCK.

NX2K4 2.4k times factor. Maximum factor is 20.
Data rate from 2.4K to 44.8K.

NX56K 56k times factor. Maximum factor is 32.
Data rate from 56K to 1792K.

NX64K 64k times factor. Maximum factor is 32.
Data rate from 64K to 2048K.

TUBE INTERVAL value

The TUBE INTERVAL command is used to control the gapping of the transmit (SCT) and receive (SCR) clocks. Permitted values are 0 to 63. An interval of 0 does not gap the clock. An interval consists of the period defined by the Frames Per Packet times the Bytes Per Frame times the bits per byte divided by the SCxCLOCK setting. The Bytes Per Frame is set to 64. The FPP is user configurable and the bits per byte is 8.

TUBE INTERVAL is used to regulate the packet rate by clocking for an interval and then not clocking for the TUBE INTERVAL VALUE . Regulation of the packet rate provides for a mechanism to control the data rate of the IPTubeRS530/V.35. The Interval setting can be utilized to clock data out of the DTE into a packet at its maximum clocking rate so as to minimize latency.

There are 2 methods of controling the IPTube data rate. One method is to set the SCxCLOCK rates to the data rate required. This method can double the delay if in the IPTube network connection there is a WAN link. The other method is to set the SCxCLOCK to the DTE's maximum clocking rate and regulating the packet rate with the interval setting.

A detailed discussion of data bandwidth and clock rate, and how TUBE CLOCK, SCXCLOCK MODE/FACTOR, TUBE FPP, TUBE INTERVAL and TUBE PERCENTAGE settings affect them is provided in *Chapter 6: IP•TubeRS530/V35 Configuration & Operation.*

TUBE PERCENTAGE {25 | 50 | 75 | 87 | 100}

The TUBE PERCENTAGE parameter, in conjunction with the SCxCLOCK MODE/ FACTOR, TUBE INTERVAL setting, controls the transmit (SCT) and receive (SCR) clock speeds on the RS-530/V.35 serial interface. A detailed discussion of data bandwidth and clock rate, and how TUBE FPP, TUBE INTERVAL and TUBE PERCENTAGE settings affect them is provided in *Chapter 6: IP•TubeRS530/V35 Configuration & Operation.*

Chapter 5

IP•Tube T1/E1 : Configuration & Operation

This chapter provides operational theory and configuration details specific to the IP•Tube-T1 and IP•Tube-E1 models. With built-in DSU/CSU interfaces, these models have unique requirements regarding timing, clocking and their interface to other T1/E1 equipment.

Note: The main difference between the IP•Tube-T1 and IP•Tube-E1 models and the IP•Tube QT1/QE1 models are as follows:

IP•Tube QT1/QE1 models have a 10/100Base T interface and one to four ports.

IP•Tube QT1/QE1 models use the same configuration for the ports except there are one to four ports.

The 100BaseT interface introduces new configuration parameters for inteface 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.

IP • Tube Installation Steps

The process of installing an IP•Tube QT1/QE1/T1/E1 involves the following steps:

1. Planning for IP•Tube interconnect
2. Installing the IP•Tube hardware
3. Configuring System and Ethernet parameters
4. Configuring the IP•Tube interface parameters
5. Making Ethernet and T1/E1 cabling connections
6. Verifying the IP•Tube connection

Note: A T1/E1 crossover cable is typically required to connect the IP•Tube T1/E1 interface to the external T1/E1 equipment. Direct connections to T1/E1 lines use straight T1/E1 cables.

System and Ethernet Parameters

Initial configuration items include the hostname for the specific IP•Tube, as well as a login password. See *Chapter 4: Command Line Interface* for specific syntax requirements. Examples:

HOST NAME Dallas Tube

PASSWD <cr>

An IP default router should be defined if the IP•Tube being configured is on a different IP network than the remote IP•Tube:

IP DEFAULT-ROUTER 172.16.1.254

The IP•Tube IP address is configured:

INTERFACE lan1

IP ADDR 172.16.1.222/24

T1 Parameters

T1 interface commands are configured by first selecting serial interface 1

INT S1

For the IP•Tube QT1/QE1 use the command:

{S1|S2|S3|S4}

The IP•Tube is enabled by the command:

TUBE ON/OFF

Tube Framing is configured for Transparent, T1 Framed, or SDLC/ HDLC:

- Transparent framing encapsulates the DS0 data without the T1 framing and signaling bits.
- T1Framed encapsulates the T1 signaling and framing bits along with the T1 DS0 data. The selection of the T1 DS0s starting channel and number of channels is setup by the Serial Interface's T1 configuration commands.

TUBE FRAMING TRANSPARENT

TUBE FRAMING T1 FRAMED

IP•Tube destination address is set to the IP address of the receiving IP•Tube. Note Loopback of the T1 occurs when the destination address is the same as the IP address of the Ethernet interface of the IP•Tube.

TUBE ADDR 172.16.0.222

DSU/CSU Parameters

The IP•Tube-T1 serial interface number 1 is configured for T1 operation. The following T1 parameters must match the configuration of the DS1/ T1 interface to which it is connected. The T1 clock setting is dependent upon the source of the T1 Clock.

Interface S1
 Type T1

T1 Data {Normal | Invert}
T1 Clocking {Internal | Network | PLL}
T1 LBO CSU {0dB | -7.5 | -15 | -22.5}
T1 Framing {ESF | D4}
T1 Coding {B8ZS | AMI}
T1 IdleCharacter 0xNN
T1 Speed 64K
T1 Spacing Contiguous
T1 Channels {Full | Fractional: Starting DS0 - Number of DS0s}

E1 Parameters

The IP•Tube E1 parameter are similar to those for T1 except as noted here:

TUBE FRAMING {E1FRAMED | TRANSPARENT}

- E1Framed: encapsulates the framing byte along with the DS0 data.
- Transparent: Only the data in the selected DS0s is transported in the IP•Tube. The E1 framing byte is not encapsulated.

DSU/CSU Parameters

The following E1 parameters must match the configuration of the E1 interface to which it is connected. The E1 clock setting is dependent upon the source of the E1 Clock.

Interface S1
Type E1
E1 Data {Normal | Invert}
E1 Clocking {Internal | Network | PLL}
E1 Framing {CRC4 | FAS|Unframed}
E1 Coding {HDB3 | AMI}
E1 IdleCharacter 0xNN
E1 Channels {Full | Fractional: Starting DS0 - Number of DS0s}

T1/E1 Clocking Considerations

Improper configuration of the T1/E1 clocking will result in an overrun or underrun condition which causes T1/E1 frame losses. One of the IP•Tube systems must be the master clock source or locked onto a T1/E1 clock and the remote end unit uses a Phase Lock Loop circuit to match the master's T1/E1 clock frequency.

In the case where the IP•Tube systems are being connected to a T1/E1 line from the Telephone company the IP•Tube connected to the Telco T1/E1 must be set to T1/E1 Clocking Network and the remote unit set to T1/E1 Clocking PLL.

TOS, QoS and UDP Port Number

The IP•Tube TOS command is used to control the Type of Service Byte in the IP packets containing the encapsulated serial data. The setting of the TOS byte can be used to ensure that the real time data from the IP•Tube is accorded high priority as it traverses the IP network. Support for the TOS byte is required within each router or switch making up the interconnect between the IP•Tubes. A TOS setting of 0x08 maximizes throughput. Note: Tube TOS is displayed in hex. Preceding the entry with 0x results in a direct hexidecimal input. Example:

TUBE TOS 0x08

Additionally, intermediary routers and switches can be configured for Quality of Service (QoS) prioritization to ensure that IP•Tube packets receive highest priority as they are routed through the IP interconnect. This QoS could be configured based on the IP•Tube Ethernet IP addresses, but a more straightforward method makes use of the unique UDP port number used by the IP•Tube.

Communication between IP•Tube systems uses packets destined for UDP port number 3175. This registered port assignment (reference www.iana.org/assignments/port-numbers) allows QoS configuration to prioritize UPD packets destined for port 3175.

This prioritization is essential for voice and other traffic which is sensitive to latency and delay on the LAN/WAN interconnection.

Latency and Bandwidth Considerations

The IP•Tube parameters TUBE BUFFERS and TUBE FPP (frames-per-packet) directly correlate with the flow of IP packets on the IP•Tube Ethernet interface. Selection of a large FPP value, resulting in large IP packets, or of a large TUBE BUFFERS setting, resulting in a excessive buffering of received data, will result in significant latency from end to end.

This latency will have a negative impact on delay-sensitive data such as voice, which is severely degraded when roundtrip delays approach 30 milliseconds.

The following examples provide insight into the various delay mechanisms which can occur if TUBE BUFFERS and TUBE FPP are configured improperly

Example 1 - A T1 frame of 193 bits takes 125 microseconds (usec) to transmit at 1.544 Mbps. Similarly, an E1 frame of 256 bits takes 125 usec to transmit at 2.048 Mbps.

If a user configures FPP (Frames Per Packet) to 8, then the IP Tube introduces a 1 millisecond (msec) packetization delay as it receives 8 frames and encapsulates them into a single IP packet: 8 * 125usec = 1 msec. If TUBE BUFFERS is then configured to 5, five packets are buffered and the resulting delay is 5 * 1msec = 5 msec. Roundtrip delay would be twice that or 10 msec.

Example 2 - The recommended FPP setting for E1 is 12 , which introduces a 1.5 msec packetization delay (12 * 125 usec = 1.5 msec). If TUBE BUFFERS is set to 4, then a 6 msec one-way, or 12 msec roundtrip delay is introduced.

Additionally, the user should also take into account the latency or delay introduced by the LAN/WAN interconnect to determine total delay.

IP • TubeCompression

IP•TubeT1 and E1 models are available with built-in, lossless data compression. When enabled on both the local and the remote IP•Tube units, this feature can achieve a 56:1 compression ratio during periods of idle data on the T1/E1 circuit.

IP Packet Encapsulation Overhead

The encapsulation of T1/E1 data into IP/UDP packets for transmission over Ethernet adds overhead due to the Ethernet, IP, and UDP headers - a total of 44 bytes. This 44 byte overhead should be taken into account when considering Ethernet bandwidth utilization.

NOTES:

- A DS0 is a 64 Kbps Voice/Data circuit.

- A Full T1 circuit is configured for 24 DS0s. The T1 signal is divided into frames, with one byte (8 bits) allocated for each configured DS0 and 1 framing bit for a total of 193 bits per frame = (24 * 8) + 1.

- A Full E1 circuit is conifigured for 31 DS0s. The E1 signal is divided into frames, with one byte (8 bits) allocated for each configured DS0 and 1 framing/signalling byte (8 bits) for a total of 32 bytes or 256 bits per frame.

The Tube Frames-per-Packet (FPP) setting controls the number of T1/E1 data frames to be encapsulated in a single IP/UDP packet. If an IP•Tube E1 is configured for Full E1 and FPP = 1, then the IP packet transmitted out the Ethernet interface will contain 256 bits (32 bytes) of E1 data and 44 bytes of header information. This is an inefficient use of Ethernet bandwidth. Increasing FPP reduces the effect of this 44 byte overhead.

The encapsulation overhead can be expressed as a ratio of (Data + Overhead)/(Data) and can be used to calculate the Ethernet bandwidth utilization for a given T1/E1 configuration. Example 1 in the QuickStart Chapter noted that 1.906 Mbps of Ethernet bandwidth is required when transporting an encapsulated Full 1.544 Mbps T1 . This is based on an overhead ratio of 1.234. The formula for the overhead ratio:

((((#DSO's * 8) + TubeFraming) * FPP) + 352) / ((#DSO's * 8) * FPP)

- DS0's is the number of 64 Kbps channels configured on T1/E1 interface

- Tube Framing is 0 for Transparent, 1 for T1Framed, 8 for **E1Framed**

- FPP is the configured Frames Per packet

- 352 represents the number of bits in the 44 byte overhead

Table 1 - Overhead Ratio of Ethernet Data to T1/E1 Data due to FPP Setting

Type	#DS0s	Framing	FPP	Overhead Ratio
Full T1	24	1	1	2.839
Full T1	24	1	8	1.234
Full T1	24	0	8	1.229
Full T1	24	1	12	1.158
Frac T1	12	1	1	4.677
Frac T1	12	1	8	1.469
Frac T1	6	1	1	8.354
Frac T1	6	1	8	1.938
Full E1	31	8	1	2.452
Full E1	31	8	12	1.151
Full E1	31	0	12	1.118
Frac E1	4	8	12	2.167
Frac E1	15	8	12	1.311

Table 1 provides the overhead ratio for a number of T1/E1 configuration examples, including both Full and Fractional.

IP • Tube Cabling

The IP•Tube with the exception IP•Tube QT1/QE1 models uses standard 10BaseT Ethernet cabling to connect to an Ethernet switch or hub. The IP•TubeQT1/QE1 uses a standard 100Base T Ethernet cabling to connect to an Ethernet switch or hub.The cabling that is used to connect the IP•Tube T1 Port (T1-1) or E1 Port (E1-1) to the T1/E1 interface to be extended through the Tube depends upon whether it is connecting to equipment or directly to a T1/E1 line. In the case of a connection to the T1/E1 interface of T1/E1 Equipment a T1/E1 cross over cable is required. Refer to the Appendices for the details of the wiring of this cable. Connections to T1 lines is done with a standard T1 cable. An E1 connection utilizes the RJ45 to DB15 male adapter and standard RJ45 cabling with all 8 connections.

IPTubeRS530 requires the use of a DB25 to DB25 male to male with all the connections (A fully wired cable is recommended).

IPTubeV.35 requires the use of a V.35 DB25 to V.35 M-Block adapter.

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.

The IP Tube QT1 supports generation of SNMPv1 Traps. Traps are messages sent from the device's LAN port when specific events occur.

The following traps may be generated:

- coldStart: this trap is generated if the Tube reinitializes itself after a configuration change.

- warmStart: this trap is generated if the Tube reinitializes itself after a reset which does not involve a configuration change.

- linkUp: this trap is generated when a physical interface transitions from being disconnected to connected.

- linkDown: this trap is generated when a physical interface transitions from being connected to disconnected.

- authenticationFailure: this trap is generated when a login to the user interface or an SNMPv1 SetRequest failed because an incorrect password was given.

- enterprisespecific: these are Engage proprietary traps. We define the following subcategories:

- engageTrapRxOverrun: this trap is generated when excessive receiver overruns are happening on an interface.

- engageTrapTxUnderrun: this trap is generated when excessive transmitter underruns are happening on an interface.

- engageTrapBufferExhaustion: this trap is generated when the device runs out of free buffers for packet processing.

- engageTrapDeafness: this trap is generated when an interface on the box has not received packets for a long period of time.

- engageTrapTubeEnetRxAbsent: this trap is generated when an IP-Tube has not been receiving IPTube-encapsulated IP packets on its LAN interface when it expects to be.

For more detail on the industry standard traps, please see http://www.faqs.org/rfc/rfc1157.html.

Chapter 6

IP • Tube RS530 / V35 : Configuration & Operation

This chapter provides operational theory and configuration details specific to the IP•Tube-RS530 and V.35 models. With the synchronous serial interface connecting to an external encryptor, video codec or router, these models have unique requirements regarding timing and data bandwidth.

IP • Tube Installation Steps

The process of installing an IP•Tube-RS530 involves the following steps:

1. Planning for IP•Tube interconnect
2. Installing the IP•Tube hardware
3. Configuring System and Ethernet parameters
4. Configuring the IP•Tube serial interface parameters
5. Making 10BaseT Ethernet and RS-530/V.35 cabling connections
6. Verifying the IP•Tube connection

System and Ethernet Parameters

Initial configuration items include the hostname for the specific IP•Tube, as well as a login password. See Chapter 4: Command Line Interface for specific syntax requirements. Examples:

HOST NAME DALLAS-IP•TUBE

PASSWD <cr>

An IP default router should be configured if the IP•Tube being configured is on a different IP network than the remote IP•Tube. Example:

IP DEFAULT-ROUTER 172.16.1.254

An Ethernet address is configured for the IP•Tube. Example:

INTERFACE E1

IP ADDR 172.16.1.222/24

Serial Interface Parameters

RS-530 or V.35 interface commands are configured by first selecting Serial Interface 1. Example:

INT S1

The IP•Tube RS-530 interface is a data communication equipment (DCE) interface. The DCE supplies both the Transmit Clock (SCT) and Receive Clock SCR) to the connected data terminal equipment (DTE) interface. The IP•Tube RS-530 provides configuration commands to set these two clocks for normal operation or they can be inverted in cases that the DTE to which the IP•Tube connects requires it. Examples showing both states:

SCR INVERTED

SCT NORMAL

NOTE: The IP•Tube RS530/V.35 models monitor the Data Terminal Ready (DTR) signal from the DTE. The IP•Tube will only transmit encapsulated data out the Ethernet interface when DTR is asserted.

IP•Tube destination address is set to the IP address of the receiving IP•Tube. Note Loopback of the RS-530 or V.35 data occurs when the destination address is the same as the IP address of the Ethernet interface of the IP•Tube. Example:

TUBE ADDR 172.16.0.222

IP•Tube DTR-DSR Sensitivity - AVAILABLE ONLY ON REV. LEVEL 20.85.28 MODELS

The SENSEDTRDSR command determines whether the the IP•Tube is sensitive to the DTR signal in the case of IP•Tube DCE or the DSR signal in the case of IP•Tube DTE. When SENSEDTRDSR is ON, the IP•Tube will send IP packets with encapsulated data only when the DTR (IP•Tube DCE) or DSR (IP•Tube DTE) signal is asserted. When SENSEDTR DSR is OFF, the IP•Tube ignores the DTR or DSR signal and sends IP packets with encapsulated data..

SENSEDTRDSR {ON|OFF}

Enable or Disable DTR Sensitivity on a Serial Port for IP•Tube DCE.
Enable or Disable DSR Sensitivity on a Serial Port for IP•Tube DTE.

TOS, QoS and UDP Port Number

The IP•Tube TOS command is used to control the Type of Service Byte in the IP packets containing the encapsulated serial data. The setting of the TOS byte can be used to ensure that the real time data from the IP•Tube is accorded high priority as it traverses the IP network. Support for the TOS byte is required within each router or switch making up the interconnect between the IP•Tubes. A TOS setting of 0x08 maximizes throughput. Note: Tube TOS is displayed in hex. Preceding the entry with 0x results in a direct hexidecimal input. Example:

TUBE TOS 0x08

Additionally, intermediary routers and switches can be configured for Quality of Service (QoS) prioritization to ensure that IP•Tube packets receive highest priority as they are routed through the IP interconnect.

This QoS could be configured based on the IP•Tube Ethernet IP addresses, but a more straightforward method makes use of the unique UDP port number used by the IP•Tube.

TUBE UDPPORT value

TUBE UDPPORT specifies the UDP port source and destination address. The IP•Tube only accepts packets that match its UDP Port configuration.

NOTE: Engage has registered with the IANA UDP port 3175 decimal. This registered port assignment (reference www.iana.org/assignments/port-numbers) allows QoS configuration to prioritize UDP packets destined for port 3175.

This prioritization is essential for voice and other traffic which is sensitive to latency and delay on the LAN/WAN interconnection.

Clocking and Bandwidth

The IP•Tube RS530 and IP•Tube V.35 products are considered Data Communication Equipment - DCEs - and as such they provide the clocking to their attached Data Terminal Equipment - DTEs. SCTCLOCK is used to clock SD data from the DTE into IP packets that are sent to the interface S1's TUBE ADDRESS. SCRCLOCK is used to clock the RD receive Ethernet packet data from the buffer memory into the DTE.

In order to take into account the variety of desired data rates, bandwidth and latency requirements involved in interconnecting DTE across Ethernet/IP networks the IP•TubeRS530 and IP•TubeV35 clocking options are very flexible.

The latest IP•TubeRS530/V35s utilize a Core Clock circuit, which can be configured to a fixed frequency or as an adaptive PLL, to provide the clocking to independently configurable Serial Clock Receive and Serial Clock Transmit base rate clocks. The Core Clock circuit is set for Internal or PLL by the TUBE CLOCK command.

The SCR and SCT base clocks are configured with the TUBE SCxCLOCK MODE command which has modes of NX2K4, NX56K, or NX64K and is multiplied by SCxCLOCK FACTOR to produce the base SCxCLOCK.

NX2K4 - clock rate from 2.4K to 44.8K as multiples of 2.4k.
NX56K - clock rate from 56K to 1792K as multiples of 56k.
NX64K - clock rate from 64K to 2048K as multiples of 64k.

Since the IP•Tubes are used to interconnect DTEs across Ethernet , which does not provide a common clock, an application appropriate method needs to be used to ensure that the clocking of the data out of one DTE and into the other DTE is not overrun or underrun. Additionally latency and overhead for the connection of data networks needs to be taken into account.

The simplest scenario is when the Tube's Interface protocol selection is HDLCoIP, which is used to interconnect data networks, encapsulates the HDLC frames into packets and only requires that the SCTs and SCRs are configured to the desired data rate. The TUBE CLOCK at each end is set to Internal, the TUBE INTERVAL is set to 0, TUBE Percentage is set to 100, TUBE BUFFER is set to 0, and the TUBE FPP is not used.

Note: HDLC, relevant to the IP•Tube, is the Bit stuffing synchronous serial framing proctocol HDLC/SDLC that utilizes the frame delimeter flag 0x7E. HDLC is used to by the Point to Point Protocol, Frame Relay, Cisco's HDLC WAN protocol, and a variety of synchronous serial DTEs.

The interconnect of DTEs that require that every bit is clocked out and in is supported with the Interface S1 Protocol of IP•Tube and CESoIP. There are 2 methods to make sure that the IP•TubeRS530/V35 does not get overrun. Method 1 that eliminates buffering delay is to have the SCRCLOCK set to a slightly higher data rate than the SCTCLOCK. The SCRCLOCK must not exceed the maximum clocking rate of the DTE. A minor amount of SCR clock gapping will occur. For Example have the SCRCLOCK FACTOR one greater than the SCTCLOCK FACTOR. This method also tolerates network congestion.

In general only Video Codecs have an issue with gapping of the clocks. WAN routers and Synchronous Encryptors tolerate gapping of the clocks. Encryptors though are sensitive to long clock gaps when they are using time sensitive Synchronization techniques with each other as the start of a synch pattern is received and is timed out if not completed within a certain amount of time.

In the case where SCTCLOCK and SCRCLOCK must be identical and without gapping just as presented by a T1/E1 DSU/CSU then TUBE BUFFERING must be used along with having one IP•TUBERS530/V35 set to be the clock master TUBE CLOCK INTERNAL and the other's TUBE CLOCK set to PLL. The amount of buffering depends upon the worst case Network congestion related inter packet delay. The buffering of TUBE packets introduces elasticity that is calculated by taking the number of data bits in each buffered packet, TUBE FPP times Bytes Per Frame, times the TUBE BUFFER setting and dividing this by the SCRCLOCK.

Note: the clocking of the data out of the IP•Tube and into the DTE only occurs only when there are bits to be clocked so that an underrun condition is not relevant and clock gapping occurs when there are not any bits in the IP•TUBE Ethernet receive buffer.

IP•Tube Clock

The TUBE CLOCK command is used to set the source of the Serial Clock Receive and Transmit Timing signals. When SCRCLOCK needs to match the SCTCLOCK exactly with a smooth non gapped clock, TUBE INTERVAL = 0, then one of the IP•TUBERS530/V.35s needs to have its TUBE CLOCK to INTERNAL and the other needs to be set to PLL and TUBE BUFFERing needs to be utilized.

IP•Tube Interval

TUBE INTERVAL is used to regulate the IP•TUBE RS530/V.35's packet rate. Regulation of the packet rate provides for a latency minimizing mechanism to control the data rate of the IP•TUBERS530/V.35. The Interval setting can be utilized to clock data out of the DTE into a packet at its maximum clocking rate so as to minimize latency. There are 2 methods of controlling the IP•Tube data rate. One method is to set the SCxCLOCK rates to the data rate required and have the TUBE INTERVAL set to 0. This method can double the delay if in the IP•Tube network connection there is a WAN link. The other method is to set the SCxCLOCK to the DTE's maximum clocking rate and regulating the packet rate with the interval setting.

TUBE INTERVAL should be set to 0 when the IP•TUBE RS530/V35s are interconnected across an Ethernet/IP network that does not have links with data rates that are significantly below the maximum clocking rate of the DTE. For Example a 100BaseT Ethernet interconnect it is recommended that the TUBE INTERVAL be set to 0 and that the TUBE SCxCLOCK MODE and FACTOR are used to control the clocking the DTE directly.

The TUBE INTERVAL command is used to control the gapping of the SCTCLOCK on a packet loading basis. The SCRCLOCK should be set to the maximum clocking rate of the DTE. The purpose of the TUBE INTERVAL setting is to provide for a method to clock data out of a DTE and into a packet at the maximum data rate and then to wait for the interval of time that allows for the slowest WAN router in the packet's route to send the packet out its serial interface before the IP•TUBE sends the next packet. The use of the TUBE INTERVAL setting minimizes latency and is great for connecting DTEs across 64kilobit WAN links such as ISDN.

Note1: The gapping of the clock is not recommended for Video interconnects and can effect the synchronization modes used by Encryptors. The duration of the off clocking interval is detemined by the number of bytes in the packet which is controlled by the Frames Per Packet setting multiplied by the Bytes per frame of 64 times the TUBE INTERVAL setting. Shorter off intervals have an adverse effect on overhead.

Note2: An interval consists of the period defined by the TUBE Frames Per Packet times the Bytes Per Frame times the bits per byte divided by the SCTCLOCK setting. The Bytes Per Frame is set to 64. The TUBE FPP is user configurable and the bits per byte is 8. Permitted values of INTERVAL are 0 to 63. An interval of 0 does not gap the clock.

Formula: SCR rate = (SCRCLOCK MODE * SCRCLOCK FACTOR * (Percentage/100)) / (Interval+1)

The following table is an example of a MODE of NX64K * 24 * Percentage of 100%

Interval	Data Rate(Kbps)
0	1,544
1	772
2	515
3	386
4	309
5	257
6	221
7	193
8	172
9	154
10	140
11	129
12	119
13	110
14	103
15	97
16	91
17	86
18	81
19	77
20	74
21	70
22	67
23	64

Table 1 - Interval vs. Serial Interface Data Rate with SCTCLOCK set to 1.544Mbps

IP•Tube Percentage

The TUBE PERCENTAGE parameter, in conjunction with the SCxCLOCK MODE/FACTOR and TUBE INTERVAL setting, controls the SCTCLOCK clocking on the RS-530/V.35 serial interface. The TUBE PERCENTAGE is used to gate the SCTCLOCK to reduce the number of clock pulses by 87, 75, 50 and 25 percent. For example the 50% setting blocks every other pulse thus reducing the SCT clock. The use of the percentage setting to achieve a specific data rate is minimized with the SCxCLOCK MODE/FACTOR settings that provide for a high resolution base clock frequency configurations.

Interval	Percentage	Tx Rate (Kbps)
0	100	1,544
0	87	1,343
0	75	1,158
0	50	772
0	25	386
1	100	772
1	87	672
1	75	579
1	50	386
1	25	193
2	100	515
2	87	448
2	75	386
2	50	257
2	25	129
3	100	386
3	87	336
3	75	290
3	50	193
3	25	97
4	100	309
4	87	269
4	75	232
4	50	154
4	25	77

Table 2 - Transmit Rate vs. Interval and Percentage.

Overhead

FPP: The Tube Frames-per-Packet (FPP) setting controls the number of data frames received on the RS-530 interface to be encapsulated in a single IP/UDP packet. The IP•Tube segments the data received on the RS-530 interface into 64 byte frames. If FPP is set to 1, then all IP packets transmitted out the Ethernet interface will contain 64 bytes of data - relatively small packets.

The user should consider that encapsulation of RS-530 data into IP packets adds overhead due to the MAC, IP and UDP headers - a total of 44 bytes. This 44 byte overhead should be taken into account when considering Ethernet data rate. The greater the FPP, the less the effect of this overhead.

In many cases it is necessary to limit the rate at which the IP•Tube transmits data on to Ethernet. Table 1 shows the overhead which results from various FPP settings.

Formula: Overhead = ((FPP*64)+44)/(FPP*64)

Use table 3 to calculate the overhead contributed by the encapsulation of data into IP packets. From this the user can determine an appropriate rate at which data should be clocked out of the DTE.

FPP Setting	Serial Data (Bytes)	Ethernet IP Packet Size (Bytes)	Overhead Ratio (Ethernet/Serial)
1	64	108	1.688
2	128	172	1.344
3	192	236	1.229
4	256	300	1.172
5	320	364	1.138
6	384	428	1.115
7	448	492	1.098
8	512	556	1.086
9	576	620	1.076
10	640	684	1.069
12	768	812	1.057
14	896	940	1.049
16	1024	1068	1.043
18	1280	1324	1.038
20	1408	1452	1.034

Table 3 - Overhead resulting from various FPP configurations

Data Rates

Ethernet Data Rate Example

If the desired data rate on the Ethernet LAN is 256 Kbps and the user has configured FPP to 12, then the rate at which serial data should be clocked out of the DTE is 256/(1.057) = 242 Kbps.

RS-530/V.35 Data Rate Example

Alternatively, if the data rate on the serial interface is 256 Kbps and the user has configured FPP at 8, the actual data rate on the ethernet LAN is 256 * 1.086 = 278 Kbps.

Data Rate and Timing Concerns

Gaps: Large packets sizes and large interval settings result in significant gaps between IP/UDP packets as they are received by the IP•Tube. These gaps can result in higher level protocol timeouts.

Bit Stuffing Overhead: If the IP/UDP packet will be traversing a WAN link, the possible effect of bit stuffing in the WAN protocol, such as PPP or Frame Relay, can introduce an additional 10% of overhead.

Consider a 256 Kbps satellite link which carries data via the PPP WAN protocol. User should consider the effect of bit stuffing in the PPP encapsulation and reduce the WAN rate by 10% = 230 Kbps.

Latency: Certain traffic types are particularly sensitive to latency - the rountrip delay of data from end to end. The user should take into account the latency or delay introduced by the LAN/WAN interconnect to determine total delay.

Chapter 7

Troubleshooting

Communication and 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 T1/E1 Equipment and the IP•Tube configuration.

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

Unable to Communicate with the IP•Tube

Installations first require communication with the IP•Tube, usually from the same network as the IP•Tube itself. Proceed through the following symptoms if you are unable to communicate with the local IP•Tube using Telnet, Ping, etc. IP Addressing should be double checked.

Ethernet/General

Cause: Network Cabling is faulty

Solution: Verify cabling is good by swapping IP•Tube cabling with a known good connection. Check the status LEDs on the 10/100BaseT switch to confirm a good connection. If necessary, create a stand-alone LAN with just the workstation and the IP•Tube.

High Ethernet Error Count

Cause: Bad cabling or building wiring

Solution: Check all cabling. Swap to known good port on 10BaseT hub to troubleshoot (testing with large Ping Packets to ascertain quality of Ethernet Connection). To eliminate issues with building wiring connect the IP•Tube with a known good Ethernet cable in the same room as the Ethernet hub.

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 only,** change lan1 interface to match what the hub is configured for.

Can't Communicate/Telnet with IP•Tube - TCP/IP

Cause: IP address is not set properly on the IP•Tube

Solution: The Console Port, which requires an RJ45 to DB9 adapter, provides direct access to the configuration of the IP•Tube. Note: the RJ45 Cable that connects to the Console Port must have 8 connections pinned 1 to 1 (Typical Ethernet cables are only 4 wires). The Console port utilizes the Command Line interface, detailed in Chapter 4: Command Line Interface, and in the Appendices. Interface E1's IP Address must be in the subnet of the computer that is attempting to access it locally.

Cause: Workstation not on the same subnet as the IP•Tube

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

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 IP•Tube - 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 and that the Flow control is set to none.

Cause: Transmit and Receive Data swapped

Solution: The console port RJ45 to DB9 adapter is configured as a DCE (data communication equipment) port. For connection to other DCE, such as a modem, a Null Modem adapter is required. Note: the RJ45 Cable that connects to the Console Port must have 8 connections pinned 1 to 1 (Typical Ethernet cables are only 4 wires).

T1/E1 Circuit Extension to Remote IP•Tube not Functioning

Local IP•Tube Port 1 LED Stays Red

All equipment has been configured and connected, and the T1/E1 equipment has been "turned up", yet the port 1 LED remains Red, rather than turning Green. Green indicates reception of T1/E1 frames, from the T1/E1 Equipment attached to Port 1's T1-1/E1-1 interface, that matches the T1/E1 framing protocol configuration of IP•Tube: T1 - ESF or D4 : E1 - CRC4 or FAS. Port 1 will turn green independent of the configuration of the network parameters and whether the number of DS0s matches. E1 requires that the line coding matches also. E1 HDB3 line coding is recommended.

Proceed through the following steps in sequence:

IP•Tube Cabling
The cabling that is used to connect the IP•Tubes depends upon whether it is connecting to equipment or directly to a T1/E1 line. In the case of a connection to the T1/E interface of T1/E1 Equipment a T1/E1 cross over cable is required. For E1 connections the cross over cable is used between the RJ45 connector on the IPTube and the RJ45 to DB15 Male adapter. Refer to the Appendices for the details of the wiring of this cable. Connections to a T1/E1 line is done with a standard RJ45 cable (8 straight 1 to 1).

Interface S1 Configuration
Interface S1 must have its Type set to T1 or E1, Tube On, Protocol set to IPTube.

IP•Tube T1 Interface Framing
Port 1 Green indicates reception of T1/E1 frames, from the T1/E1 Equipment attached to Port 1's T1/E1 interface, that matches the T1/E1 framing protocol configuration of IP•Tube: T1 - ESF or D4 : E1 - CRC4 or FAS and E1 Coding - HDB3 or AMI. Port 1 will turn green independent of the configuration of the network parameters and whether the number of DS0s matches.

Local IP•Tube Port 1 LED Green But T1/E1 Circuit Extension not working

IP•Tube T1/E1OverIP Interface Loopback
A method to locally loopback the T1/E1OverIP interface back to itself in order to test the configuration of the T1/E1 Equipment and Interface S1 and the cabling (Port 1 Green Indicator does not verify Transmit signal connection from the IP•Tube to the T1/E1 Equipment/Line), is to set the Tube's destination IP Address to be the same as the IP Address of the Ethernet Interface. During this test to insure that interference is not occurring from an IP•Tube that is pointed to the IP•Tube placed in loopback, make sure that all known IP•Tubes that could be streaming T1/E1OverIP packets to it are turned off.

The T1/E1 equipment should then detect that it is receiving what it is sending. A T1/E1 test set could be used to stream a test pattern into Interface S1 for testing. Basic T1/E1 Test sets do not have fractional T1/E1 configuration and the IP•Tube may need to be set to Full T1/E1 on its interface S1 to thoughly test the connection. A typical problem with T1/E1 circuit extension is the misconfiguration of the Fractional T1/E1 DS0s.

If the T1/E1OverIP Interface Local Loopback works marginally (data bit errors are occurring), the T1/E1 clock settings of the T1/E1 Equipment and the IP•Tube's T1/E1 interface must be set up to a master/slave relationship. For example the T1/E1 Equipment should be set to Network Timing and the IP•Tube's T1/E1 clock should be set to Internal timing.

IP•Tube IP Interconnect Verification
The most straight forward way to test the T1/E1 Circuit extention of the IP•Tubes is to have them connected into the same Ethernet Hub with unique IP addressses that are within the same subnet. For Example set

one of the IP•Tubes to 192.168.1.1 and the other to 192.168.1.2. Note: Once an IP•Tube has determined the Mac Ethernet Address of the remote unit, it requires a reset to obtain the Mac Ethernet Address of a substitute unit.

IP•Tube Off Net IP Interconnect Verification

In most applications the IP•Tubes will be located on different IP networks and the interconnection is through a routed connection. At each end of the routed connection the IP•Tube's default router IP address needs to be pointed to the first router in the path to that remote IP subnet. Through a Telnet connection to an IP•Tube it is possible to verify the ability of the IP•Tube to ping its local default router and to ping the remote IP•Tube. Note: the console port does not support the Ping Command as it does not have an IP Address.

Show Statistics

The CLI command SHOW STATISTICS provides a way to check whether the T1OverIP port is receiving T1 frames on its Port interface and transmitting them out its Ethernet interface. Also reception of packets on its Ethernet interface and transmission out is Port 1 interface can be checked. Repeatedly issuing the command SHOW STATISTICS (short hand SH ST) can help determine the source of a problem.

For example, errors with the Ethernet interface reception of packets will slow or stop the Port interface transmission of packets. Errors with Port interface reception of packets will slow or stop the expected rate of the Ethernet interface transmission of packets.

Certain statistics can indicate clocking problems. Port interface Transmit UN (underruns) indicate the interface ran out of packets to transmit. If the Ethernet interface is running without errors, then this might indicate the transmit clock on this tube is running faster than the remote tube is clocking reception of data on its port interface.

Transmit Drain Drops indicates the number of packets dropped by the IP•Tube after Ethernet interface reception because too many buffers are queued on the port interface.

The number of buffers queued are indicated by Transmit Buffer Queue

Depth. If Transmit Buffer Queue Depth is increasing beyond the configured Tube Buffers and Transmit Drain Drops are occuring, then this would indicate the IP•Tube's transmit clock is running slower than remote tube is clocking reception of data on its port interface.

In either case of port interface Transmit UN errors or Transmit Drain Drops, check the clocking configuration on both IP•Tubes. One IP•Tube E1/T1 Clocking should be Internal or Network and the other should be PLL.

Improper configuration of the T1/E1 clocking will result in an overrun or underrun condition which causes T1/E1 periodic frame losses. One of the IP•Tubes must be the master clock source or locked onto a master and the remote end unit uses a Phase Lock Loop circuit to match the master's T1 clock frequency. In the case where an IP•Tube is being connected to a T1 line from the Telephone company, the IP•Tube connected to the Telco T1 line must be set to T1 Clocking Network and the remote unit set to T1 Clocking PLL.

Packets Out Of Sequence indicates an expected packet did not arrive at the Ethernet Interface. Usually this indicates a problem with the Ethernet interface of the local or remote tube, or a problem with the IP network.

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 IP•Tube" section.

Can't IP Ping Remote IP•Tube

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.

Cause: default router on the net, serving as Default Gateway for all net workstations, does not know about the remote IP net where the remote IP•Tube is located.

Appendix

IP•Tube T1/E1/RS530/V.35 Specifications

Ethernet Port

- 10 Base T Full Ethernet

LAN Protocol

- IP, TCP, UDP, ICMP

Tube Protocols

- Engage IP•Tube
- Circuit Extension Over IP
- HDLC Over IP
- SS7 Over IP

Serial Interfaces

- Optional RS-530 DCE/DTE: DB-25 female
- Optional V.35 DCE/DTE: DB-25 female
- Optional T1/fractionalT1 DSU/CSU
- Optional E1/fractionalE1 DSU/CSU

Power Supply

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

Physical

- Standard 19 inch rack mount kit available
- Dimensions: 9.0 x 7.3 x 1.63 inches
- Weight: approximately 2 lbs., excluding external power adapter.

IP • Tube QT1/QE1 Specifications

Ethernet Port

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

LAN Protocol

- IP, TCP, UDP, ICMP

Tube Protocols

- Engage IP•Tube
- Circuit Extension Over IP
- HDLC Over IP
- SS7 Over IP

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
  Not Contiguous Configuration x-y,z Supported

IP•Tube QT1/QE1 con't.

Lossless Data Compression:

- Detects idle and redundant data within each DS0
- Interconnect bandwidth is not consumed by silent or redundant data within the voice circuits.
- Low Latency 16 to 1 Compression
- Maximum Compression setting 56 to 1

Quality of Service Support:

- IP Type of Service (TOS) CLI configurable
- IANA Registered UDP Port 3175

TFTP Online Upgrade Capable (FLASH ROMs)

- IPTube 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

IP • Tube QT1/QE1 con't.

T1 Over IP Protocol:

- TDM Over IP - TDMOIP
- Circuit Extension Services Over IP - CESOIP
- HDLC Over IP - HDLCOIP
- Frames Per Packet Configurable from 8 to 56
  - Low Latency Mode: 1 millisecond - 8 T1 frames
  - Max Payload Mode: 7 millisecond - 56 T1 frames

Regulatory:

- Safety -IEC60950
- EMC - CFR 47 Part 15 Sub Part B:2002
  EN55022:1994+A1&A2
  EN55024, ICES-003 1997
  CISPR 22 Level A
- Telecom - Part68
- CE

Power:

- 12-24 VAC/VDC 1.0A International Adapters Available
- Optional -48V 0.25 Amp
- Hot Standby with 2nd Power Module

Dimensions:

- 14" (L) x 5.5" (W) x 2.50" (H)
- Weight: approximately 3 lbs., excluding external power adapter.

IP • Tube Switch Settings-All Models

IP•Tube systems contain a four position DIP Switch which is accessible by removing the unit rear panel and sliding out the motherboard.

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

Switch 1

Powering cycling the unit with DIP Switch 1 ON forces the IP•Tube to return to factory default settings. Factory settings include operation from Base Flash and deleting any download upgrades. Ensure Switch 1 is returned to the OFF position after clearing an upgrade so future upgrades can be performed successfully.

Switch 2

Applies only to IP•Tube C units - with lossless DS0 compression. Setting to ON will disable the compression. Note: this must be done at each IP•Tube and a RESTART or power cycle issued.

Switch 3

Switch 3 is used during manufacturing to test the Voltage Controlled Crystal Oscillator (VCXO). The switch must be set to OFF for normal operation.

Switch 4

DIP Switch 4 has two functions. When turned ON, it forces the IP•Tube T1/E1/RS530/V.35 interface into a loopback mode. This is useful for troubleshooting the Telco/Serial connection.

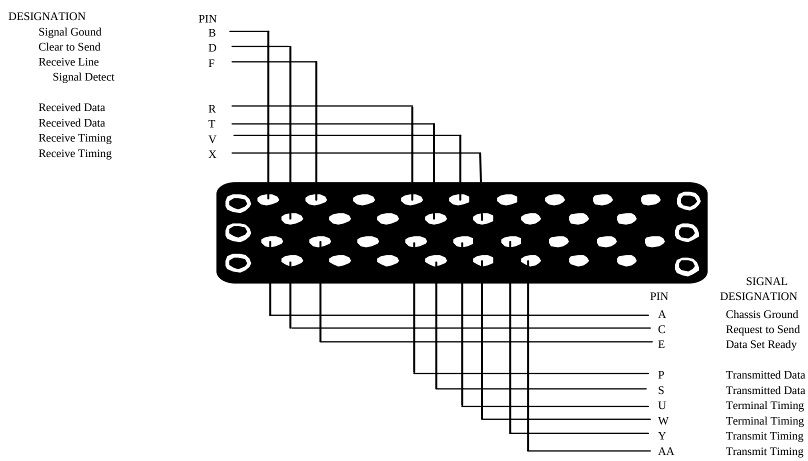
Switch 4 is also used to clear IP filters. When the unit is powered up with DIP Switch 4 set ON, all TCP/IP filters will be deleted. This is a good method for recovering from improperly configured filters.

RS-530 Port Specification

The IP•Tube RS-530 Interface is a Data Communication Equipment (DCE) interface, provided via a db25 female connector

DB25 Pin No.	Signal Name	I/O
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	N/C	
19	RTS-B	I
20	DTR-A	I
21	N/C	
22	DSR-B	O
23	DTR-B	I
24	ETC-A	I
25	N/C	

V.35 Interface Specifications

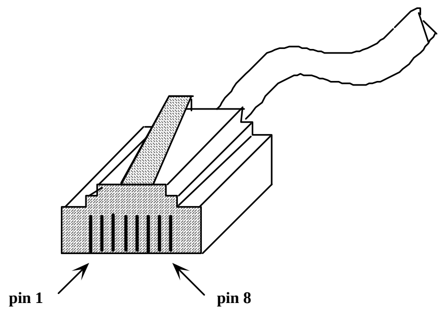


V.35 Interface Specifications (cont'd)

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

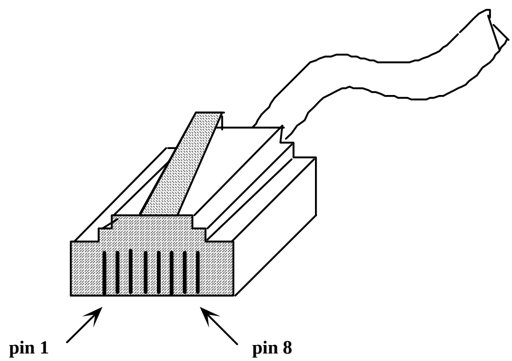
For T1 Crossover (allowing connection directly between two T1/fracT1 DSU/CSU devices) wire:

(TxTip)	Pin 5	to	Pin 2	(RxTip)
(TxRing)	Pin 4	to	Pin 1	(RxRing)
(RxRing)	Pin 1	to	Pin4	(TxRing)
(RxTip)	Pin 2	to	Pin 5	(TxTip)

E1 RJ45 to db15 Cable

Signal	RJ45	db15 Male
TxD Tip	5	1
RxD Tip	2	3
TxD Ring	4	9
RxD Ring	1	11
Frame Ground	7	2

10BaseT Port Specification
(w/ Crossover cable pinout)



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	Pin1	(TD+)
(RD-)	Pin 6	to	Pin 2	(TD-)

Console Port Information

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.

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 vy transport level

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

Communication Link Definitions

Synchronous Serial Interfaces
A serial interface between two devices which provides for bi-directional data transfer as well as clocking. One device, the DCE, provides the transmit and the receive timing to the second device, the DTE.

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.