The ImageStream Linux Router Series

ImageStream Internet Solutions, Inc.
Industrial Series Routers
Router Distribution Version 4.2.3 or later release

Friday, December 10, 2004

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Frequently used chapters are displayed in **BOLD**

General Information

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AUDIENCE

This guide is designed for qualified system administrators and network managers, and for persons with a working knowledge of networking and routing. The examples in this manual assume the use of the Pico text editor. Appendix A, “Networking Concepts,” provides an overview of network address conventions but is intended as a quick refresher and should not be used as a substitute for careful study of these principles. Refer to “Additional References” in this preface for appropriate RFCs and other suggested reading.

ACCURACY

All information in this manual is based on the latest product information available at the time of printing. ImageStream has carefully reviewed the accuracy of this manual, but cannot be held liable for omissions or errors that may appear. ImageStream reserves the right to revise this publication and to make changes in its contents without obligation of notifying any persons of such revision changes.

WARRANTY

ImageStream Internet Solutions, Inc. warrants that at the time of shipment the router product and its installed components shall be free from defect in material and workmanship. ImageStream Internet Solutions, Inc. warrants that the router will meet the product's standard specifications at the time of shipment. This warranty excludes damage resulting from mishandling, tampering, improper installation and misuse by the purchaser.

ImageStream Internet Solutions, Inc. warrants the router for a period of 1 year from the invoice date. For warranty claims, contact your place of purchase, or ImageStream Internet Solutions, Inc. immediately upon the discovery of such defect. If the Router or its installed components are found to be defective, ImageStream Internet Solutions, Inc. will repair or replace the router at ImageStream's option.

In no event shall ImageStream Internet Solutions, Inc., be liable for direct, indirect, incidental or consequential damages in connection with, or arising from, the furnishing, performance, or use of the router. Purchaser may have other rights that vary from state to state.

SALES AND TECHNICAL SUPPORT

ImageStream's on-line resources provide the latest information on software driver upgrades, frequently asked questions and other issues. These services are available 24 hours a day, 7 days a week via the World Wide Web at http://support.imagestream.com/

The ImageStream Support Team is available 24 hours a day, 7 days a week. For phone support please call 574-935-8484. The ImageStream fax number is 574-935-8488. For email support please send mail to support@imagestream.com.

ADDITIONAL REFERENCES

Consult the following Requests for Comments (RFCs) and books for more information about the topics covered in this manual.

RFCs

To find a Request for Comments (RFC) online, visit the website of the Internet Engineering Task Force (IETF) at **http://www.ietf.org/**.

RFC 768, *User Datagram Protocol*
RFC 791, *Internet Protocol*
RFC 792, *Internet Control Message Protocol*
RFC 793, *Transmission Control Protocol*
RFC 854, *Telnet Protocol Specification*
RFC 950, *Internet Standard Subnetting Procedure*
RFC 1058, *Routing Information Protocol*
RFC 1112, *Host Extensions for IP Multicasting*
RFC 1144, *Compressing TCP/IP Headers for Low-Speed Serial Links*
RFC 1157, *A Simple Network Management Protocol (SNMP)*
RFC 1166, *Internet Numbers*
RFC 1212, *Concise MIB Definitions*
RFC 1213, *Management Information Base for Network Management of TCP/IP-based Internets: MIB-II*
RFC 1256, *ICMP Router Discovery Messages*
RFC 1321, *The MD5 Message-Digest Algorithm*
RFC 1331, *The Point-to-Point Protocol (PPP) for the Transmission of Multiprotocol Datagrams over Point-to-Point Links*
RFC 1332, *The PPP Internet Protocol Control Protocol (IPCP)*
RFC 1334, *PPP Authentication Protocols*

RFC 1349, *Type of Service in the Internet Protocol Suite*
RFC 1413, *Identification Protocol*
RFC 1483, *Multiprotocol Encapsulation over ATM Adaption Layer 5*
RFC 1490, *Multiprotocol Interconnect Over Frame Relay*
RFC 1542, *Clarifications and Extensions for the Bootstrap Protocol*
RFC 1552*, The PPP Internet Packet Exchange Control Protocol (IPXCP)*
RFC 1587, *The OSPF NSSA Option*
RFC 1597, *Address Allocations for Private Internets*
RFC 1627, *Network 10 Considered Harmful (Some Practices Shouldn't be Codified)*
RFC 1634, *Novell IPX Over Various WAN Media (IPXWAN)*
RFC 1661, *The Point-to-Point Protocol (PPP)*
RFC 1700, *Assigned Numbers*
RFC 1723, *RIP Version 2*
RFC 1771, *A Border Gateway Protocol 4 (BGP-4)*
RFC 1812, *Requirements for IP Version 4 Routers*
RFC 1814, *Unique Addresses are Good*
RFC 1818, *Best Current Practices*
RFC 1824, *Requirements for IP Version 4 Routers*
RFC 1825, *Security Architecture for the Internet Protocol*
RFC 1826, *IP Authentication Header*
RFC 1827, *IP Encapsulating Payload*
RFC 1828, *IP Authentication Using Keyed MD5*
RFC 1829, *The ESP DES-CBC Transform*
RFC 1851, *The ESP Triple DES Transform*
RFC 1877, *PPP IPCP Extensions for Name Server Addresses*
RFC 1878, *Variable Length Subnet Table for IPv4*
RFC 1918, *Address Allocation for Private Internets*
RFC 1962, *The PPP Compression Control Protocol (CCP)*
RFC 1965, *Autonomous System Confederations for BGP*
RFC 1966, *BGP Route Reflection, An Alternative to Full Mesh IBGP*
RFC 1974*, PPP Stac LZS Compression Protocol*
RFC 1990*, The PPP Multilink Protocol (MP)*
RFC 1994, *PPP Challenge Handshake Authentication Protocol (CHAP)*
RFC 1997, *BGP Communities Attribute*
RFC 2003, *IP Encapsulation within IP*
RFC 2104, *HMAC: Keyed-Hashing for Message Authentication*
RFC 2125, *The PPP Bandwidth Allocation Protocol (BAP), The PPP Bandwidth Allocation Control Protocol (BACP)*
RFC 2131, *Dynamic Host Configuration Protocol*
RFC 2132, *DHCP Options and BOOTP Vendor Extensions*
RFC 2138, *Remote Authentication Dial In User Service (RADIUS)*
RFC 2139, *RADIUS Accounting*
RFC 2153, *PPP Vendor Extensions*
RFC 2328, *OSPF Version 2*
RFC 2364, *PPP over AAL5*
RFC 2400, *Internet Official Protocol Standards*

RFC 2403, *The Use of HMAC-MD5-96 within ESP and AH*
RFC 2404, *The Use of HMAC-SHA-1-96 within ESP and AH*
RFC 2405, *The ESP DES-CBC Cipher Algorithm with Explicit IV*
RFC 2451, *The ESP CBC-Mode Cipher Algorithm*
RFC 2453, *RIP Version 2*
RFC 2663, *IP Network Address Translator (NAT) Terminology and Considerations*

DOCUMENT CONVENTIONS

The following conventions are used in this guide:

Convention	Use	Examples
Bold font	Indicates a user entry—a command, menu option, button, or key—or the name of a file, directory, or utility, except in code samples.	• Enter **description** to set the interface description. • Press **Enter**. • Open the **wan.conf** file.
Italic font	Identifies a command line placeholder. Replace with a real name or value.	**ip address** *address* **vrrp** *vrid address*
`Courier font`	Identifies display output from the router	`Re-enter new password:`
Square brackets [ ]	Enclose optional keywords and values in command syntax.	**rate-limit** *bits per second* **[input|output]**
Curly braces { }	Enclose a required choice between keywords and/or values in command syntax.	**service-module t1 framing** *{ esf | sf }*
Vertical bar |	Separates two or more possible options in command syntax.	**service-module e1 framing** *{ ccs | cas }*

TRADEMARKS

UNIX is a registered trademark of AT&T Bell Labs.
Linux is a registered trademark of Linus Torvalds.
Cisco is a registered trademark of Cisco Systems.

FCC CLASS A LIMITS

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

Note: This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial 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 the 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.

Shielded cables must be used with this unit to ensure compliance with FCC Class A limits.

CANADIAN DEPARTMENT OF COMMUNICATIONS CLASS A LIMITS

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriqqes de la class A prescrites dans le Reglement sur le brouillage radioelectrique edicte par le ministere des Communications du Canada.

FCC PART 68 RULE DISCLOSURE

The following information is required by FCC Part 68 Rules which informs the user of his rights and obligations in connecting this equipment to the network and in ordering service.

This equipment complies with Part 68 of FCC Rules. Please note the following:

1. When you order service, the telephone company needs to know:

    a. The Facility Interface Code:
       04DU-B (1.544 MB D4 framing format)
       04DU9-C (1.544 MB ESF framing format)
    b. The Service Order Code: 6.0F

A signal power affidavit may be required to guarantee encoded analog content and billing protection unless this unit is used in combination with and XD type device or no encoded analog signals and billing information are transmitted.

c. The USOC Jack Required: RJ48C

In addition, if requested, please inform the telephone company of the make, model and FCC Registration Number, which are on the label.

2. Your telephone company may make changes in its facilities, equipment, operations or procedures that could affect the proper functioning of your equipment. If they do, you will be notified in advance to give you and opportunity to maintain uninterrupted telephone service.

3. If your telephone equipment causes harm to the telephone network, the telephone company may discontinue your service temporarily. If possible, they will notify you in advance, but if advance notice is not practical, you will be notified as soon as possible. You will be informed of your right to file a complaint with the FCC.

4. If you experience trouble with the telephone equipment, please contact us for information on obtaining service or repairs. Only ImageStream or our authorized agents should perform repairs.

5. You are required to notify the telephone company when this unit is disconnected from the network.

TRAINING COURSES

ImageStream offers hands-on, technical training courses on ImageStream products and their applications. For more information, visit the ImageStream Web site at **http://www.imagestream.com/Training.html**.

MAILING LISTS

ImageStream maintains the following Internet mailing lists for ImageStream router users:

• **isis-announce** — a general announcements list that carries announcements from ImageStream regarding product releases, news releases and general company information. To subscribe, send email to **majordomo@imagestream.com** with **subscribe isis-announce** in the body of the message.

• **isis-support** — a general discussion list that carries announcements from the isis-announce list, as well as software version release announcements and product releases. To subscribe, send email to **majordomo@imagestream.com** with **subscribe isis-support** in the body of the message.

Please read this entire manual before contacting ImageStream for technical assistance. Please report any errata or change recommendations to support@imagestream.com.

I. Introduction And Preparing For Installation

Introduction

This chapter discusses the following topics:

- “Unpacking The Router”
- “Router Software”
- “Pre-configuration Planning”
- “Configuration Tips”
- “Basic Configuration Steps”

Unpacking The Router

This section outlines the procedure for unpacking, configuring, installing and testing your ImageStream router. It is assumed that the installer is familiar with the basic layout and operation of electronic equipment, routers, and cables.

Though an ImageStream router is shipped in a sturdy cardboard box with foam padding, it maybe damaged in shipping. We suggest that each box and its contents be examined for visual damage. If your shipment arrives damaged, incomplete, or incorrect, contact ImageStream Internet Solutions immediately.

The following items are typically shipped in a router box. However, the packing list should be reviewed to verify the completeness of the shipment:

Base router chassis

a. Router chassis
b. Power cable(s)
c. Quick start guide
d. Terms and Conditions of Sale and Warranty Notice

Cards without integrated CSU/DSUs

a. WAN card with RS232, EIA-530 or V.35 interface options
b. RS232, RS449, EIA530 or V.35 Adapter Cable (if ordered)

Cards with integrated CSU/DSUs

a. WAN card with CSU and RS232, EIA-530 or V.35 interface options (if any)
b. RS232, RS449, EIA530 or V.35 Adapter Cable (if ordered)
c. RJ48 Loop Back Plug (if ordered)

The Ethernet (100BaseTX/10BaseT), Token Ring, serial and console ports contain safety extra-low voltage (SELV) circuits. T1, 56 Kbps (DDS), BRI and PRI circuits are telephone-network voltage (TNV) circuits. Avoid connecting SELV circuits to TNV circuit equipment, such as WAN cards with integrated CSU/DSUs, as this can cause damage to the equipment.

Router Software

All ImageStream products are shipped with ImageStream's Enterprise Linux software. For more information about Enterprise Linux, visit the ImageStream Web site at: **http://www.imagestream.com/EnterpriseLinux.html**. Enterprise Linux contains the following standard embedded packages:

Base-binaries – Includes all basic Linux binary utilities and devices. This package includes command line utilities such as **vi**, **pico** and **rm** as well as the tty login devices and process ID storage directories.
Base-libraries – Includes all shared libraries required by Enterprise Linux. This package includes curses libraries, terminal information and basic cryptography libraries.
Base-networking – Includes all basic Linux networking utilities and libraries. This package includes command line utilities such as **iptables**, **telnet**, and **ping** and their associated libraries.
Failsafe-Configuration – This package and associated directory contains basic information required to boot the router. Basic entries in the /etc configuration directory and startup scripts are included in the package. Coupled with the Failsafe directory stored in the router's nonvolatile (Flash) RAM, this package can be used to boot the router with a simple default configuration in the event of problems with the main configuration or if the router password is lost.
OpenSSH – This package contains the command line utilities and libraries for the open source secure shell (SSH) program. This package is used to support secure connections to the router over a network connection.
OpenSSL – This package contains the libraries for the open source secure socket layer (SSL) libraries. This package is used to support SSH, SNMP, SSL (OpenVPN) VPNs and other secure connections to the router over a network connection.
Pluggable-Auth-Module – This package contains the libraries for open source PAM software. This package supports login authentication over various methods, including TACACS+, RADIUS, and UNIX password files through a single authentication mechanism.
QOS-routing – This package contains the command line utilities for quality of service and bandwidth shaping management. Additionally, the default QoS and bandwidth shaping configuration files are stored in this package.
VRRP – This package contains VRRPd, ImageStream's open source implementation of the Virtual Router Redundancy Protocol as specified in rfc2338. VRRPd is interoperable with other RFC-based VRRP implementations, including Cisco and Juniper, and is included as a standard feature on ImageStream routers.

adsl – This package contains software to support ImageStream's ADSL, ADSL2, and ADSL2+ interfaces used in conjunction with ImageStream routers.
bridge – This package enables Enterprise Linux's bridging support for WAN, LAN, Tunnel and other standard devices.
crond – This package contains the cron scheduler daemon. cron enables users to schedule events on the router, and supports the router's network time protocol (NTP) synchronization.
dialout-ppp – This package contains support for ImageStream's analog modems used for outbound connectivity.
ebtables – This package contains the command line utilities and libraries that support the Linux ebtables software for filtering and access control on bridged (layer 2) network devices.
gated – This package contains ImageStream's version of NextHop Technologies' GateD. This program is used to support dynamic routing protocols such as BGP, OSPF, ISIS and RIP.
IPSec-OpenSWan – This package contains the open source IPSec cryptography and encryption service, OpenSWan. This set of utilities and libraries support IPSec VPN's with high encryption.
iptables – This package contains the command line utilities and libraries that support the Linux iptables software for filtering and access control on routed (layer 3) network devices.
isdn – This package contains support for ImageStream's ISDN terminal adapters used for outbound connectivity.
kernel-modules – This package contains Linux kernel modules for the Enterprise Linux kernel used with the distribution version on the router. Special IP routing and policy routing modules, as well as Ethernet chipset and hardware health monitoring modules are included in this package.
Net-SNMP – This package contains the SNMP management package for the router. All command line utilities and supported MIBs are contained in this package.
nprobe – This package contains the command line utilities, libraries and scripts required to support the embedded NetFlow probe included with ImageStream routers.
pppd – This package contains the command line utilities, libraries and scripts required to support PPP authentication and encapsulation over Ethernet, ATM and other devices commonly used with broadband aggregation.
router-utils – This package contains Enterprise Linux's menuing system and other router-specific utilities. All of the utilities required to start and stop various router services are included in this package.
SAND – This package contains ImageStream's Standard Architecture for Network Drivers package for ImageStream routers. SAND provides the framework and support for all WAN cards used in conjunction with ImageStream routers.
sconsole – This package contains the programs and libraries required to provide a serial console connection to the router. This package provides support for both modem and dumb terminal/direct serial cable connections to the router.

sensors – This package contains the utilities and libraries for hardware health monitoring. The sensors package supports monitoring of CPU temperatures, CPU fans and speeds, chassis fans and speeds and other hardware monitors supported by ImageStream router hardware.
cipe – This package contains the software that supports the Crypto IP Encapsulation (CIPE) VPN protocol available on ImageStream routers and standard Linux systems.
OpenVPN – This package contains the software that supports the SSL VPN protocol available on ImageStream routers and supported by most common operating systems.
Quagga – This package contains the open source Quagga routing daemons. These programs are used to support dynamic routing protocols such as BGP, OSPF and RIP. This unsupported package is provided for administrators familiar with Quagga, Zebra or Cisco-like command line interfaces.
udhcpd – This package contains the embedded DHCP client, DHCP server and DHCP relay client included with Enterprise Linux.

Pre-Configuration Planning

Before the ImageStream router can be used to connect wide area networks (WANs), you must install the hardware using the instructions in the installation guide for your system. This configuration guide is designed to introduce the most common configuration options available for ImageStream products. Review this material before you configure your router and, if possible, answer the following questions:

- What general configuration do you want to implement?
- Will you be using internal or external CSU/DSUs with your high-speed lines?
- Will your high-speed lines use ATM, Frame Relay, HDLC, PPP or ISDN encapsulation?
- Do you need dial-on-demand for ISDN backup connections?
- Do you need to bond multiple circuits or virtual circuits together?
- Do you want packet filtering or firewalling for Internet or other connections?
- Have you obtained a sufficient number of network addresses, or do you want to use the network address translation (NAT) software?
- Do you need to bridge multiple segments together?
- Do you want to enable Simple Network Management Protocol (SNMP) for network monitoring?

Many other decisions must be made during the configuration process. This guide discusses the various configuration options and their implications.

Pre-Installation Information

Have the following information ready before you start

Parameter	Where to find it	Description
Local IP address	Line Provider	The local IP address will be the address for the specific link/port (“numbered link”) or primary Ethernet address (“unnumbered link”) of your router.
Remote IP address	Line Provider	The remote IP address will be the address for the specific link/port (“numbered link”) or primary Ethernet address (“unnumbered link”) of the router on the other end of the link.
Clock Source	Line Provider	The clock source will either be internal (provided by the WAN card or integrated CSU) or external (provided by a CSU/DSU or by the line provider).
Line Encoding/Framing	Line Provider	If you have a card with an integrated CSU/DSU, you will need to know these values. The normal encoding values for will be B8ZS or AMI and normal framing values are Extended Super Frame (“ESF”) or Super Frame (“SF” or “D4”).
DLCI Number (Frame Relay Only)	Line Provider	Used to establish virtual circuit across frame relay network to remote router.

Basic Configuration Tips

The exact configuration steps you follow depend upon the hardware you are installing and your network configuration. However, the following general configuration steps are the same for all ImageStream products:

1. Install the ImageStream hardware as described in the quick start guide shipped with your router.
Additional information on configuring the router password, IP address and other basic information is below.

2. Boot the system and log in with the administrative password.
You can configure the ImageStream router from a keyboard and monitor (on supported systems), a terminal attached to the console port, by an administrative telnet session, or by a network connection.

3. Configure the global settings.
Global settings are described in Chapter 3, “Configuring Global Settings: Global Configuration Menu.”

4. Configure the Ethernet or Token Ring settings.
Ethernet and Token Ring settings are described in Chapter 4, “Configuring a LAN Interface.”

5. Configure the synchronous serial WAN port(s), if available.
Synchronous serial WAN interface settings are described in Chapter 6, “Configuring a Synchronous WAN Interface.”

6. Configure the integrated CSU/DSU connection(s), if available.
OC-48, OC-12, OC-3, ATM DS3, ATM E3, T1, and E1 connection configuration is described in Chapter 7, “Configuring an Integrated CSU/DSU WAN Interface.” ISDN BRI connection configuration is covered in Chapter 10, “Configuring an ISDN BRI Interface.”

7. Configure the ATM connection(s), if available.
ATM OC-12, OC-3, DS3, E3, T1, and E1 connection configuration is described in Chapter 8, “Configuring an ATM Interface.”

8. Configure the Frame Relay connection(s), if available.
Frame Relay DS3, E3, T1, and E1 connection configuration is described in Chapter 9, “Configuring a Frame Relay Interface.”

9. Configure ISDN BRI connection(s), if available.
Basic Rate ISDN connection configuration is described in Chapter 10, “Configuring an ISDN BRI Interface.”

10. **Configure iptables, if you are using it.**
iptables is Linux's open source traffic filtering and firewalling mechanism for networks. Iptables configuration is described in Chapter 16, "Configuring Services: Firewall Menu."

11. **Configure Differentiated Services/Quality of Service, if you are using it.**
ImageStream uses the IETF-standard DiffServ implementation for bandwidth/rate limiting and quality of service for networks. Configuration of these tools is described in Chapter 11, "Configuring Bonder For Load Balancing And Aggregation," Chapter 12, "Configuring Rate Limiting Within SAND" and in Chapter 13, "Configuring Services: Quality of Service Menu."

12. **Configure RIP, if you are using this protocol.**
RIP is described in the *GateD Configuration Manual*.

13. **Configure OSPF, if you are using this protocol.**
OSPF is described in the *GateD Configuration Manual.*

14. **Configure ISIS, if you are using this protocol.**
ISIS is described in the *GateD Configuration Manual.*

15. **Configure BGP, if you are using this protocol.**
BGP is described in the *GateD Configuration Manual.*

16. **Configure other router services, if necessary.**
Additional router services such as SNMP, SSH, serial console.

17. **Troubleshoot your configuration, if necessary, and back it up.**
See the chapter "Troubleshooting" for instructions. Once you have correctly configured all the settings necessary for your circumstances, your ImageStream router is ready to provide communication service and routing for your network.

II. How The ImageStream Router Works

This chapter summarizes ImageStream router operation and capabilities so you can choose how to configure your system. Consult the glossary or *Command Reference* for definitions of unfamiliar terms.

This chapter discusses the following topics:

- “Booting the ImageStream Router”
- “ImageStream Router Initialization”
- “Router Security and User Management”
- “LAN/WAN Port Status”

See the *Command Reference* for more detailed command descriptions and instructions.

Booting the ImageStream Router

When you start up the ImageStream router, it carries out the following functions during the booting process:

1. Self-diagnostics are performed. The results are displayed to the integrated video or the console port, depending on the product you are installing.
2. A selection dialog is displayed allowing the router to be booted into its normal operating configuration, a failsafe configuration or to boot and run a special memory test.
3. Assuming normal operation, or if no selection is made from the dialog, Enterprise Linux is loaded.
4. The user configuration is loaded from nonvolatile RAM.

ImageStream Router Initialization

Once the ImageStream router has successfully booted, it does the following:

1. Ethernet chipset support is loaded.
2. The **syslog** utility starts.
3. The **klog** utility starts.
4. Services enabled on boot are started.
5. Ethernet interfaces are started.
6. SAND-enabled ports are started.
7. **iptables** commands are executed, if enabled.
8. QoS commands are executed, if enabled
9. User-defined commands in rc.local are executed.
10. Continuous dial-out connections are started.

11. Broadcasting and listening for routing packets are initiated on routed interfaces. The router listens for TCP connections on any ports configured as network devices.
12. The router listens for activity on TCP and UDP ports, such as for administrative
13. telnet sessions on TCP port 23, ssh sessions on TCP port 22, and SNMP requests on UDP port 161.
14. The ImageStream router is now ready to begin providing service.

Router Security and User Management

The ImageStream provides security through a shadowed password file. When an administrative user attempts to authenticate at the login prompt, or via telnet, the router refers to the entry in the shadowed password file that corresponds to the user. If the password entered by the user does not match, the router denies access with an “Invalid Login” message. If an administrative user attempts to authenticate via secure shell (ssh), the router performs the authentication procedure under a special secure user process and refers to the entry in the shadowed password file that corresponds to the user. If the password entered by the user does not match, the router denies access with an “Invalid Login” message.

Access is denied with the “Unable to connect to remote host: Connection refused” if the host is down or otherwise not responding to the login request. If an access filter is configured on the port and the login host for the user is not permitted by the filter, the router refuses service with an “Unable to connect to remote host: Connection refused” message.

Logging In For The First Time

The first step in the installation is to log in to the router on console using a keyboard and monitor, a direct serial connection, or by connecting over your network using telnet or ssh. The router is shipped with a factory default IP address of 10.10.199.199 with a netmask of 255.0.0.0.

ImageStream routers are configured using a standard menu-based interface. The first time you log in to your router, you may want to browse the various menus to familiarize yourself with the menu navigation. The factory default login is “root” with no password. Type **root** at the **Login:** prompt and press **Enter**. Press **Enter** at the **Password:** prompt when accessing the router for the first time.

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
```

```
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Your first steps should be to configure the global configuration settings on the router, described in the next chapter.

WHENEVER YOU MAKE CHANGES TO THE CONFIGURATION ON YOUR ROUTER, REMEMBER TO SAVE THE CHANGES USING THE "Save configuration to flash" MENU OPTION OR THE "backup flash" COMMAND FROM THE BASH SHELL.

FAILURE TO SAVE ANY CONFIGURATION CHANGES YOU MAKE TO THE ROUTER WILL RESULT IN THE LOSS OF ANY CHANGES IF THE ROUTER IS REBOOTED OR LOSES POWER FOR ANY REASON.

LAN/WAN Port Status

From the main menu of the router displayed after login, choose option **2**, "Interface statistics" and press **Enter** to display ImageStream's real-time "stats" utility. This utility is used to display the current status, active configuration, and default configuration of each port. See the chapter "Understanding The Interface Statistics (stats) Program" for more information about this utility.

III. Configuring Global Settings: The AAA and Global Configuration Menus

This chapter describes how to configure settings that the ImageStream router uses across all of its ports and interfaces.

This chapter discusses the following topics:

“Setting the Administrative Password”
“Configuring the Router for TACACS+ Server Authentication”
“Setting the Hostname”
“Configuring Name Resolution”
“Configuring Local Event Logging”
“Configuring Remote Event Logging”
“Configuring Advanced Event Logging"
“Configuring the User-Configurable Startup Script”
“Configuring the Default Terminal Type”
“Configuring the Default Text Editor”
“Setting the System Time”

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Your first steps should be to configure the global configuration settings on the router. Select the “Configuration menu” by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the “AAA (password) configuration” menu by pressing **1** on the keyboard and press **Enter** to configure the router’s login and password settings (again, your menu may look slightly different):

```
AAA (Password) Configuration
------------------------------------------------------------
1. Change local root password
2. TACACS+ authentication (disabled)
3. Disable all remote AAA
0. Configuration menu
```

Setting the Administrative Password

ImageStream routers are shipped without a password. Press **Enter** at the **Password:** prompt when accessing the router for the first time. The password is an ASCII-printable string of up to 127 characters used to access the router’s administration features. Only the administrator can change the password.

To set the password, Press **1** (“Change password”) and press **Enter**:

```
Changing password for root
Enter the new password (minimum of 5, maximum of 127 characters)
Please use a combination of upper and lower case letters and
numbers.

New password:
```

Enter your new password and press **Enter**. Your password will not be displayed on the screen for security purposes. Pressing **Enter** without entering a password resets the password to the default value, which is no password.

The router will then display the prompt:

```
Re-enter new password:
```

Re-enter your new password *exactly* as before and press **Enter**. Your password will not be displayed on the screen. If your passwords do not match, the router will respond with:

```
They don't match; try again.
```

You will then be prompted for your new password again. If you use a dictionary word, a short password or no password, the router will respond with:

```
Bad password: too short.
Warning: weak password (enter it again to use it anyway).
```

and prompt you for the new password again for confirmation. You will then have to re-enter the password as described above. Once you have successfully entered the password, the router will respond with:

```
Password changed.
```

and return you to the menu system. Remember that this password change is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the password change to become permanent.

Configuring the Router for TACACS+ Server Authentication

ImageStream routers support centralized user authentication and login shell selection using a Terminal Access Controller Access Control System (TACACS+) server/database. When enabled, the router will contact the TACACS+ server to authenticate users that attempt to log in to the router. If the TACACS+ server does not have an entry for the user ID, or if the router cannot contact the TACACS+ server, then the router will check the local password file. Although the local password file contains only the root administrative user, it is possible to create multiple levels of access to the router when using a TACACS+ server for authentication.

You should only configure TACACS+ authentication if you have a valid TACACS+ server available on your network. If you are unsure, do not configure this option.

Select the "TACACS+ authentication" menu by pressing **2** on the keyboard and press **Enter** to configure the router's TACACS+ authentication settings. The router will display:

```
Remember that you must configure your TACACS+ server.
The router will use the local password as a fallback.

Enter the hostname or IP address of the primary TACACS+ server
or leave blank to disable TACACS+ for AAA:
```

Enter the IP address or the fully qualified domain name (FQDN) for your primary TACACS+ server and press **Enter**. For example, if your TACACS+ server is located at **tacacs.imagestream.com**, you would enter **tacacs.imagestream.com** at the prompt. If you are attempting to clear a previous TACACS+ server configuration, then press **Enter** at the prompt without entering any information.

After entering the primary server, the router will display:

```
You may configure up to 3 additional TACACS+ servers.
```

```
Do you have additional TACACS+ servers to configure (y/N)?:
```

If you have backup TACACS+ servers, follow the on-screen prompts to fill in the IP address or FQDN of the backup server(s). After you have entered your TACACS+ servers, the router will display:

```
Enter the encryption secret (all servers must use a common
secret) or leave blank to disable encryption:
```

If your TACACS+ server uses an encryption key, enter it here. *The key must be the same for all servers. The router will not prompt you for alternate keys*. If your TACACS+ server does not use encryption, then leave the entry blank and press **Enter** at the prompt. You will be prompted to confirm that encryption should be disabled.

When you have entered the encryption secret information, the router will display:

```
Now rebuilding AAA configurations (/etc/pam.conf)...done.
```

and return you to the menu system. Remember that this remote AAA change is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the hostname change to become permanent.

Disabling Remote AAA Configurations

To disable any remote AAA configurations, select the "Disable all remote AAA" option by pressing **3** on the keyboard and press **Enter** to reset the router to its default AAA configuration (local password file only).

Global Configurations

Select the "Global configuration" menu by pressing **1** on the keyboard and press **Enter** to configure the router's global settings (again, your menu may look slightly different):

```
Global configuration
------------------------------------------------------------
1. Change hostname
2. Change DNS server
3. Configure Event Logging
4. Configure rc.local (user configurable startup script)
5. Select terminal type (linux)
6. Select default editor (pico)
7. Set the time
0. Configuration menu
```

Setting the Hostname

The hostname, or system name, is the name that identifies the router for Domain Name Service (DNS) queries, SNMP queries, IPSec and SSH authentication. Enter a name that is valid for your network. The system name can have up to 16 characters, and appears in the command line prompt.

To set the hostname, Press **2** ("Change hostname") and press **Enter**. The router will display:

```
Enter the domain for this machine:
```

Enter the domain name for your router and press **Enter**. For example, if your router is named **router.imagestream.com**, you would enter **imagestream.com** at the prompt. Do not enter the hostname (**router** in our example); you will be prompted for this information next.

After entering the domain name, the router will display:

```
Enter the hostname for this machine:
```

Enter the hostname for your router and press **Enter**. For example, if your router is named **router.imagestream.com**, you would enter **router** at the prompt. Do not enter the domain name (**imagestream.com** in our example) here.

The router will then prompt you to confirm the fully qualified domain name (FQDN) of your router, for example:

```
Your FQDN (Fully Qualified Domain Name) is
router.imagestream.com, is this correct (Y/n) :
```

Press **Y** or **y** if the entry displayed is correct. Press **N** or **n** if the entry displayed is incorrect. Pressing **N** or **n** will erase your entries and the router will prompt you again for the domain name and hostname. If you press **Y** or **y**, the router will display the hostname you have entered, for example:

```
Hostname changed to router.imagestream.com.
```

and return you to the menu system. Remember that this hostname change is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the hostname change to become permanent.

Configuring Name Resolution

The ImageStream router can work with a Domain Name Server (DNS). Appendix A, "Networking Concepts," describes this name service. *If you do not set a valid domain name resolution server, you will not be able to use the automatic software update feature on your router*.

To set the DNS server, Press **3** ("Change DNS server") and press **Enter**. The router will display:

```
Enter the domain for this machine:
```

Enter the domain name for your router and press **Enter**. For example, if your router is named **router.imagestream.com**, you would enter **imagestream.com** at the prompt. Do not enter the hostname (**router** in our example). This domain name does not necessarily have to be the same domain as the router's domain name. This value will be the first domain searched to resolve names. For example, if you enter the command **telnet router** from the command line, the DNS resolver on the router will search **imagestream.com** if that value is entered in response to the question above.

Once you have entered the domain name, you will be prompted for the IP address of the domain name server for your network:

```
Enter the nameserver IP address for this router:
```

Enter the IP address of the nameserver for your router and press **Enter**. For example, if your nameserver is located at the IP address **192.168.100.1**, you would enter **192.168.100.1** at the prompt. The router will display:

```
Now writing the /etc/resolv.conf file...done.
```

and return you to the menu system. If you need to add additional search domains or name servers, you can do this from the command line. Enter the command **/etc/editor /etc/resolv.conf**. This will open the standard Linux resolv.conf file in your default text editor. This is an advanced option, and you should only edit this file if you are familiar with the resolv.conf file under Linux. Remember that any changes to the DNS server are not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the changes to become permanent.

Configuring Local Event Logging

The ImageStream router can log messages to a local file, to the console or to remote devices or logging servers via the standard syslog facility. By default, system messages are logged only to a local file on the router.

Select the “Configure Event Logging” menu by pressing **3** on the keyboard and press **Enter** to configure the router’s global settings (again, your menu may look slightly different):

```
Configure Event Logging
-----------------------------------------------------------
1. Configure remote event logging
2. Enable local event logging
3. Configure advanced event logging
0. Global configuration
```

To configure the router’s local event logging settings, Press **2** (“Enable local event logging”) and press **Enter**. The router will display:

```
Enabling local logging will create an automatically rotated
system logfile accessible from the router's Advanced menu or in
the file '/var/log/syslog'.

Would you like to enable local system logging?  Press 'Y' or 'y'
to enable system logging or press Enter/Return to disable system
logging and remove old logs (y/N) :
```

Follow the on-screen prompts to enable or disable local system logging. The logfile created by the router will not fill the router’s virtual filesystem. By default, the system will log to /var/log/syslog, with 1 backup file. Files will rotate every 24 hours or after 250KB of log information, whichever comes first.. For debugging purposes, ImageStream recommends that you leave local system logging enabled by pressing **Y** at the prompt.

The router will then display:

```
Enabling console logging will send all messages to both remote
and console root logins.

Would you like to enable console logging?  Press 'Y' or 'y' to
enable console logging or press Enter/Return to disable console
logging (y/N) :
```

Enabling console logging will print all system messages on your screen when you are logged in as the root user. For some users, the number of messages generated may make it difficult to use the router, so this option is disabled by default. If the appearance of messages on your console does not affect your use of the router, ImageStream recommends enabling this option. Follow the on-screen prompts to enable or disable console logging. The router will then display:

```
Now writing the /etc/syslog.conf file...done.
```

and return you to the menu system. Remember that this change is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the change to become permanent.

Configuring Remote Event Logging

The ImageStream router can log messages to a local file, to the console or to remote devices or logging servers via the standard syslog facility. By default, system messages are logged only to a local file on the router.

Select the "Configure Event Logging" menu by pressing **3** on the keyboard and press **Enter** to configure the router's global settings (again, your menu may look slightly different):

```
Configure Event Logging
------------------------------------------------------------
1. Configure remote event logging
2. Enable local event logging
3. Configure advanced event logging
0. Global configuration
```

To set a remote logging server, Press **1** ("Configure remote event logging") and press **Enter**. The router will display:

```
Remember that you must configure your remote syslog server to
accept syslog data from remote systems.  Most syslog
implementations use '-r' to enable this function.  Consult your
server documentation or man pages.

Enter name or IP address of machine to log to, or leave blank to
disable remote logging:
```

Enter either the IP address or FQDN of the remote logging machine and press **Enter**. For example, if the remote logging machine is **server.imagestream.com** and its IP address is **192.168.100.1**, you would enter either of those values at the prompt. If you leave the entry blank, remote logging will be disabled. The router will display:

```
Now writing the /etc/syslog.conf file...done.
```

and return you to the menu system. Remember that this change is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the change to become permanent.

Configuring Advanced Event Logging

For users familiar with the UNIX syslog facility, the Event Logging menu includes an advanced configuration option. This configuration file allows you to configure advanced logging parameters for local and remote logging. The default configuration file includes two types of examples: remote logging using a "local" facility and local logging using log rotation.

Select the "Configure Event Logging" menu by pressing **3** on the keyboard and press **Enter** to configure the router's global settings (again, your menu may look slightly different):

```
Configure Event Logging
-----------------------------------------------------------
1. Configure remote event logging
2. Enable local event logging
3. Configure advanced event logging
0. Global configuration
```

To set a remote logging server, Press **3** ("Configure advanced event logging") and press **Enter**. The router will display the syslog.conf.local file. The first example shows the use of a "local" facility for log separation on a remote server:

```
local0.*        @server.imagestream.com
```

The command above directs the router to send all local0 messages to the machine at the FQDN **server.imagestream.com**. The remote logging server can be configured to send any "local0" messages to a separate data file for easier analysis. Any local facility from 0 to 7 is valid. The local facilities can be used to create separate log files directly on the router as well.

The second example shows the use of ImageStream's log rotation options:

```
*.*             /var/log/syslog rotate,size=250k,age=24,files=1
```

The entries in the syslog.conf.local file follow the format:

```
<facilities to log>   <output file/destination>  <logging options>
```

Each section should be separated by a space or a tab. The logging options are separated by a comma. You may not use a tab or a space in the output file/destination. The available logging options are:

rotate Signals the syslog daemon to automatically rotate log files. If you do not

provide any other options, then syslog will rotate the log file after it reaches 1 MB in size and will maintain 5 spare/backup files.

sizek Specified in "k", this option tells the syslog daemon the size at which files should be rotated.

age Specified in hours, this option tells the syslog daemon how often to automatically rotate files. For example, age=24 signals syslog to rotate the file every 24 hours regardless of size.

files This option tells the syslog daemon how many spare/backup files to maintain. For example, files=2 creates 2 spare/backup files (syslog.1 and syslog.2) in addition to the main log file.

After saving the file and exiting, the router will display:

```
Now writing the /etc/syslog.conf file...done.
```

and return you to the menu system. Remember that this change is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the change to become permanent.

Configuring the User-Configurable Startup Script

The ImageStream router supports the use of user-defined commands or scripts on startup. To enable any user scripts or issue special commands, choose option 4 ("Configure rc.local (user configurable startup script") and press Enter:

```
Global configuration
------------------------------------------------------------
1. Change hostname
2. Change DNS server
3. Configure Event Logging
4. Configure rc.local (user configurable startup script)
5. Select terminal type (linux)
6. Select default editor (pico)
7. Set the time
0. Configuration menu
```

This will open the rc.local file in your default text editor. This is an advanced option, and you should only edit this file if you are familiar with the rc.local file under Linux. Remember that any changes to the DNS server are not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the changes to become permanent.

Configuring the Default Terminal Type

The ImageStream router supports thirteen common terminal types for use in displaying the router's menu and command line system to the connected display. The default value of vt100 should work for most users. This is an advanced option, and you should only change this setting if you are familiar with terminal types and need support for a different type. Remember that any changes to the terminal type are not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the changes to become permanent.

To set the default terminal type, Press **6** ("Set your terminal type") and press **Enter**. The router will display:

```
Set your terminal type (vt100)
------------------------------------------------------------
1. vt100 (default)
2. vt102
3. vt220
4. linux (linux systems only)
5. Other (May cause software to be inoperable)
0. Global configuration
```

Press **1** to select the vt100 editor or the corresponding number to select a different editor. The router will display (assuming vt100 is selected):

```
vt100 selected as the default terminal type.
```

and return you to the menu system. Remember that any change in the default editor is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the hostname change to become permanent.

Configuring the Default Text Editor

The ImageStream router supports two common text editors for use in configuring the system, vi and pico. Both text editors are available from the command line. The menu system defaults to pico. The pico editor is recommended for most users. If you are an advanced administrator familiar with vi, then select this option as your default.

To set the default text editor, Press 7 ("Select default editor") and press Enter. The router will display:

```
Select default editor (pico)
------------------------------------------------------------
1. Pico
2. vi (for advanced users)
0. Global configuration
```

Press **1** to select the Pico editor or **2** to select the vi editor and press **Enter**. The router will display (assuming Pico is selected):

```
pico selected as the default editor.
```

and return you to the menu system. Remember that any change in the default editor is not saved automatically to the router's nonvolatile (Flash) memory. You must save your configuration to flash for the hostname change to become permanent.

Setting the System Time

The ImageStream router you receive has a system clock. This clock is used to calculate device uptimes and downtimes, log system messages via syslog and maintain modification times on files. The system clock can be synchronized with a server running the Network Time Protocol (NTP).

To set the system time, press **7** ("Set the time") and press **Enter**. The router will display the current time and prompt you if you want to synchronize the system time with a network time server.

Setting the system time manually

To set the system time manually, press **N** and press **Enter**. The router will display

```
Please enter the date in this format (MMDDhhmmCCYY) :
```

Enter the date in the specified format. For example, if the date is September 10, 2002 at 7:10 a.m., enter:

091007102002

The router will then prompt you to confirm the date and time that you entered your router, for example:

```
You have entered 09-10-2002  07:10, is this correct (Y/n) :
```

Press **Y** or **y** if the entry displayed is correct. Press **N** or **n** if the entry displayed is incorrect. Pressing **N** or **n** will erase your entries and the router will prompt you again for the system time. If you press **Y** or **y**, the router will ask for the local time zone:

```
Please enter the time zone abbreviation ('UTC' for Coordinated
Universal Time) :
```

Enter the correct abbreviation for the time zone you want to use with the router. For example, Central European Summer Time is entered as CEST. Next, the router will ask for the time offset from UTC:

```
Please enter the UTC offset for your time zone ('-8' for Pacific
Standard Time) :
```

Enter a **+** or a **-** and the number of hours between your local time zone and UTC. The router will then prompt you to confirm the time zone and offset. Once you confirm the time zone and offset, the router will display the time:

```
Tue Sep 10 07:10:00 PST 2002
```

and return you to the menu system. The system time will be automatically changed on the router and saved to the router's nonvolatile (Flash) memory.

When you have completed any global configuration changes, press **0** and press **Enter** to return to the Configuration menu.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

IV. Configuring a LAN Interface

This chapter describes how to configure the ImageStream router Ethernet and Token Ring interfaces, Ethernet VLAN subinterfaces and VRRP, and includes the following topics:

- "Understanding the Network Interface Configuration File"
- "Default LAN Interface Configuration"
- "Customizing the Configuration"
- "Configuring Additional Ethernet Devices"
- "Configuring Token Ring Interfaces"

Before configuring the Ethernet or Token Ring interface, you must make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the LAN connection. See the *Command Reference* for more detailed command descriptions and instructions.

```
Configuration menu
------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Next, select the "Network interface configuration" option by pressing **3** and **Enter**. This will open the ImageStream router's primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Understanding the Network Interface Configuration File

wan.conf is the primary configuration file used by ImageStream's open source Standard Architecture for Network Drivers (SAND). SAND handles configuration and management of all LAN and WAN devices on an ImageStream router. For more information about ImageStream's SAND technology, visit the ImageStream Web site at **http://www.imagestream.com/SAND.html**. See the *Command Reference* for more detailed command descriptions and instructions.

The default **wan.conf** file is:

```
!
version 2.00
!
interface Ethernet0
 ip address 10.10.199.199 255.0.0.0
!
interface Serial0
 shutdown
 description Port 0
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
# Set the default route via Serial0 using the device
#ip route add 0.0.0.0/0 dev Serial0
# Set the default route via Serial0 using an IP
#ip route add default via 192.168.10.2
!
end
```

The values in the default file are explained below.

version 2.00:

Denotes the version number of the configuration file and driver set. This value is set by ImageStream and should not be changed or modified.

interface Ethernet0:

Denotes the start of the configuration section for the first Ethernet device in your system. All commands that follow this line until the next **!** mark will be applied to Ethernet0.

ip address 10.10.199.199 255.0.0.0:

Specifies the IP address and netmask for Ethernet0.

!, end:

Signifies the end of a configuration section or the end of the wan.conf file. *You must include a "!" to delimit each section of the configuration file and an "end" statement at the end of the file*.

interface Serial0:

Denotes the start of the configuration section for the first Serial port in your system. All commands that follow this line until the next **!** mark will be applied to Serial0.

shutdown:

Instructs the router not to start this port when SAND is started or reloaded.

description Port 0:

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

encapsulation hdlc:

Specifies the Cisco HDLC protocol for this serial port.

ip address 192.168.10.1 255.255.255.252:

Specifies the IP address and netmask for Serial0.

 # Set the default route via Serial0 using the device:

A comment inserted in the configuration file. Lines that begin with **#** or **!** are ignored by SAND when starting or reloading configurations.

#ip route add 0.0.0.0/0 dev Serial0

A route statement setting the default route to the Serial0 device. Note that this command is commented out, so it will be ignored by SAND.

#ip route add default via 192.168.10.2

A route statement setting the default route to the IP address of 192.168.10.2. Note that this command is commented out, so it will be ignored by SAND. This command also uses the alternate default route designator of **default** instead of the numeric **0.0.0.0/0**. The designators are equivalent.

Default LAN Interface Configuration

The default values of the 10/100 Mbps Ethernet and Gigabit Ethernet on-board and expansion cards are as follows:

- On-board Ethernet ports always are the first device(s) in the router. A router with one on-board Ethernet port and one expansion port will use Ethernet0 for the on-board port and Ethernet1 for the expansion port.
- All 10/100 Mbps Ethernet and Gigabit Ethernet ports are enabled.
- No port description is configured for any port.
- All 10/100 Mbps Ethernet ports are set to autonegotiate speed and duplex.
- All Gigabit Ethernet ports are set to full duplex autonegotiation.
- VLAN's are not configured.
- Bridging is not configured.
- VRRP is not configured.

Remember that default settings are not necessarily shown in the configuration file.

Customizing the Configuration

To customize the Ethernet port configurations, complete the following sections. The ordering of the commands is done by convention, but a specific order is not required. Likewise, all configurations are indented to make configurations easy to read, but indentation is not required. In general, ImageStream follows this ordering convention:

1. Comments
2. Port description
3. Bandwidth scaling statement
4. Other optional settings
5. IP address/netmask
6. Secondary IP addresses/netmasks
7. VRRP configuration

Setting the port description

You can assign description to all 10/100 Ethernet and Gigabit Ethernet ports. Although this feature is optional, it may be particularly useful to assign names to facilitate administration. Setting a description does not change the operation or name of the port.

To assign a description to a port, enter this command in the **wan.conf** file in the Ethernet interface configuration section:

description *string*

Using the router's default configuration above, we have added a description to Ethernet0:

```
!
```

```
interface Ethernet0
 description Office LAN
 ip address 10.10.199.199 255.0.0.0
!
```

Configuring duplex and speed settings

By default, all 10/100 Ethernet devices autonegotiate duplex and speed settings with the connected device. However, you can set different combinations of duplex and speed modes based on the requirements of your application or the connected device's capabilities. Most Ethernet hubs, as well as older Ethernet cards and wireless radios may not support MII autonegotiation of duplex and speeds.

To force a duplex setting on an Ethernet port, enter this command in the **wan.conf** file in the Ethernet interface configuration section:

duplex *{ auto | full | half }*

The *auto*, *full*, or *half* keyword configures the duplex operation on an interface. *auto* is the default setting. To force a speed setting on an Ethernet port, enter this command in the **wan.conf** file in the Ethernet interface configuration section:

speed *{ auto | 100 | 10 }*

The *auto*, *100* or *10* keyword configures the speed on an interface. *auto* is the default. The duplex and speed commands are not valid for 10/100/1000 Ethernet ports or Gigabit Ethernet ports.

Using the router's default configuration above, we have added duplex and speed settings to Ethernet0:

```
!
interface Ethernet0
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.199.199 255.0.0.0
!
```

The table below describes the relationship between different combinations of the duplex and speed modes. The specified **duplex** command configured with the specified **speed** command produces the resulting action on the Ethernet port.

Relationship Between **duplex** and **speed** Commands

duplex Command	**speed Command**	**Resulting Action By Ethernet Port**
duplex *auto*	**speed** *auto*	Autonegotiates both speed and duplex

		modes.
duplex *half* or *full*	**speed** *auto*	Autonegotiates both speed and duplex modes.
duplex *auto*	**speed** *10*	Forces 10 Mbps and autonegotiates duplex mode.
duplex *auto*	**speed** *100*	Forces 100 Mbps and autonegotiates duplex mode.
duplex *half*	**speed** *10*	Forces 10 Mbps and half duplex.
duplex *full*	**speed** *10*	Forces 10 Mbps and full duplex.
duplex *half*	**speed** *100*	Forces 100 Mbps and half duplex.
duplex *full*	**speed** *100*	Forces 100 Mbps and full duplex.

Setting the IP address and netmask

During the initial installation process, you will set the IP address and netmask for the Ethernet interface. To change the IP address and netmask of the Ethernet interface from the default, modify the **ip address** command. The syntax of this command is:

ip address *ipaddress netmask*

Set the IP address to the address to be used by the router on your network. If you have divided your network into subnets, enter the subnet mask that identifies how your network addresses are divided between the network portion and the host portion.

Using the default configuration above, we have set the Ethernet0 IP address to 10.10.10.1 with a Class C netmask (/24, or 255.255.255.0). You will need to substitute your address and netmask for your network.

```
!
interface Ethernet0
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.10.1 255.255.255.0
!
```

Setting a dynamic IP address via DHCP

Some routers, especially those connected to broadband Internet connections, may obtain an IP address from a DHCP server. To change the IP address and netmask of the Ethernet interface from the default, modify the **ip address** command to instruct the router to act as a DHCP client on this interface. The syntax of this DHCP client command is:

ip address dhcp *[client-id { your-client-id }] [client-name { your-client-name }]*

The **client-id** and **client-name** commands are optional. If your DHCP server, or your broadband provider, require a client ID or name, specify either one or both of these optional parameters as necessary.

Using the default configuration above, we have set the Ethernet0 IP address to a dynamic IP address. When the router boots, or when the SAND service is reloaded, the router will make a DHCP request on the Ethernet0 device and wait for a response from the DHCP server. The DHCP client will accept an IP address, netmask, default gateway IP, DNS server addresses, and domain name if supplied by the DHCP server.

```
!
interface Ethernet0
 description Cable Modem Connection
 duplex auto
 speed auto
 ip address dhcp
!
```

Adding secondary Ethernet addresses

Depending on your network configuration, you may need to configure more than one address on an Ethernet device. This task is accomplished by adding the **secondary** keyword to the **ip address** line used previously. The **secondary** keyword is used for all addresses on an Ethernet device other than the primary address. Only one primary address can be configured on an Ethernet device. Configuring more than one primary address or leaving the **secondary** keyword off of a secondary address configuration will cause the last primary IP address to be used when the port is configured by SAND.

Using the default configuration above, we have added two secondary IP addresses to Ethernet0. You will need to substitute your address and netmask for your network.

```
!
interface Ethernet0
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.10.1 255.255.255.0
 ip address 192.168.0.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
!
```

Enabling or disabling an Ethernet interface

To disable an interface, use the **shutdown** interface configuration command. Unlike other command line interfaces, the **wan.conf** file does not require a "no" version of a command to reverse the operation. Entering "no" followed by a command will be ignored by SAND.

To disable Ethernet0 in the default configuration above, enter the **shutdown** command:

```
!
interface Ethernet0
 shutdown
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.10.1 255.255.255.0
 ip address 192.168.1.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
!
```

To enable Ethernet0 in the configuration, remove the **shutdown** command. Do not use "no shutdown", as this will be ignored by SAND. It is not necessary to enter "no" and a command to negate the command. Simply remove the command from the configuration file to enable the interface.

To disable an Ethernet interface, you must use the **shutdown** command. Disconnecting the Ethernet cable, removing the interface's IP address, or removing the interface from **wan.conf** does *not* disable the Ethernet interface. Only the **shutdown** command can disable an Ethernet interface.

Adding comments to an Ethernet configuration

Comments may be added to the Ethernet configuration, or anywhere in the **wan.conf** file by inserting a line that begins with the **#** symbol. The contents of the line will be ignored by SAND. Comments may be used to place contact information, ticket numbers, circuit IDs or any other information into the **wan.conf** file. There are no limits on the number or length of comments that may be inserted.

```
!
interface Ethernet0
#Connects to DES-3326, Port 5 in 3rd floor wiring closet
#Call Dave at x4653 for cable or port problems
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.10.1 255.255.255.0
 ip address 192.168.1.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
!
```

Scaling the interface bandwidth calculation

For some media, such as Ethernet and Token Ring, the bandwidth is fixed; for other media, such as serial lines, you can change the actual bandwidth by adjusting the hardware. For both classes of media, you can use the **bandwidth** configuration command to communicate the current bandwidth to the router's statistical output program and other programs. The **bandwidth** command sets an informational parameter only to communicate the current bandwidth to other programs. The **bandwidth** command does not adjust the actual bandwidth of an interface. For certain types of interfaces (Bonder, Ethernet, ATM, ports with integrated CSU/DSUs), the bandwidth value is automatically calculated for you. The syntax of the **bandwidth** command is:

bandwidth *bits per second*

In the default example from above, we have added a bandwidth of 5 Mbps to the "Connection to co-lo" interface, Ethernet1:

```
!
interface Ethernet0
#Connects to DES-3326, Port 5 in 3rd floor wiring closet
#Call Dave at x4653 for cable or port problems
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.10.1 255.255.255.0
 ip address 192.168.1.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
!
interface Ethernet1
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to co-lo
 bandwidth 5000000
 ip address 63.67.72.155 255.255.255.0
!
```

Configuring additional Ethernet devices

If your router is equipped with multiple Ethernet devices, you can add additional interface configurations to the **wan.conf** file. Although the order of the devices in the file does not matter, ImageStream by convention keeps the interfaces in order.

Additional Ethernet devices are configured in the same manner as the on-board Ethernet0 device. Add an additional **interface** command for each additional Ethernet port, separating each section with a **!** symbol. The syntax of the **interface** command is:

interface *DeviceName*

In the default example from above, we have added a second Ethernet port at Ethernet1.

```
!
interface Ethernet0
#Connects to DES-3326, Port 5 in 3rd floor wiring closet
#Call Dave at x4653 for cable or port problems
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.10.1 255.255.255.0
 ip address 192.168.1.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
!
interface Ethernet1
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to co-lo
 bandwidth 5000000
 ip address 63.67.72.155 255.255.255.0
!
interface Ethernet2
 description public servers
 ip address 20.215.25.1 255.255.254.0
!
```

Configuring Token Ring devices

If your router is equipped with expansion Token Ring devices, you can add additional interface configurations to the **wan.conf** file. Although the order of the devices in the file does not matter, ImageStream by convention keeps the interfaces in order.

Additional Token Ring devices are configured in the same manner as additional Ethernet devices. Add an additional **interface** command for each Token Ring port, beginning with TokenRing0 and separating each section with a **!** symbol. The syntax of the **interface** command is:

interface *DeviceName*

In the default example from above, we have added a Token Ring port at TokenRing0.

```
!
interface Ethernet0
#Connects to DES-3326, Port 5 in 3rd floor wiring closet
#Call Dave at x4653 for cable or port problems
 description Office LAN
 duplex auto
 speed auto
 ip address 10.10.10.1 255.255.255.0
 ip address 192.168.1.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
!
interface Ethernet1
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to co-lo
 bandwidth 5000000
 ip address 63.67.72.155 255.255.255.0
!
interface TokenRing0
 description Legacy network
 ip address 20.215.25.1 255.255.254.0
!
```

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

V. Advanced Ethernet Configurations

This chapter describes how to configure the ImageStream router's Ethernet ports with VLAN subinterfaces and VRRP, and includes the following topics:

- "Configuring VRRP on an Ethernet Interface"
- "Configuring Ethernet VLAN Subinterfaces"

Configuring Virtual Router Redundancy Protocol (VRRP)

Note: The information in this section is for advanced users only. VRRP configuration requires at least two routers or VRRP capable devices. For more information on VRRP, see the VRRP White Paper at ImageStream's Web site: **http://www.imagestream.com/VRRP.html**.

The configurations below are based on using two ImageStream routers, though any VRRP-capable device may be used in conjunction with an ImageStream router.

The Virtual Router Redundancy Protocol (VRRP) eliminates the single point of failure inherent in the static default routed environment. VRRP specifies an election protocol that dynamically assigns responsibility for a Virtual Router to a router running VRRP on a LAN. The VRRP Router controlling the IP address(es) associated with a Virtual Router is called the Master, and forwards packets sent to those IP addresses. When the Master becomes unavailable, a Backup VRRP Router takes the place of the Master.

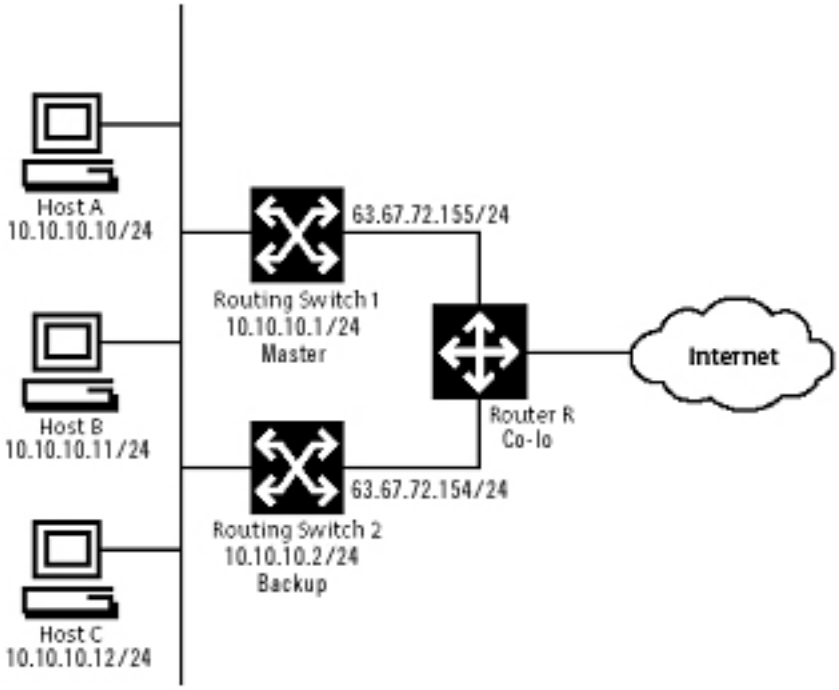
How does ImageStream implement VRRP?

1. VRRP Routers are identified by group using a unique identifier.
2. A single Master is chosen for the group.
3. One or more VRRP Routers can be Backups of the group's Master.
4. The Master communicates its status to the Backup devices.
5. If the Master fails to communicate its status, VRRP tries each Backup in order of precedence. The responding Backup assumes the role of Master.

   Note: VRRP enables redundancy for tunnelled/forwarded connections only, so if a VRRP failover occurs, the Backup will only listen to tunnelled/forwarded protocols and traffic. Pinging the Backup will not work, since it is not the IP Address Owner. The virtual addresses configured on the Bacukps for VRRP must match those configured on the interface addresses of the Master.

How to configure VRRP

In the following configuration, VRRP is configured on the public and private interfaces. VRRP applies only to configurations where two or more devices operate in parallel. All participating router have identical VRRP and LAN-to-LAN settings. If the Master fails, the Backup begins to service traffic formerly handled by the Master. This switchover occurs in 3 to 10 seconds. While IPSec and Point-to-Point Tunnel Protocol (PPTP) client connections are disconnected during this transition, users need only to reconnect without changing the destination address of their connection profile. In a LAN-to-LAN connection, switchover is seamless.



Using the diagram above, and our Ethernet configuration from earlier in this chapter, we will configure VRRP for this fictional network. In this example, there are two networks, 63.67.72.0/24 and 10.10.10.0/24. The “Master” router has the highest priority. To keep things simple, assume that all of the network segments use the same physical topology. *Customers with dynamic routing environments (using BGP, OSPF or RIP) should not use virtual addresses from a VRRP ID in the dynamic routing configuration.*

“Master” router configuration:

```
!
interface Ethernet0
#Connects to DES-3326, Port 5 in 3rd floor wiring closet
#Call Dave at x4653 for cable or port problems
 description Office LAN
 ip address 10.10.10.3 255.255.255.0
 ip address 192.168.1.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
 vrrp 1 ip 10.10.10.1
 vrrp 1 ip 63.67.72.155 secondary
 vrrp 1 priority 200
 vrrp 1 authentication isis
!
interface Ethernet1
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to co-lo
 ip address 63.67.72.155 255.255.255.0
!
```

“Backup” router configuration:

```
!
interface Ethernet0
description Office LAN
 ip address 10.10.10.2 255.255.255.0
 vrrp 1 ip 10.10.10.1
 vrrp 1 ip 63.67.72.155 secondary
 vrrp 1 priority 100
 vrrp 1 authentication isis
!
interface Ethernet1
 description Connection to co-lo
 ip address 63.67.72.154 255.255.255.0
!
```

The VRRP configuration is identical for the two routers, except for the priority. The “Master” router has its priority set to 200, which will place the second router into a backup mode. There are no limits on the number of Virtual Routers that can be configured using VRRP. There are no limits on the number of Virtual Routers of which a particular VRRP Router can be a member.

The values in the configuration sample above are explained below. For a complete list of VRRP commands see the *Command Reference*.

vrrp 1 ip 10.10.10.1:

Sets a primary IP address for the virtual router. This address is used by the Master, and can be taken over by the Backup in the event of the Master VRRP Router's failure. The **1** in the configuration indicates that this virtual router will use a Virtual Router Identification (VRID) of 1.

vrrp 1 ip 63.67.72.155 secondary:

Sets a secondary IP address for the virtual router. This address is used by the Master, and can be taken over by the Backup in the event of the Master VRRP Router's failure. The **secondary** keyword is used for all addresses on a Virtual Router other than the primary address. Only one primary address can be configured on a Virtual Router. Configuring more than one primary address or leaving the **secondary** keyword off of a secondary address configuration will cause the last primary IP address to be used when the Virtual Router is configured by SAND.

vrrp 1 priority { 100 | 200 }:

Set the VRRP Router's priority in the group. A value of 100 is the default priority, though any number from 0 (lowest) to 254 (highest) may be used for a VRRP Router that is not the IP address owner.

vrrp 1 authentication isis

Requires the members of the group to use simple text password authentication and to use the password **isis**. The password may be any string of up to 8 characters. Passwords of longer than 8 characters will be truncated.

Configuring Virtual LAN (VLANs)

A VLAN is an administratively configured LAN or broadcast domain. Instead of moving devices between different physical LANs, network administrators can configure a Ethernet port on an ImageStream router or an 802.1Q-compliant Ethernet switch to belong to a different VLAN. The ability to move endstations to different broadcast domains by setting membership profiles for each port on centrally managed devices is one of the main advantages of 802.1Q VLANs.

Ethernet VLAN subinterfaces are configured in the same manner as the on-board Ethernet0 device. Add an additional **interface** command for each Ethernet VLAN port, separating each section with a **!** symbol. The syntax of the **interface** command for VLAN devices is:

interface *DeviceName.VLANid*

In the default example from above, we have added a VLAN subinterface on Ethernet0 at VLAN ID 10. Valid VLAN ids are 1 through 4094.

```
!
interface Ethernet0
#Connects to DES-3326, Port 5 in 3rd floor wiring closet
#Call Dave at x4653 for cable or port problems
 description Office LAN
 ip address 10.10.10.1 255.255.255.0
 ip address 192.168.1.1 255.255.255.128 secondary
 ip address 192.168.10.1 255.255.254.0 secondary
!
interface Ethernet0.10
 description Customer servers VLAN
 ip address 63.67.72.155 255.255.255.0
!
```

If you want your Ethernet device to transmit and receive only on a VLAN and not transmit or receive untagged frames, set the primary device's IP address to all zeros or omit the **ip address** line from the configuration. The example below shows Ethernet0 and with two VLAN subinterfaces and no IP address configured on Ethernet0:

```
!
interface Ethernet0
#Connects to DES-3326, Port 5 in 3rd floor wiring closet
#Call Dave at x4653 for cable or port problems
 description Office LAN
# Not required – adding ip address of 0.0.0.0 is optional here
# ip address 0.0.0.0 255.255.255.255
!
interface Ethernet0.10
 description Customer servers VLAN #10
 ip address 63.67.72.155 255.255.255.0
!
interface Ethernet0.11
 description Office servers VLAN #11
 ip address 12.45.22.1 255.255.255.0
!
```

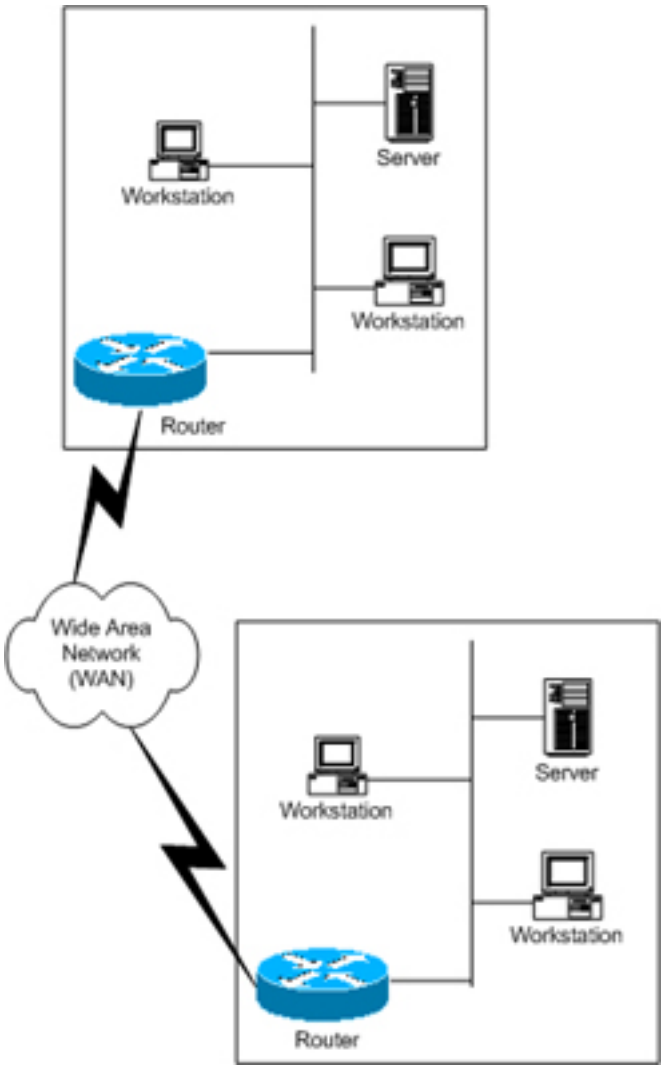
VLAN devices appear as regular devices within the ImageStream router. All Ethernet configuration options, including VRRP configurations, firewall and Quality of Service, are valid for VLAN devices.

VI. Configuring a Synchronous Serial WAN Interface

This chapter describes how to configure the ImageStream router serial WAN interfaces without integrated CSU/DSUs and includes the following topics:

- “WAN Port Uses”
- “Understanding the Network Interface Configuration File”
- “Configuring a Synchronous Serial WAN Internface”
- “Default Serial WAN Interface Configuration”
- “Customizing the Configuration”
- “Configuring Additional Serial Devices”

Before configuring the WAN interface, you must make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.



WAN Port Uses

WAN ports are used for high-speed dedicated connections between two local area networks (LANs). Once a connection is established between two sites, a wide area network (WAN) is achieved. WAN connections can be achieved through the use of dedicated leased lines such as T1, E1 or higher bandwidth lines, SONET/SDH connections, ATM connections, Frame Relay connections, or ISDN lines. Connection rates can range from 9600bps to 2.048Mbps (E1) to 2.488Gbps (OC-48). ImageStream routers support these connection types using one or more serial ports with or without integrated CSU/DSUs.

All WAN port connections are very similar and are represented in the diagram at left.

For most applications, a dedicated line connects two routers, each located on a separate remote network. The following examples describe various uses for synchronous ports.

Routing over Leased Lines. A serial port with or without integrated CSU/DSUs can be used to connect to synchronous leased lines from 9600bps to T1 (1.544Mbps) or E1 (2.048Mbps) to DS3 (44.736Mbps) or E3 (34.368Mbps) for continuous operation. Synchronous optical network (SONET) or Synchronous Digital Hierarchy (SDH) interfaces use optical instead of copper wiring and commonly operate at speeds from OC-3/STM-1 (155.52Mbps) to OC-48/STM-16 (2.488Gbps) and higher. A channel service unit/digital service unit (CSU/DSU) must be attached to the serial port, or integrated into the serial card. For more information about configuring cards with integrated CSU/DSUs, see the chapter "Configuring an Integrated CSU/DSU WAN Interface."

Routing over ATM. ATM (asynchronous transfer mode) is a dedicated-connection switching technology that organizes digital data into 53-byte cell units (48 bytes of data, 5 bytes of overhead) and transmits them over a physical medium using digital signal technology. Individually, a cell is processed asynchronously relative to other related cells. Like frame relay, two advantages over a leased line network are lower cost and the ability to have multiple virtual circuits (VCs) come into a single physical port. It is especially popular for DSL service and hub-and-spoke network arrangements. However, unlike frame relay, ATM is designed for easy implementation in hardware (rather than software) and is designed for optical links at higher speeds. For more information about configuring ATM, see the chapter "Configuring an ATM Interface."

Routing over Frame Relay. Frame Relay provides connectivity using a packet-switched network. Its two advantages over a leased line network are lower cost and the ability to have multiple permanent virtual circuits (PVCs) come into a single physical port. It is especially popular for hub-and-spoke network arrangements. For example, a dozen field offices with T1 or fractional T1 Frame Relay connections can connect to a central office using a single DS3, fractional DS3 or T1 Frame Relay connection. The central office requires only one CSU/DSU and serial port on the router, instead of twelve. For more information about configuring frame relay, see the chapter "Configuring a Frame Relay Interface."

Routing over ISDN. Integrated Services Digital Network (ISDN) provides fast dial-up connectivity for applications where the expense of a dedicated Frame Relay, ATM or leased line connection is not appropriate for the amount and nature of the traffic. For more information about ISDN Basic Rate Interface (BRI) connections, see the chapter "Configuring an ISDN BRI Interface."

Configuring a Synchronous Serial WAN Interface

Once you have determined the type of synchronous connection to use between your remote locations, the synchronous port on each end of the connection must be configured. If your WAN interface has an integrated CSU/DSU, please see the chapter "Configuring an Integrated CSU/DSU WAN Interface."

```
Configuration menu
------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the "Configuration menu", select the "Network interface configuration" option by pressing **3** and **Enter**. This will open the ImageStream router's primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Understanding the Network Interface Configuration File

wan.conf is the primary configuration file used by ImageStream's open source Standard Architecture for Network Drivers (SAND). SAND handles configuration and management of all LAN and WAN devices on an ImageStream router. For more information about ImageStream's SAND technology, visit the ImageStream Web site at **http://www.imagestream.com/SAND.html**. See the *Command Reference* for more detailed command descriptions and instructions.

The default **wan.conf** file is:

```
!
version 2.00
!
interface Ethernet0
 ip address 10.10.199.199 255.0.0.0
!
interface Serial0
 shutdown
 description Port 0
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
# Set the default route via Serial0 using the device
#ip route add 0.0.0.0/0 dev Serial0
# Set the default route via Serial0 using an IP
#ip route add default via 192.168.10.2
!
end
```

The values in the default file are explained below.

version 2.00:

Denotes the version number of the configuration file and driver set. This value is set by ImageStream and should not be changed or modified.

interface Ethernet0:

Denotes the start of the configuration section for the first Ethernet device in your system. All commands that follow this line until the next **!** mark will be applied to Ethernet0.

ip address 10.10.199.199 255.0.0.0:

Specifies the IP address and netmask for Ethernet0.

!, end:

Signifies the end of a configuration section or the end of the wan.conf file. *You must include a "!" to delimit each section of the configuration file and an "end" statement at the end of the file*.

interface Serial0:

Denotes the start of the configuration section for the first Serial port in your system. All commands that follow this line until the next **!** mark will be applied to Serial0.

shutdown:

Instructs the router not to start this port when SAND is started or reloaded.

description Port 0:

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

encapsulation hdlc:

Specifies the Cisco HDLC protocol for this serial port.

ip address 192.168.10.1 255.255.255.252:

Specifies the IP address and netmask for Serial0.

 # Set the default route via Serial0 using the device:

A comment inserted in the configuration file. Lines that begin with **#** or **!** are ignored by SAND when starting or reloading configurations.

#ip route add 0.0.0.0/0 dev Serial0

A route statement setting the default route to the Serial0 device. Note that this command is commented out, so it will be ignored by SAND.

#ip route add default via 192.168.10.2

A route statement setting the default route to the IP address of 192.168.10.2. Note that this command is commented out, so it will be ignored by SAND. This command also uses the alternate default route designator of **default** instead of the numeric **0.0.0.0/0**. The designators are equivalent.

Default Serial WAN Interface Configuration

The default values of cards equipped with a Serial interface are as follows:

- Cards equipped with a multi-interface cable serial interface (cards whose part name ends in “-SE”) default to V.35 operation.
- All cards use external (also known as “line” or “network”) clocking.
- No port description is configured for any port.
- PPP encapsulation is enabled.
- Bridging is not configured.

Remember that default settings are not necessarily shown in the configuration file.

Customizing the Configuration

To customize the WAN port configurations, complete the following sections. The ordering of the commands is done by convention, but a specific order is not required. Likewise, all configurations are indented to make configurations easy to read, but indentation is not required. In general, ImageStream follows this ordering convention:

1. Comments
2. Port description
3. Bandwidth scaling statement
4. Interface type settings
5. Other optional settings
6. IP address/netmask
7. Secondary IP addresses/netmasks

Setting the port description

You can assign description to all WAN ports. Although this feature is optional, it may be particularly useful to assign names to facilitate administration. Setting a description does not change the operation or name of the port.

To assign a description to a port, enter this command in the **wan.conf** file in the Serial interface configuration section:

description *string*

Using the router’s default configuration above, we have modified the description for Serial0:

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
```

Setting the IP address and netmask

During the initial installation process, you will set the IP address and netmask for the Serial interface. To change the IP address and netmask of the Serial interface from the default, modify the **ip address** command. The syntax of this command is:

ip address *ipaddress netmask*

Set the IP address to the address to be used by the serial interface of the router on your network. If you have divided your network into subnets, enter the subnet mask that identifies how your network addresses are divided between the network portion and the host portion.

Using the default configuration above, we have set the Serial0 IP address to 20.0.0.2 with a netmask of 255.255.255.252. Often, with numbered point-to-point Serial links, the netmask will be a /30 (a subnet with 2 valid addresses). You will need to substitute your address and netmask for your network.

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Setting serial transport encapsulation

The serial transport encapsulation must be set for a synchronous serial port. Only one encapsulation may be specified, and this setting must match the one used on the remote end of the serial interface. If your provider has specified an encapsulation type, use this value. Normal encapsulations for a serial link are: *hdlc*, *ppp*, *frame-relay ietf*, or *atm***.** The syntax of this command is:

encapsulation *type*

In the default configuration above, we have specified HDLC encapsulation. This encapsulation type is the default on most Cisco routers. If you are not connecting to a Cisco router, you will likely use PPP encapsulation. ATM and frame relay encapsulation types require special configurations and will be discussed in later chapters. You will need to set the encapsulation type for your network.

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Enabling or disabling a Serial interface

To disable an interface, use the **shutdown** interface configuration command. Unlike other command line interfaces, the **wan.conf** file does not require a "no" version of a command to reverse the operation. Entering "no" followed by a command will be ignored by SAND.

By default, Serial0 is disabled in the default configuration above because the **shutdown** command has been entered.

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

To enable Serial0 in the configuration, remove the **shutdown** command. Do not use "no shutdown", as this will be ignored by SAND. It is not necessary to enter "no" and a command to negate the command. Simply remove the command from the configuration file.

Adding comments to a Serial configuration

Comments may be added to the Serial configuration, or anywhere in the **wan.conf** file by inserting a line that begins with the **#** symbol. The contents of the line will be ignored by SAND. Comments may be used to place contact information, ticket numbers, circuit IDs or any other information into the **wan.conf** file. There are no limits on the number or length of comments that may be inserted.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Scaling the connection speed calculation

For some media, such as Ethernet and Token Ring, the bandwidth is fixed; for other media, such as serial lines, you can change the actual bandwidth by adjusting the hardware. For both classes of media, you can use the **bandwidth** configuration command to communicate the current bandwidth to the router's statistical output program and other programs. The **bandwidth** command sets an informational parameter only to communicate the current bandwidth to other programs.

The **bandwidth** command does not adjust the actual bandwidth of an interface. For certain types of interfaces (Bonder, Ethernet, ATM, ports with integrated CSU/DSUs), the bandwidth value is automatically calculated for you. For synchronous serial interfaces, the bandwidth value cannot be determined automatically, so you must set it. The syntax of the **bandwidth** command is:

bandwidth *bits per second*

In the default example from above, we have added a bandwidth equal to a full T1 line (less overhead) to the Serial0 interface:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Setting the serial interface type

Most ImageStream synchronous serial interfaces are capable of operating with several different wiring interfaces. All cards whose part name ends in "-SE" are multi-interface capable. The default setting is for V.35 interfaces, but the multi-interface serial cards can also support RS-232, RS-422/RS-449/X.21 wiring connections when coupled with the correct cable and wiring interface setting.

The **dctype** command is used to set the serial card's daughtercard to use a particular wiring interface. In most cases, the synchronous serial connection to the external CSU/DSU will be V.35 or X.21. The **dctype** must be set to match the wiring interface used. The syntax of the **dctype** command is:

dctype *type-code*

where the type code is either *0* (V.35), *1* (RS-422/RS-449/X.21), or *2* (RS-232). In the default example from above, we have omitted the **dctype** command since the connection to the CSU/DSU is V.35. Optionally, the command **dctype 0** could be added for V.35 operation, although it would have the same effect as omitting the command.

Adding secondary Serial addresses

Although rarely necessary, depending on your network configuration, you may need to configure more than one address on a Serial device. This task is accomplished by adding the **secondary** keyword to the **ip address** line used previously. The **secondary** keyword is used for all addresses on a Serial device other than the primary address. Only one primary address can be configured on a Serial device. Configuring more than one primary address or leaving the **secondary** keyword off of a secondary address configuration will cause the last primary IP address to be used when the port is configured by SAND.

Using the default configuration above, we have added two secondary IP addresses to Serial0. You will need to substitute your address and netmask for your network.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
 ip address 20.0.1.1 255.255.255.0 secondary
!
```

Configuring X.21 connections

In many non-North American countries, X.21 wiring interfaces are used instead of V.35. X.21 wiring, which provides a balanced signal, differs from other wiring interfaces in that no Data Carrier Detect (DCD) or Data Terminal Ready (DTR) pins are used. Setting **dctype 1** sets only the hardware wiring interface. The router must also be configured to ignore the DCD and DTR signals and use the Request To Send (RTS) and Clear To Send (CTS) signals to determine interface status.

For proper X.21 operation, enter the command **x21-clockmode**. Failing to enter this command will prevent your X.21 connection from becoming active. This command is not necessary for any other wiring interface, including standard RS-422 and RS-449 wiring interfaces which also share the **dctype 1** configuration command.

Configuring additional Serial devices

If your router is equipped with multiple Serial devices, you can add additional interface configurations to the **wan.conf** file. Although the order of the devices in the file does not matter, ImageStream by convention keeps the interfaces in order.

Additional Serial devices are configured in the same manner as Serial0 in our example configuration. Add an additional **interface** command for each additional Serial port, separating each section with a **!** symbol. The syntax of the **interface** command is:

interface *DeviceName*

In the default example from above, we have added a second Serial port at Serial1 (note the use of the **dctype** command and **x21-clockmode** command for X.21 operation) and a third Serial port at Serial2.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
 ip address 20.0.1.1 255.255.255.0 secondary
!
interface Serial1
 description Connection to London office
 bandwidth 2048000
 encapsulation ppp
 dctype 1
 x21-clockmode
 ip address 25.0.0.1 255.255.255.252
!
interface Serial2
#HSSI card
 description fractional DS3 to NYC
 bandwidth 10000000
 encapsulation hdlc
 ip address 30.0.0.1 255.255.255.252
!
```

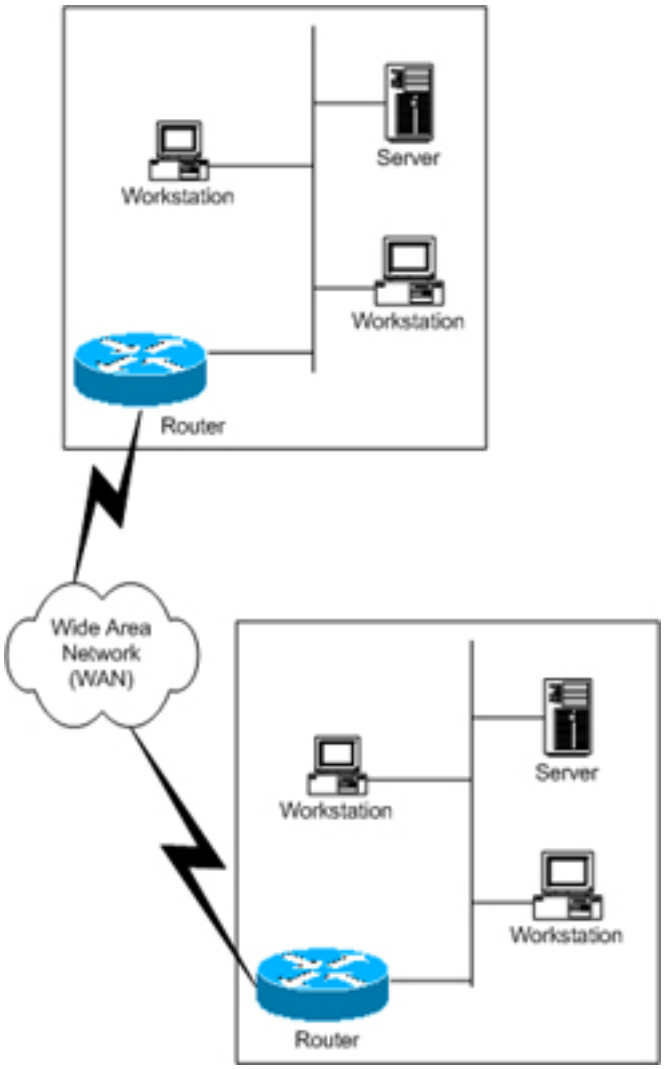
Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

VII. Configuring an Integrated CSU/DSU WAN Interface

This chapter describes how to configure the ImageStream router serial WAN interfaces with integrated CSU/DSUs and includes the following topics:

- “WAN Port Uses”
- “Understanding the Network Interface Configuration File”
- “Configuring an Integrated CSU/DSU WAN Interface”
- “Default Integrated CSU/DSU WAN Interface Configuration”
- “Customizing the Configuration”
- “Setting Integrated CSU/DSU Parameters”
- “Configuring Additional Serial Devices”

Before configuring the WAN interface, you must make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.



WAN Port Uses

WAN ports are used for high-speed dedicated connections between two local area networks (LANs). Once a connection is established between two sites, a wide area network (WAN) is achieved. WAN connections can be achieved through the use of dedicated leased lines such as T1, E1 or higher bandwidth lines, SONET/SDH connections, ATM connections, Frame Relay connections, or ISDN lines. Connection rates can range from 9600bps to 2.048Mbps (E1) to 2.488Gbps (OC-48). ImageStream routers support these connection types using one or more serial ports with or without integrated CSU/DSUs.

All WAN port connections are very similar and are represented in the diagram at left.

For most applications, a dedicated line connects two routers, each located on a separate remote network. The following examples describe various uses for synchronous ports.

Routing over Leased Lines. A serial port with or without integrated CSU/DSUs can be used to connect to synchronous leased lines from 9600bps to T1 (1.544Mbps) or E1 (2.048Mbps) to DS3 (44.736Mbps) or E3 (34.368Mbps) for continuous operation. Synchronous optical network (SONET) or Synchronous Digital Hierarchy (SDH) interfaces use optical instead of copper wiring and commonly operate at speeds from OC-3/STM-1 (155.52Mbps) to OC-48/STM-16 (2.488Gbps) and higher. A channel service unit/digital service unit (CSU/DSU) must be attached to the serial port, or integrated into the serial card. For more information about configuring cards without integrated CSU/DSUs, See the chapter “Configuring a Synchronous Serial WAN Interface.”

Routing over ATM. ATM (asynchronous transfer mode) is a dedicated-connection switching technology that organizes digital data into 53-byte cell units (48 bytes of data, 5 bytes of overhead) and transmits them over a physical medium using digital signal technology. Individually, a cell is processed asynchronously relative to other related cells. Like frame relay, two advantages over a leased line network are lower cost and the ability to have multiple virtual circuits (VCs) come into a single physical port. It is especially popular for DSL service and hub-and-spoke network arrangements. However, unlike frame relay, ATM is designed for easy implementation in hardware (rather than software) and is designed for optical links at higher speeds. For more information about configuring ATM, See the chapter “Configuring an ATM Interface.”

Routing over Frame Relay. Frame Relay provides connectivity using a packet-switched network. Its two advantages over a leased line network are lower cost and the ability to have multiple permanent virtual circuits (PVCs) come into a single physical port. It is especially popular for hub-and-spoke network arrangements. For example, a dozen field offices with T1 or fractional T1 Frame Relay connections can connect to a central office using a single DS3, fractional DS3 or T1 Frame Relay connection. The central office requires only one CSU/DSU and serial port on the router, instead of twelve. For more information about configuring frame relay, See the chapter “Configuring a Frame Relay Interface.”

Routing over ISDN. Integrated Services Digital Network (ISDN) provides fast dial-up connectivity for applications where the expense of a dedicated Frame Relay, ATM or leased line connection is not appropriate for the amount and nature of the traffic. For more information about ISDN Basic Rate Interface (BRI) connections, See the chapter “Configuring an ISDN BRI Interface.”

Configuring an Integrated CSU/DSU WAN Interface

Once you have determined the type of synchronous connection to use between your remote locations, the synchronous port on each end of the connection must be configured. If your WAN interface does not have an integrated CSU/DSU, please See the chapter “Configuring a Synchronous Serial WAN Interface.”

```
Configuration menu
------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the “Configuration menu”, select the “Network interface configuration” option by pressing **3** and **Enter**. This will open the ImageStream router’s primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Understanding the Network Interface Configuration File

wan.conf is the primary configuration file used by ImageStream’s open source Standard Architecture for Network Drivers (SAND). SAND handles configuration and management of all LAN and WAN devices on an ImageStream router. For more information about ImageStream’s SAND technology, visit the ImageStream Web site at **http://www.imagestream.com/SAND.html**. See the *Command Reference* for more detailed command descriptions and instructions.

The default **wan.conf** file is:

```
!
version 2.00
!
interface Ethernet0
 ip address 10.10.199.199 255.0.0.0
!
interface Serial0
 shutdown
 description Port 0
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
# Set the default route via Serial0 using the device
#ip route add 0.0.0.0/0 dev Serial0
# Set the default route via Serial0 using an IP
#ip route add default via 192.168.10.2
!
end
```

The values in the default file are explained below.

version 2.00:

Denotes the version number of the configuration file and driver set. This value is set by ImageStream and should not be changed or modified.

interface Ethernet0:

Denotes the start of the configuration section for the first Ethernet device in your system. All commands that follow this line until the next **!** mark will be applied to Ethernet0.

ip address 10.10.199.199 255.0.0.0:

Specifies the IP address and netmask for Ethernet0.

!, end:

Signifies the end of a configuration section or the end of the wan.conf file. *You must include a "!" to delimit each section of the configuration file and an "end" statement at the end of the file*.

interface Serial0:

Denotes the start of the configuration section for the first Serial port in your system. All commands that follow this line until the next **!** mark will be applied to Serial0.

shutdown:

Instructs the router not to start this port when SAND is started or reloaded.

description Port 0:

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

encapsulation hdlc:

Specifies the Cisco HDLC protocol for this serial port.

ip address 192.168.10.1 255.255.255.252:

Specifies the IP address and netmask for Serial0.

 # Set the default route via Serial0 using the device:

A comment inserted in the configuration file. Lines that begin with **#** or **!** are ignored by SAND when starting or reloading configurations.

#ip route add 0.0.0.0/0 dev Serial0

A route statement setting the default route to the Serial0 device. Note that this command is commented out, so it will be ignored by SAND.

#ip route add default via 192.168.10.2

A route statement setting the default route to the IP address of 192.168.10.2. Note that this command is commented out, so it will be ignored by SAND. This command also uses the alternate default route designator of **default** instead of the numeric **0.0.0.0/0**. The designators are equivalent.

Default Integrated CSU/DSU WAN Card Configuration

The default values of cards equipped with an integrated CSU/DSU interface are as follows:

- Integrated T1 and E1 CSU/DSUs default to the following values:
    - ESF framing (CCS for E1 circuits)
    - B8ZS encoding (HDB3 for E1 circuits)
    - No line buildout
    - All timeslots configured, all at 64K speeds
    - Equalizer gain limit (EGL) off
    - Normal data encoding
    - Structured mode (E1 only)
    - CRC4 checksums disabled (E1 only)
- Integrated DS3 and E3 CSU/DSUs default to the following values:
    - C-bit framing
    - No line buildout
    - All timeslots configured
    - Equalizer gain limit (EGL) off
- All cards use external (also known as “line” or “network”) clocking.
- No port description is configured for any port.
- PPP encapsulation is enabled.
- Bridging is not configured.

Remember that default settings are not necessarily shown in the configuration file.

Customizing the Configuration

To customize the WAN port configurations, complete the following sections. The ordering of the commands is done by convention, but a specific order is not required. Likewise, all configurations are indented to make configurations easy to read, but indentation is not required. In general, ImageStream follows this ordering convention:

1. Comments
2. Port description
3. Bandwidth scaling statement
4. CSU/DSU settings
5. Other optional settings
6. IP address/netmask
7. Secondary IP addresses/netmasks

Setting the port description

You can assign description to all WAN ports. Although this feature is optional, it may be particularly useful to assign names to facilitate administration. Setting a description does not change the operation or name of the port.

To assign a description to a port, enter this command in the **wan.conf** file in the Serial interface configuration section:

description *string*

Using the router's default configuration above, we have modified the description for Serial0:

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
```

Setting the IP address and netmask

During the initial installation process, you will set the IP address and netmask for the Serial interface. To change the IP address and netmask of the Serial interface from the default, modify the **ip address** command. The syntax of this command is:

ip address *ipaddress netmask*

Set the IP address to the address to be used by the serial interface of the router on your network. If you have divided your network into subnets, enter the subnet mask that identifies how your network addresses are divided between the network portion and the host portion.

Using the default configuration above, we have set the Serial0 IP address to 20.0.0.2 with a netmask of 255.255.255.252. Often, with numbered point-to-point Serial links, the netmask will be a /30 (a subnet with 2 valid addresses). You will need to substitute your address and netmask for your network.

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Setting serial transport encapsulation

The serial transport encapsulation must be set for an integrated CSU/DSU serial port. Only one encapsulation may be specified, and this setting must match the one used on the remote end of the serial interface. If your provider has specified an encapsulation type, use this value. Normal encapsulations for a serial link are: *hdlc*, *ppp*, *frame-relay ietf*, or *atm***.** The syntax of this command is:

encapsulation *type*

In the default configuration above, we have specified HDLC encapsulation. This encapsulation type is the default on most Cisco routers. If you are not connecting to a Cisco router, you will likely use PPP encapsulation. ATM and frame relay encapsulation types require special configurations and will be discussed in later chapters. You will need to set the encapsulation type for your network.

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Enabling or disabling a Serial interface

To disable an interface, use the **shutdown** interface configuration command. Unlike other command line interfaces, the **wan.conf** file does not require a “no” version of a command to reverse the operation. Entering “no” followed by a command will be ignored by SAND.

By default, Serial0 is disabled in the default configuration above because the **shutdown** command has been entered.

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

To enable Serial0 in the configuration, remove the **shutdown** command. Do not use “no shutdown”, as this will be ignored by SAND. It is not necessary to enter “no” and a command to negate the command. Simply remove the command from the configuration file.

Adding comments to a Serial configuration

Comments may be added to the Serial configuration, or anywhere in the **wan.conf** file by inserting a line that begins with the **#** symbol. The contents of the line will be ignored by SAND. Comments may be used to place contact information, ticket numbers, circuit IDs or any other information into the **wan.conf** file. There are no limits on the number or length of comments that may be inserted.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Scaling the connection speed calculation

For some media, such as Ethernet and Token Ring, the bandwidth is fixed; for other media, such as serial lines, you can change the actual bandwidth by adjusting the hardware. For both classes of media, you can use the **bandwidth** configuration command to communicate the current bandwidth to the router's statistical output program and other programs. The **bandwidth** command sets an informational parameter only to communicate the current bandwidth to other programs.

The **bandwidth** command does not adjust the actual bandwidth of an interface. Ports with integrated CSU/DSUs automatically calculate the bandwidth value based on the number of timeslots configured. In our example above, the router will automatically calculate the bandwidth of 1536000 (full T1 less overhead). The syntax of the **bandwidth** command is:

bandwidth *bits per second*

In the default example from above, we have added a bandwidth equal to a full T1 line (less overhead) to the Serial0 interface. This value is calculated automatically, so this command is optional:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Setting Integrated T1 CSU/DSU Parameters

The **service-module** command is used to configure the serial card's integrated T1 CSU/DSU. In most cases, the defaults provided on the integrated CSU/DSU will match the network configuration. Check with your line provider to determine if your line settings differ from the default CSU/DSU configuration. The configurations in the interface configuration must match the settings for your line or your serial interface will not function correctly.

Configuring the T1 line clocking source

Unlike asynchronous devices, a synchronous data interface must a clock source to use for network timing. One and only one clock source should be configured on a line. In most cases, your line provider will provide a clock source for the T1 line. The T1 CSU/DSU can also be configured to provide a clock source. The syntax of this command is:

service-module t1 clock source *{ line* | *internal }*

The *line* or *internal* keyword specifies the type of clocking to use on this interface. Line (also known as "network" or "external") timing is the default value. Using the *internal* keyword will enable the CSU/DSU's internal clock and will instruct the CSU/DSU to place this clock source on the line. Configuring more than one clock source, or having no clock source, can cause a line to have synchronization problems resulting in framing errors and data loss. Check with your line provider before enabling internal clocking to ensure that this setting is needed. We have specified the default value in the default configuration from above.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module t1 clock source line
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring T1 time slots and channel speeds

To configure the number of time slots allocated to the Serial interface, include the time slots statement in the interface configuration. The syntax of this command is:

service-module t1 timeslots *{ range* | *all } [speed { 56* | *64 }]*

where the range is a value of 1 to 24 for T1. The **speed** keyword configures the byte encoding of the T1 line. By default, T1 lines use a byte encoding of 8 bits per byte (64 kbps channels). You can configure an alternative byte encoding of 7 bits per byte (56 kbps channels).

You can designate any combination of time slots for usage. The default is to use all time slots.

To use time slots 1 through 10, designate time-slot-number as follows:

service-module t1 timeslots 1-10

To use time slots 1 through 5, time slot 10, and time slot 24, designate the timeslot range as follows:

service-module t1 timeslots 1-5,10,24;

To use the first four odd-numbered time slots, designate the timeslot range as follows:

service-module t1 timeslots 1,3,5,7

Spaces are not allowed between timeslot numbers.

In the default configuration, we have inserted the default value:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module t1 clock source line
 service-module t1 timeslots all speed 64
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring T1 data inversion

By default, data inversion is disabled. To enable data inversion at the HDLC level, include the **service-module t1 data coding** *{ normal | inverted }* statement in the interface configuration. When you enable data inversion, all data bits in the data stream are transmitted as inverted; that is, zeroes are transmitted as ones and ones as zeroes. Data inversion is normally used only in AMI mode to guarantee ones density in the transmitted stream.

Configuring T1 line buildout

A T1 interface has 4 possible settings for T1 line buildout. The line buildout setting is used to set the signal attenuation factor due to the impedance of copper cabling. The line buildout setting is used on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the T1 interfaces use the shortest setting (none). The command syntax is:

service-module t1 lbo *value*

where the value is either *-22.5 db*, *-15 db*, *-7.5 db*, or *none*. If you are unsure of which setting to use, leave the builtout at the shortest setting. In the default example from above, we have omitted the **service-module t1 lbo** command since the connection to the demarc is less than 225 feet. Optionally, the command **service-module t1 lbo none** could be added, although it would have the same effect as omitting the command.

Configuring the T1 equalizer gain limiter

The T1 interface has an equalizer gain limiter. This setting is used to turn on the receiver gain limiter to overcome impedance of copper cabling. The gain limiter should be turned on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the T1 interfaces do not enable the gain limiter. To enable the equalizer gain limiter, add the command **service-module t1 egl** to the interface configuration. This command is normally used in conjunction with the line buildout command.

Configuring T1 framing

By default, T1 interfaces use an ESF (extended super frame) framing format. To explicitly configure ESF framing, include the framing statement in the interface configuration for the serial device:

service-module t1 framing *esf*

You can configure SF (super frame, also known as “D4”) format as an alternative. To have the interface use the SF framing format, include the framing statement in the interface configuration, specifying the *sf* option. In the default configuration from above, we have specified the default ESF framing:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module t1 clock source line
 service-module t1 timeslots all speed 64
 service-module t1 framing esf
 ip address 20.0.0.2 255.255.255.252
```

!

Configuring T1 line encoding

By default, T1 interfaces use a B8ZS line encoding. To explicitly configure B8ZS line encoding, include the linecode statement in the interface configuration for the serial device:

service-module t1 linecode *b8zs*

You can configure AMI line encoding as an alternative. To have the interface use the AMI framing format, include the framing statement in the interface configuration, specifying the *ami* option. In the default configuration from above, we have specified the default B8ZS line encoding:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module t1 clock source line
 service-module t1 timeslots all speed 64
 service-module t1 framing esf
 service-module t1 linecode b8zs
 ip address 20.0.0.2 255.255.255.252
!
```

Setting Integrated E1 CSU/DSU Parameters

The **service-module** command is used to configure the serial card's integrated E1 CSU/DSU. In most cases, the defaults provided on the integrated CSU/DSU will match the network configuration. Check with your line provider to determine if your line settings differ from the default CSU/DSU configuration. The configurations in the interface configuration must match the settings for your line or your serial interface will not function correctly.

Configuring the E1 line clocking source

Unlike asynchronous devices, a synchronous data interface must a clock source to use for network timing. One and only one clock source should be configured on a line. In most cases, your line provider will provide a clock source for the E1 line. The E1 CSU/DSU can also be configured to provide a clock source. The syntax of this command is:

service-module e1 clock source *{ line* | *internal }*

The *line* or *internal* keyword specifies the type of clocking to use on this interface. Line (also known as “network” or “external”) timing is the default value. Using the *internal* keyword will enable the CSU/DSU’s internal clock and will instruct the CSU/DSU to place this clock source on the line. Configuring more than one clock source, or having no clock source, can cause a line to have synchronization problems resulting in framing errors and data loss. Check with your line provider before enabling internal clocking to ensure that this setting is needed. We have specified the default value in the default configuration from above.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module e1 clock source line
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring E1 time slots and channel speeds

To configure the number of time slots allocated to the Serial interface, include the time slots statement in the interface configuration. The syntax of this command is:

service-module e1 timeslots *{ range | all } [speed { 56 | 64 }]*

where the range is a value of 2 to 32 for structured E1. The **speed** keyword configures the byte encoding of the E1 line. By default, E1 lines use a byte encoding of 8 bits per byte (64 kbps channels). You can configure an alternative byte encoding of 7 bits per byte (56 kbps channels).

You can designate any combination of time slots for usage. Structured E1 circuits use the first time slot in the channel group for framing and signaling. Channels 2-32 are available for data. The router will not use time slot 1 for data in structured mode, even if you configure it to do so. The default time slot configuration is to use all data time slots.

To use time slots 1 through 11, designate time-slot-number as follows (remember that slot 1 will be used for signaling and slots 2-11 will be used for data):

service-module e1 timeslots 1-11

To use time slots 2 through 5, time slot 10, and time slot 24, designate the timeslot range as follows:

service-module e1 timeslots 2-5,10,24;

To use the first four odd-numbered time slots, designate the timeslot range as follows:

service-module e1 timeslots 3,5,7,9

Spaces are not allowed between timeslot numbers.

In the default configuration, we have inserted the default value:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module e1 clock source line
 service-module e1 timeslots all speed 64
 ip address 20.0.0.2 255.255.255.252
!
```

E1 interfaces can be operated in an unstructured mode where all 32 timeslots are available for use. To enable this option, add the **service-module e1 unstructured** command to your configuration. Not all cards support this option. Check the *Command Reference* to see if your E1 card supports unstructured operation.

Configuring E1 data inversion

By default, data inversion is disabled. To enable data inversion at the HDLC level, include the **service-module e1 data coding** *{ normal | inverted }* statement in the interface configuration. When you enable data inversion, all data bits in the data stream are transmitted as inverted; that is, zeroes are transmitted as ones and ones as zeroes. Data inversion is normally used only in AMI mode to guarantee ones density in the transmitted stream.

Configuring E1 line buildout

An E1 interface has 4 possible settings for E1 line buildout. The line buildout setting is used to set the signal attenuation factor due to the impedance of copper cabling. The line buildout setting is used on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the E1 interfaces use the shortest setting (none). The command syntax is:

service-module e1 lbo *value*

where the value is either *-22.5 db*, *-15 db*, *-7.5 db*, or *none*. If you are unsure of which setting to use, leave the builtout at the shortest setting. In the default example from above, we have omitted the **service-module e1 lbo** command since the connection to the demarc is less than 225 feet. Optionally, the command **service-module e1 lbo none** could be added, although it would have the same effect as omitting the command.

Configuring the E1 equalizer gain limiter

The E1 interface has an equalizer gain limiter. This setting is used to turn on the receiver gain limiter to overcome impedance of copper cabling. The gain limiter should be turned on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the E1 interfaces do not enable the gain limiter. To enable the equalizer gain limiter, add the command **service-module e1 egl** to the interface configuration. This command is normally used in conjunction with the line buildout command.

Configuring E1 framing

By default, E1 interfaces use an CCS (Common Channel Signaling) framing format. CCS carries framing information in timeslot 0, but does not tie signaling to a particular timeslot. To explicitly configure CCS framing, include the framing statement in the interface configuration for the serial device:

service-module e1 framing *ccs*

You can configure CAS (Channel Associated Framing) format as an alternative. In CAS framing, signaling information is contained in channel 16 and framing is carried in timeslot 0. To have the interface use the CAS framing format, include the framing statement in the interface configuration, specifying the *cas* option. In the default configuration from above, we have specified the default CCS framing:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module e1 clock source line
 service-module e1 timeslots all speed 64
 service-module e1 framing ccs
 ip address 20.0.0.2 255.255.255.252
!
```

Additionally, E1 interfaces can use a CRC4 check to improve data integrity. To turn on CRC4 checking, include the **service-module e1 crc4** framing statement in the interface configuration for the serial device. Not all cards support this option. Check the *Command Reference* to see if your E1 card supports CRC4 checking.

Configuring E1 line encoding

By default, E1 interfaces use HDB3 line encoding. To explicitly configure HDB3 line encoding, include the linecode statement in the interface configuration for the serial device:

service-module e1 linecode *hdb3*

You can configure AMI line encoding as an alternative. To have the interface use the AMI framing format, include the framing statement in the interface configuration, specifying the *ami* option. In the default configuration from above, we have specified the default hdb3 line encoding:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module e1 clock source line
 service-module e1 timeslots all speed 64
 service-module e1 framing ccs
 service-module e1 linecode hdb3
 ip address 20.0.0.2 255.255.255.252
!
```

Setting Integrated DS3/E3 CSU/DSU Parameters

The **service-module** command is used to configure the serial card's integrated DS3/E3 CSU/DSU. In most cases, the defaults provided on the integrated CSU/DSU will match the network configuration. Check with your line provider to determine if your line settings differ from the default CSU/DSU configuration. The configurations in the interface configuration must match the settings for your line or your serial interface will not function correctly.

Configuring the DS3/E3 line clocking source

Unlike asynchronous devices, a synchronous data interface must a clock source to use for network timing. One and only one clock source should be configured on a line. In most cases, your line provider will provide a clock source for the DS3/E3 line. The DS3/E3 CSU/DSU can also be configured to provide a clock source. The syntax of this command is:

service-module { ds3 | e3 } clock source *{ line | internal }*

The *line* or *internal* keyword specifies the type of clocking to use on this interface. Line (also known as "network" or "external") timing is the default value. Using the *internal* keyword will enable the CSU/DSU's internal clock and will instruct the CSU/DSU to place this clock source on the line. Configuring more than one clock source, or having no clock source, can cause a line to have synchronization problems resulting in framing errors and data loss. Check with your line provider before enabling internal clocking to ensure that this setting is needed. An example configuration showing "line" clocking follows:

```
!
interface Serial2
 description Connection to provider
 encapsulation ppp
 service-module ds3 clock source line
 ip address 20.0.1.2 255.255.255.252
!
```

Configuring DS3/E3 line buildout

The DS3/E3 interface has a setting for line buildout. The line buildout setting is used to set the signal attenuation factor due to the impedance of copper cabling. The line buildout setting is used on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the DS3/E3 interfaces use the shortest setting (none). To turn on line buildout, use the command:

service-module { ds3 | e3 } lbo

Configuring the DS3/E3 equalizer gain limiter

The DS3/E3 interface has an equalizer gain limiter. This setting is used to turn on the receiver gain limiter to overcome impedance of copper cabling. The gain limiter should be turned on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the DS3/E3 interfaces do not enable the gain limiter. To enable the equalizer gain limiter, add the command **service-module { ds3 | e3 } egl** to the interface configuration. This command is normally used in conjunction with the line buildout command.

Configuring Other Serial Interface Parameters

This section will use the example configuration from the T1 CSU/DSU configuration section above.

Adding secondary Serial addresses

Although rarely necessary, depending on your network configuration, you may need to configure more than one address on a Serial device. This task is accomplished by adding the **secondary** keyword to the **ip address** line used previously. The **secondary** keyword is used for all addresses on a Serial device other than the primary address. Only one primary address can be configured on a Serial device. Configuring more than one primary address or leaving the **secondary** keyword off of a secondary address configuration will cause the last primary IP address to be used when the port is configured by SAND.

Using the default configuration above, we have added two secondary IP addresses to Serial0. You will need to substitute your address and netmask for your network.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module t1 clock source line
 service-module t1 timeslots all speed 64
 service-module t1 framing esf
 service-module t1 linecode b8zs
 ip address 20.0.0.2 255.255.255.252
 ip address 20.0.1.1 255.255.255.0 secondary
!
```

Configuring additional Serial devices

If your router is equipped with multiple Serial devices, you can add additional interface configurations to the **wan.conf** file. Although the order of the devices in the file does not matter, ImageStream by convention keeps the interfaces in order.

Additional Serial devices are configured in the same manner as Serial0 in our example configuration. Add an additional **interface** command for each additional Serial port, separating each section with a **!** symbol. The syntax of the **interface** command is:

interface *DeviceName*

In the default example from above, we have added a second Serial port at Serial1 (note the use of the internal clocking command and alternate framing and encoding settings) and a third Serial port at Serial2.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 bandwidth 1536000
 encapsulation hdlc
 service-module t1 clock source line
 service-module t1 timeslots all speed 64
 service-module t1 framing esf
 service-module t1 linecode b8zs
 ip address 20.0.0.2 255.255.255.252
 ip address 20.0.1.1 255.255.255.0 secondary
!
interface Serial1
 description Connection to London office
 encapsulation ppp
 service-module t1 clocking internal
 service-module t1 framing sf
 service-module t1 linecode ami
 ip address 25.0.0.1 255.255.255.252
!
interface Serial2
#HSSI card
 description fractional DS3 to NYC
 bandwidth 10000000
 encapsulation hdlc
 ip address 30.0.0.1 255.255.255.252
!
```

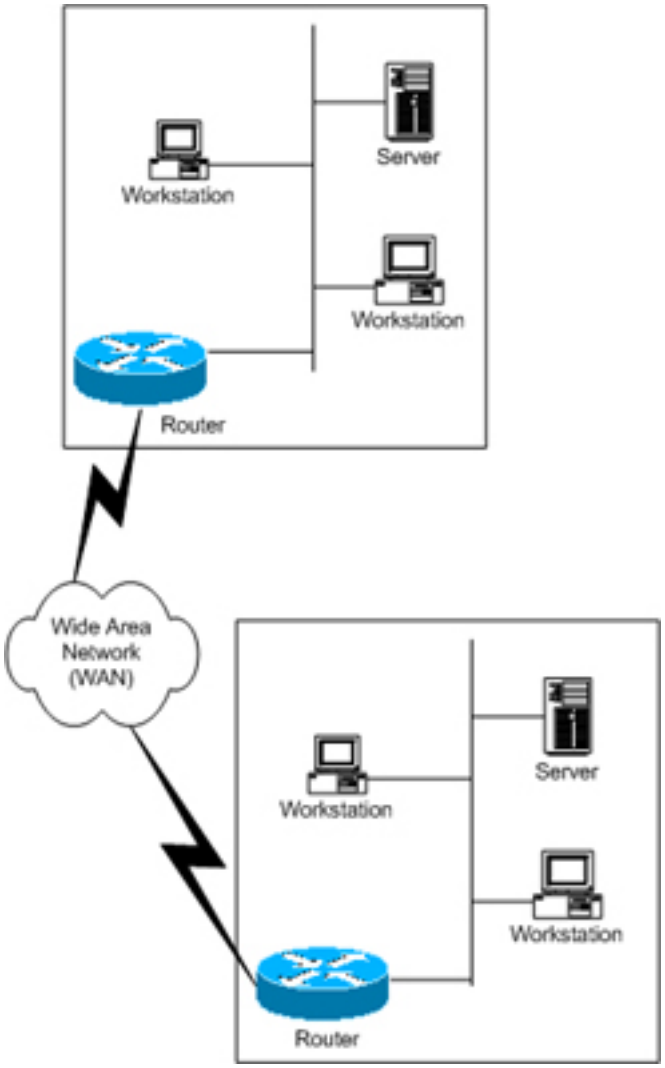
Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

VIII. Configuring an ATM Interface

This chapter describes how to configure the ImageStream router ATM WAN interfaces and includes the following topics:

- “WAN Port Uses”
- “Understanding the Network Interface Configuration File”
- “Configuring an ATM Master Interface”
- “Default ATM Interface Configuration”
- “Customizing the Configuration”
- “Setting ATM Master Interface Parameters”
- “Configuring an ATM Subinterface”

Before configuring the WAN interface, you must make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the Technical Notes section on the ImageStream Web site or the *Command Reference* for more detailed command descriptions, examples and instructions.



WAN Port Uses

WAN ports are used for high-speed dedicated connections between two local area networks (LANs). Once a connection is established between two sites, a wide area network (WAN) is achieved. WAN connections can be achieved through the use of dedicated leased lines such as T1, E1 or higher bandwidth lines, SONET/SDH connections, ATM connections, Frame Relay connections, or ISDN lines. Connection rates can range from 9600bps to 2.048Mbps (E1) to 2.488Gbps (OC-48). ImageStream routers support these connection types using one or more serial ports with or without integrated CSU/DSUs.

All WAN port connections are very similar and are represented in the diagram at left.

For most applications, a dedicated line connects two routers, each located on a separate remote network. The following examples describe various uses for synchronous ports.

Routing over Leased Lines. A serial port with or without integrated CSU/DSUs can be used to connect to synchronous leased lines from 9600bps to T1 (1.544Mbps) or E1 (2.048Mbps) to DS3 (44.736Mbps) or E3 (34.368Mbps) for continuous operation. Synchronous optical network (SONET) or Synchronous Digital Hierarchy (SDH) interfaces use optical instead of copper wiring and commonly operate at speeds from OC-3/STM-1 (155.52Mbps) to OC-48/STM-16 (2.488Gbps) and higher. A channel service unit/digital service unit (CSU/DSU) must be attached to the serial port, or integrated into the serial card. For more information about configuring cards without integrated CSU/DSUs, See the chapter "Configuring a Synchronous Serial WAN Interface."

Routing over ATM. ATM (asynchronous transfer mode) is a dedicated-connection switching technology that organizes digital data into 53-byte cell units (48 bytes of data, 5 bytes of overhead) and transmits them over a physical medium using digital signal technology. Individually, a cell is processed asynchronously relative to other related cells. Like frame relay, two advantages over a leased line network are lower cost and the ability to have multiple virtual circuits (VCs) come into a single physical port. It is especially popular for DSL service and hub-and-spoke network arrangements. However, unlike frame relay, ATM is designed for easy implementation in hardware (rather than software) and is designed for optical links at higher speeds.

Routing over Frame Relay. Frame Relay provides connectivity using a packet-switched network. Its two advantages over a leased line network are lower cost and the ability to have multiple permanent virtual circuits (PVCs) come into a single physical port. It is especially popular for hub-and-spoke network arrangements. For example, a dozen field offices with T1 or fractional T1 Frame Relay connections can connect to a central office using a single DS3, fractional DS3 or T1 Frame Relay connection. The central office requires only one CSU/DSU and serial port on the router, instead of twelve. For more information about configuring frame relay, See the chapter "Configuring a Frame Relay Interface."

Routing over ISDN. Integrated Services Digital Network (ISDN) provides fast dial-up connectivity for applications where the expense of a dedicated Frame Relay, ATM or leased line connection is not appropriate for the amount and nature of the traffic. For more information about ISDN Basic Rate Interface (BRI) connections, See the chapter "Configuring an ISDN BRI Interface."

Configuring an ATM Master Interface

Asynchronous Transfer Mode (ATM) is a network protocol designed to facilitate the simultaneous transfer of various types of traffic streams (voice, data, video) on public and private networks over the same physical connection. By always using 53-byte cells, ATM simplifies the design of hardware, enabling it to quickly determine the destination address of each cell. This allows simple switching of network traffic at much higher speeds than are easily accomplished using protocols with variable sizes of transfer units, such as Frame Relay and TCP/IP.

ATM relies on the concepts of virtual paths and virtual circuits. A virtual path, represented by a specific virtual path identifier (VPI), establishes a route between two devices in a network. Each VPI can contain multiple virtual circuits, each represented by a virtual circuit identifier (VCI).

On an ImagStream router, each VPI/VCI pair is defined on the physical ATM interface as a subinterface. A subinterface is a logical (virtual) interface and is a part of a physical interface, such as an ATM DS3. Each physical ATM interface can be logically divided into as many as 64,000 different logical subinterfaces, depending on the card used.

The ATM port on each end of the connection must be configured prior to use. If your WAN interface does not support ATM encapsulations, please See the chapter "Configuring a Synchronous Serial WAN Interface" or Chapter 7 "Configuring an Integrated CSU/DSU WAN Interface." Attempting to configuring non-ATM encapsulations on an ATM card will result in errors.

```
Configuration menu
------------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the "Configuration menu", select the "Network interface configuration" option by pressing **2** and **Enter**. This will open the ImageStream router's primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Understanding the Network Interface Configuration File

wan.conf is the primary configuration file used by ImageStream's open source Standard Architecture for Network Drivers (SAND). SAND handles configuration and management of all LAN and WAN devices on an ImageStream router. For more information about ImageStream's SAND technology, visit the ImageStream Web site at **http://www.imagestream.com/SAND.html**. See the *Command Reference* for more detailed command descriptions and instructions.

The default **wan.conf** file is:

```
!
version 2.00
!
interface Ethernet0
 ip address 10.10.199.199 255.0.0.0
!
interface Serial0
 shutdown
 description Port 0
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
# Set the default route via Serial0 using the device
#ip route add 0.0.0.0/0 dev Serial0
# Set the default route via Serial0 using an IP
#ip route add default via 192.168.10.2
!
end
```

The values in the default file are explained below.

version 2.00:

Denotes the version number of the configuration file and driver set. This value is set by ImageStream and should not be changed or modified.

interface Ethernet0:

Denotes the start of the configuration section for the first Ethernet device in your system. All commands that follow this line until the next **!** mark will be applied to Ethernet0.

ip address 10.10.199.199 255.0.0.0:

Specifies the IP address and netmask for Ethernet0.

!, end:

Signifies the end of a configuration section or the end of the wan.conf file. *You must include a "!" to delimit each section of the configuration file and an "end" statement at the end of the file*.

interface Serial0:

Denotes the start of the configuration section for the first Serial port in your system. All commands that follow this line until the next **!** mark will be applied to Serial0.

shutdown:

Instructs the router not to start this port when SAND is started or reloaded.

description Port 0:

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

encapsulation hdlc:

Specifies the Cisco HDLC protocol for this serial port.

ip address 192.168.10.1 255.255.255.252:

Specifies the IP address and netmask for Serial0.

 # Set the default route via Serial0 using the device:

A comment inserted in the configuration file. Lines that begin with **#** or **!** are ignored by SAND when starting or reloading configurations.

#ip route add 0.0.0.0/0 dev Serial0

A route statement setting the default route to the Serial0 device. Note that this command is commented out, so it will be ignored by SAND.

#ip route add default via 192.168.10.2

A route statement setting the default route to the IP address of 192.168.10.2. Note that this command is commented out, so it will be ignored by SAND. This command also uses the alternate default route designator of **default** instead of the numeric **0.0.0.0/0**. The designators are equivalent.

Default ATM WAN Card Configuration

The default values of cards equipped with an ATM interface are as follows:

- ATM WAN interfaces default to the following values:
    - C-bit framing (for DS3)
    - PLCP mode
    - DS3 transport
    - No line buildout
    - ATM cell scrambling configured
    - Equalizer gain limit (EGL) off
    - SONET interface mode (for OC-3, OC-12)
- All cards use external (also known as “line” or “network”) clocking.
- No port description is configured for any port.
- Classical IP over ATM encapsulation is enabled.
- Bridging is not configured.

Remember that default settings are not necessarily shown in the configuration file.

Customizing the Configuration

To customize the WAN port configurations, complete the following sections. The ordering of the commands is done by convention, but a specific order is not required. Likewise, all configurations are indented to make configurations easy to read, but indentation is not required. In general, ImageStream follows this ordering convention:

1. Comments
2. Port description
3. Bandwidth scaling statement
4. ATM interface settings
5. Other optional settings
6. IP address/netmask
7. Secondary IP addresses/netmasks
8. Subinterface configurations

Setting the port description

You can assign description to all WAN ports. Although this feature is optional, it may be particularly useful to assign names to facilitate administration. Setting a description does not change the operation or name of the port.

To assign a description to a port, enter this command in the **wan.conf** file in the Serial interface configuration section:

description *string*

Using the router's default configuration above, we have modified the description for Serial0:

```
!
interface Serial0
 shutdown
 description ATM connection to branch offices
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
```

Setting the IP address and netmask

The ATM master interface does not contain IP addressing information. All IP addresses are contained in the subinterfaces (logical interfaces) configured on the master interface. Using the default configuration above, we have deleted the **ip address** line.

```
!
interface Serial0
 shutdown
 description ATM connection to branch offices
 encapsulation hdlc
!
```

Setting serial transport encapsulation

The serial transport encapsulation must be set to an ATM encapsulation for an ATM interface. No other encapsulation types may be specified.The syntax of this command is:

encapsulation *atm*

In the default configuration above, we have changed the encapsulation to Classical IP over ATM. This encapsulation type corresponds to "encapsulation aal5" on a Cisco router. Alternately, you may specify an encapsulation type of *aal5snap* for SNAP-encapsulated ATM connections. See the ImageStream Technical Support Web site for additional ATM configuration examples.

```
!
interface Serial0
 shutdown
 description ATM connection to branch offices
```

```
 encapsulation atm
!
```

Setting ATM DS3/E3 circuit transport

ImageStream's ATM DS3/E3 card supports either DS3 or E3 transport. By default, the card uses DS3 transport. The transport type can be set using the **transport** command. The syntax of this command is:

transport *{ ds3 | e3 }*

In the default configuration above, we have set the default transport type of DS3.

```
!
interface Serial0
 shutdown
 description ATM connection to branch offices
 encapsulation atm
 transport ds3
!
```

Setting ATM OC-3/OC-12 circuit transport

ImageStream's ATM OC-3 and OC-12 cards support either SONET or SDH as the underlying network transport for the ATM traffic. By default, the cards use SONET mode. The mode can be set using the **service-module { oc-3 | oc-12 } mode** command and specifying a value of either *sonet* or *sdh*.

Enabling or disabling a Serial interface

To disable an interface, use the **shutdown** interface configuration command. Unlike other command line interfaces, the **wan.conf** file does not require a "no" version of a command to reverse the operation. Entering "no" followed by a command will be ignored by SAND.

By default, Serial0 is disabled in the default configuration above because the **shutdown** command has been entered. Disabling a master interface will also disable all subinterfaces configured on the master device.

```
!
interface Serial0
 shutdown
 description ATM connection to branch offices
 encapsulation atm
 transport ds3
!
```

To enable Serial0 in the configuration, remove the **shutdown** command. Do not use "no shutdown", as this will be ignored by SAND. It is not necessary to enter "no" and a command to negate the command. Simply remove the command from the configuration file.

Adding comments to a Serial configuration

Comments may be added to the Serial configuration, or anywhere in the **wan.conf** file by inserting a line that begins with the **#** symbol. The contents of the line will be ignored by SAND. Comments may be used to place contact information, ticket numbers, circuit IDs or any other information into the **wan.conf** file. There are no limits on the number or length of comments that may be inserted.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 encapsulation atm
 transport ds3
!
```

Scaling the connection speed calculation

For some media, such as Ethernet and Token Ring, the bandwidth is fixed; for other media, such as serial lines, you can change the actual bandwidth by adjusting the hardware. For both classes of media, you can use the **bandwidth** configuration command to communicate the current bandwidth to the router's statistical output program and other programs. The **bandwidth** command sets an informational parameter only to communicate the current bandwidth to other programs.

The **bandwidth** command does not adjust the actual bandwidth of an interface. ATM ports automatically calculate the bandwidth value based on the type of ATM device configured and the bandwidths of the subinterfaces. The syntax of the **bandwidth** command is:

bandwidth *bits per second*

In the default example from above, we have added a bandwidth equal to 10 Mbps line (less overhead) to the Serial0 interface. This value is calculated automatically, so this command is optional:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
```

```
!
```

Setting ATM DS3/E3 Master Interface Parameters

The **service-module** command is used to configure the master interface for the ATM card. In most cases, the defaults provided on the card will match the network configuration. Check with your line provider to determine if your line settings differ from the default configuration. The configurations in the interface configuration must match in three places: on the router, on the ATM switch, and at the remote end. If these settings do not match, your serial interface will not function correctly.

Configuring the DS3/E3 line clocking source

One and only one clock source should be configured on a line. In most cases, your line provider will provide a clock source for the ATM circuit. The ATM DS3/E3 card can also be configured to provide a clock source. The syntax of this command is:

service-module { ds3 | e3 } clock source *{ line* | *internal }*

The *line* or *internal* keyword specifies the type of clocking to use on this interface. Line (also known as "network" or "external") timing is the default value. Using the *internal* keyword will enable the card's internal clock and will instruct the card to place this clock source on the line. Configuring more than one clock source, or having no clock source, can cause a line to have synchronization problems resulting in framing errors and data loss. Check with your line provider before enabling internal clocking to ensure that this setting is needed. We have specified the default value in the default configuration from above.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module ds3 clock source line
!
```

Configuring DS3/E3 cell mode

By default, DS3 and E3 ATM interfaces add a special header for the Physical Layer Convergence Protocol (PLCP). This mode can be disabled allowing the interface to operate in direct cell mapping mode (DCM) and eliminating the PLCP header. To enable DCM, include the command:

service-module { ds3 | e3 } mode *dcm*

in the interface configuration. Cisco router configurations may refer to Direct Cell Mapping as ATM Direct Cell Mapping or ADM.

Configuring DS3 line buildout

The DS3 interface has a setting for line buildout. The line buildout setting is used to set the signal attenuation factor due to the impedance of copper cabling. The line buildout setting is used on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the DS3 interfaces use the shortest setting (none). To turn on line buildout, use the command:

service-module ds3 lbo

In E3 transport mode, the line buildout command is invalid.

Configuring the DS3/E3 equalizer gain limiter

The DS3/E3 interface has an equalizer gain limiter. This setting is used to turn on the receiver gain limiter to overcome impedance of copper cabling. The gain limiter should be turned on when the connection between the integrated CSU/DSU and the line provider demarcation point is greater than 225 feet. By default, the DS3/E3 interfaces do not enable the gain limiter. To enable the equalizer gain limiter, add the command **service-module { ds3 | e3 } egl** to the interface configuration. This command is normally used in conjunction with the line buildout command.

Configuring DS3 framing

By default, ATM DS3 interfaces use c-bit parity for framing. This command is not valid in E3 transport mode. To explicitly configure ESF framing, include the framing statement in the interface configuration for the serial device:

service-module ds3 framing *cbit*

You can configure the m23 format as an alternative. To have the interface use the m23 framing format, include the framing statement in the interface configuration, specifying the *m23* option. In the default configuration from above, we have specified the default c-bit framing:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module ds3 clock source line
 service-module ds3 framing cbit
!
```

Configuring DS3/E3 cell scrambling

By default, DS3/E3 ATM interfaces enable cell scrambling. Scrambling cells randomizes the ATM cell payload frames to avoid continuous non-variable bit patterns and improves the efficiency of ATM's cell delineation algorithms. Normally, the default setting for this command is sufficient.

To explicitly configure cell scrambling, include the scrambling statement in the interface configuration for the serial device:

service-module { ds3 | e3 } scrambling *on*

You can turn off scrambling as an alternative. To have the interface disable cell scrambling, include the scrambling statement in the interface configuration, specifying the *off* option. This setting must match the remote router or your ATM master interface will not function correctly. In the default configuration from above, we have specified the default cell scrambling:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module ds3 clock source line
 service-module ds3 framing cbit
 service-module ds3 scrambling on
!
```

Setting ATM OC-3/OC-12 Master Interface Parameters

The **service-module** command is used to configure the master interface for the ATM card. In most cases, the defaults provided on the card will match the network configuration. Check with your line provider to determine if your line settings differ from the default configuration. The configurations in the interface configuration must match in three places: on the router, on the ATM switch, and at the remote end. If these settings do not match, your serial interface will not function correctly.

Configuring the OC-3/OC-12 line clocking source

One and only one clock source should be configured on a line. In most cases, your line provider will provide a clock source for the ATM circuit. The ATM OC-3/OC-12 card can also be configured to provide a clock source. The syntax of this command is:

service-module { oc3 | oc12 } clock source *{ line | internal }*

The *line* or *internal* keyword specifies the type of clocking to use on this interface. Line (also known as “network” or “external”) timing is the default value. Using the *internal* keyword will enable the card’s internal clock and will instruct the card to place this clock source on the line. Configuring more than one clock source, or having no clock source, can cause a line to have synchronization problems resulting in framing errors and data loss. Check with your line provider before enabling internal clocking to ensure that this setting is needed. We have specified the default value in the default configuration from above.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module oc3 clock source line
!
```

Configuring OC-3/OC-12 cell scrambling

By default, OC-3/OC-12 ATM interfaces enable cell scrambling. Scrambling cells randomizes the ATM cell payload frames to avoid continuous non-variable bit patterns and improves the efficiency of ATM's cell delineation algorithms. Normally, the default setting for this command is sufficient.

To explicitly configure cell scrambling, include the scrambling statement in the interface configuration for the serial device:

service-module { oc3 | oc12 } scrambling *on*

You can turn off scrambling as an alternative. To have the interface disable cell scrambling, include the scrambling statement in the interface configuration, specifying the *off* option. This setting must match the remote router or your ATM master interface will not function correctly. In the default configuration from above, we have specified the default cell scrambling:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module oc3 clock source line
 service-module oc12 scrambling on
!
```

Configuring An ATM Subinterface

This section will use the example configuration from the ATM DS3 configuration section above.

ATM subinterfaces provide a mechanism for supporting partially meshed ATM networks. Most protocols assume transitivity on a logical network; that is, if station A can talk to station B, and station B can talk to station C, then station A should be able to talk to station C directly. Transitivity is true on LANs, but not on ATM networks unless A is directly connected to C.

Additionally, certain protocols, such as AppleTalk and transparent bridging, cannot be supported on partially meshed networks because they require "split horizon" in which a packet received on an interface cannot be transmitted out the same interface even if the packet is received and transmitted on different virtual circuits.

Configuring ATM subinterfaces ensures that a single physical interface is treated as multiple virtual interfaces. This capability allows us to overcome split horizon rules. Packets received on one virtual interface can now be forwarded out another virtual interface, even if they are configured on the same physical interface.

Subinterfaces provide a way to subdivide an ATM network into a number of smaller, fully meshed (or point-to-point) subnetworks. Each subnetwork is assigned its own network number (Virtual Circuit Identifier, or VCI) and appears to the protocols as if it is reachable through a separate interface. Note that point-to-point subinterfaces can be unnumbered for use with IP, reducing the addressing burden that might otherwise result.

Adding an ATM subinterface to a configuration

Each virtual interface (ATM Permanent Virtual Circuit, or PVC) is configured using a subinterface in the **wan.conf** file. Although the order of the devices in the file does not matter, ImageStream by convention keeps the interfaces in order.

ATM subinterfaces are configured in the same manner as Serial0 in our example configuration. Add an additional **interface** command for each ATM serial interface, separating each section with a **!** symbol. The syntax of the **interface** command is:

interface *DeviceName.subinterface#*

This command creates an ATM subinterface under the specified interface name. A subinterface is treated as a separate interface dedicated for an ATM PVC to a remote site. In the example below, "Serial0" indicates that the subinterface belongs to the physical Serial0 interface and "1" is the unique subinterface ID number. The subinterface ID number can be any unique value between zero and 64,000 and does not have to be in any particular order (i.e. it is not necessary to begin with 1 and sequentially progress with 2, 3, 4…etc.). To reduce confusion, ImageStream recommends sequential progression or identifying a subinterface with the same number as the VPI/VCI used on that subinterface.

In the default example from above, we have added a two ATM subinterfaces.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module ds3 clock source line
 service-module ds3 framing cbit
 service-module ds3 scrambling on
!
interface Serial0.1
 description Connection to NYC office
 encapsulation atm
!
interface Serial0.2
 description Connection to Dallas office
 encapsulation atm
!
```

Configuring the VPI and VCI for an ATM subinterface

The configuration above is not yet complete. Each subinterface must contain a unique identifier used to send traffic across the ATM network. ATM networks are connection oriented. Before information is transferred from the router to the network, a logical/virtual connection is set. When you are using ATM encapsulation on an interface, you must map each subinterface to a virtual circuit identifier (VCI) and a virtual path identifier (VPI) assigned by your ATM line provider.

To configure a VCI and a VPI on a point-to-point ATM subinterface, include the **pvc** statement in the subinterface configuration. The syntax of the **pvc** command is:

pvc *{ vpi }/{ vci }*

For each subinterface, you must configure the VCI and VPI identifiers. On many networks, your line provider will not specify a VPI. Use a value of *0* as this is the most common VPI value. Your line provider will assign a unique VCI to each PVC. In the default example from above, we have added **pvc** statements. These settings must match those used on the ATM network by your line provider or the ATM interface will not function correctly.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module ds3 clock source line
 service-module ds3 framing cbit
 service-module ds3 scrambling on
!
interface Serial0.1
 description Connection to NYC office
 encapsulation atm
 pvc 0/10
!
interface Serial0.2
 description Connection to Dallas office
 encapsulation atm
 pvc 1/22
!
```

Setting the IP address and netmask

During the subinterface setup process, you will set the IP address and netmask for the subinterface. To change the IP address and netmask of the Serial subinterface, modify the **ip address** command. The syntax of this command is:

ip address *ipaddress netmask*

Set the IP address to the address to be used by the ATM subinterface of the router on your network. If you have divided your network into subnets, enter the subnet mask that identifies how your network addresses are divided between the network portion and the host portion.

Using the default configuration above, we have set the Serial0.1 IP address to 25.0.0.1 with a netmask of 255.255.255.252. We have also set Serial0.2 to use an IP address of 30.0.0.1 and a /30 subnet mask. Often, with numbered point-to-point Serial links, the netmask will be a /30 (a subnet with 2 valid addresses). You will need to substitute your address and netmask for your network.

```
!
```

```
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description ATM connection to branch offices
 bandwidth 10000000
 encapsulation atm
 service-module ds3 clock source line
 service-module ds3 framing cbit
 service-module ds3 scrambling on
!
interface Serial0.1
 description Connection to NYC office
 encapsulation atm
 pvc 0/10
 ip address 25.0.0.1 255.255.255.252
!
interface Serial0.2
 description Connection to Dallas office
 encapsulation atm
 pvc 1/22
 ip address 30.0.0.1 255.255.255.252
!
```

Adding secondary Serial addresses

Although rarely necessary, depending on your network configuration, you may need to configure more than one address on a subinterface. This task is accomplished by adding the **secondary** keyword to the **ip address** line used previously. The **secondary** keyword is used for all addresses on a Serial device other than the primary address. Only one primary address can be configured on a Serial device. Configuring more than one primary address or leaving the **secondary** keyword off of a secondary address configuration will cause the last primary IP address to be used when the port is configured by SAND.

Using the default configuration above, we have added two secondary IP addresses to Serial0.1. Only a portion of the previous configuration is shown.

```
!
interface Serial0.1
 description Connection to NYC office
 encapsulation atm
 pvc 0/10
 ip address 25.0.0.1 255.255.255.252
 ip address 20.0.1.1 255.255.255.0 secondary
!
```

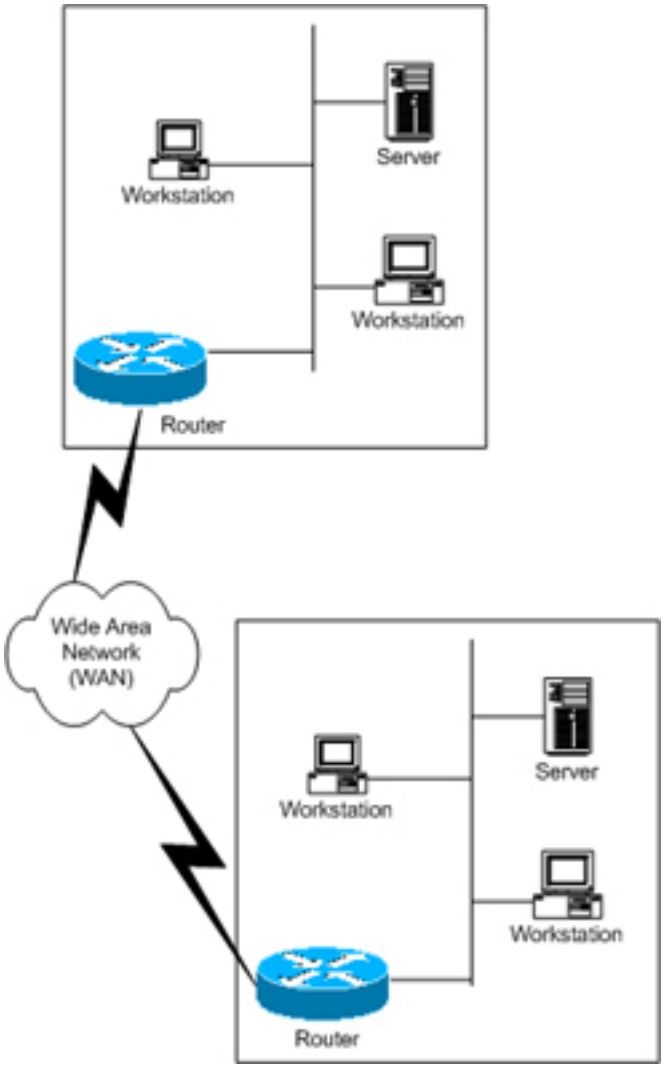
Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

IX. Configuring a Frame Relay Interface

This chapter describes how to configure the ImageStream router serial WAN interfaces for frame relay operation and includes the following topics:

- “Configuring a Frame Relay Master Interface”
- “Default Frame Relay Interface Configuration”
- “Customizing the Configuration”
- “Setting Frame Relay Master Interface Parameters”
- “Configuring a Frame Relay Subinterface”

Before configuring the WAN interface, you must make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.



WAN Port Uses

WAN ports are used for high-speed dedicated connections between two local area networks (LANs). Once a connection is established between two sites, a wide area network (WAN) is achieved. WAN connections can be achieved through the use of dedicated leased lines such as T1, E1 or higher bandwidth lines, SONET/SDH connections, ATM connections, Frame Relay connections, or ISDN lines. Connection rates can range from 9600bps to 2.048Mbps (E1) to 2.488Gbps (OC-48). ImageStream routers support these connection types using one or more serial ports with or without integrated CSU/DSUs.

All WAN port connections are very similar and are represented in the diagram at left.

For most applications, a dedicated line connects two routers, each located on a separate remote network. The following examples describe various uses for synchronous ports.

Routing over Leased Lines. A serial port with or without integrated CSU/DSUs can be used to connect to synchronous leased lines from 9600bps to T1 (1.544Mbps) or E1 (2.048Mbps) to DS3 (44.736Mbps) or E3 (34.368Mbps) for continuous operation. Synchronous optical network (SONET) or Synchronous Digital Hierarchy (SDH) interfaces use optical instead of copper wiring and commonly operate at speeds from OC-3/STM-1 (155.52Mbps) to OC-48/STM-16 (2.488Gbps) and higher. A channel service unit/digital service unit (CSU/DSU) must be attached to the serial port, or integrated into the serial card. For more information about configuring cards without integrated CSU/DSUs, See the chapter "Configuring a Synchronous Serial WAN Interface."

Routing over ATM. ATM (asynchronous transfer mode) is a dedicated-connection switching technology that organizes digital data into 53-byte cell units (48 bytes of data, 5 bytes of overhead) and transmits them over a physical medium using digital signal technology. Individually, a cell is processed asynchronously relative to other related cells. Like frame relay, two advantages over a leased line network are lower cost and the ability to have multiple virtual circuits (VCs) come into a single physical port. It is especially popular for DSL service and hub-and-spoke network arrangements. However, unlike frame relay, ATM is designed for easy implementation in hardware (rather than software) and is designed for optical links at higher speeds. For more information about configuring frame relay, See the chapter "Configuring an ATM Interface."

Routing over Frame Relay. Frame Relay provides connectivity using a packet-switched network. Its two advantages over a leased line network are lower cost and the ability to have multiple permanent virtual circuits (PVCs) come into a single physical port. It is especially popular for hub-and-spoke network arrangements. For example, a dozen field offices with T1 or fractional T1 Frame Relay connections can connect to a central office using a single DS3, fractional DS3 or T1 Frame Relay connection. The central office requires only one CSU/DSU and serial port on the router, instead of twelve.

Routing over ISDN. Integrated Services Digital Network (ISDN) provides fast dial-up connectivity for applications where the expense of a dedicated Frame Relay, ATM or leased line connection is not appropriate for the amount and nature of the traffic. For more information about ISDN Basic Rate Interface (BRI) connections, See the chapter "Configuring an ISDN BRI Interface."

Configuring a Frame Relay Master Interface

Frame Relay is a standard communication protocol that is specified in CCITT recommendations I.122 and Q.922 which add relay and routing functions to the data link layer (layer 2 of the OSI reference model). Frames are constructed by encapsulating layer 2 messages (excluding the CRC and flags), with a two byte header, a CRC, and a flag delimiter. The frame relay header consists of a data link connection identifier (DLCI) that allows the network to route each frame on a hop-by-hop basis along a virtual path defined either at call setup or subscription time. The start and end flags, and the CRC are identical to those used by HDLC or SDLC based interfaced packages.

On an ImagStream router, each DLCI is defined on the physical frame relay interface as a subinterface. A subinterface is a logical (virtual) interface and is a part of a physical interface, such as a DS3. Each physical frame relay interface can be logically divided into as many as 4,092 different logical subinterfaces.

The frame relay port on each end of the connection must be configured prior to use. If your WAN interface has a synchronous serial interface, please See the chapter "Configuring a Synchronous Serial WAN Interface" prior to reading this chapter. If your WAN interface has an integrated CSU/DSU, please see the chapter "Configuring an Integrated CSU/DSU WAN Interface" prior to reading this chapter.

This chapter will assume that the default configurations for your serial or integrated CSU/DSU WAN interface have already been configured. Only basic general commands will be covered in this chapter.

```
Configuration menu
------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the "Configuration menu", select the "Network interface configuration" option by pressing **2** and **Enter**. This will open the ImageStream router's primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Understanding the Network Interface Configuration File

wan.conf is the primary configuration file used by ImageStream's open source Standard Architecture for Network Drivers (SAND). SAND handles configuration and management of all LAN and WAN devices on an ImageStream router. For more information about ImageStream's SAND technology, visit the ImageStream Web site at **http://www.imagestream.com/SAND.html**. See the *Command Reference* for more detailed command descriptions and instructions.

The default **wan.conf** file is:

```
!
version 2.00
!
interface Ethernet0
 ip address 10.10.199.199 255.0.0.0
!
interface Serial0
 shutdown
 description Port 0
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
# Set the default route via Serial0 using the device
#ip route add 0.0.0.0/0 dev Serial0
# Set the default route via Serial0 using an IP
#ip route add default via 192.168.10.2
!
end
```

The values in the default file are explained below.

version 2.00:

Denotes the version number of the configuration file and driver set. This value is set by ImageStream and should not be changed or modified.

interface Ethernet0:

Denotes the start of the configuration section for the first Ethernet device in your system. All commands that follow this line until the next **!** mark will be applied to Ethernet0.

ip address 10.10.199.199 255.0.0.0:

Specifies the IP address and netmask for Ethernet0.

!, end:

Signifies the end of a configuration section or the end of the wan.conf file. *You must include a "!" to delimit each section of the configuration file and an "end" statement at the end of the file*.

interface Serial0:

Denotes the start of the configuration section for the first Serial port in your system. All commands that follow this line until the next **!** mark will be applied to Serial0.

shutdown:

Instructs the router not to start this port when SAND is started or reloaded.

description Port 0:

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

encapsulation hdlc:

Specifies the Cisco HDLC protocol for this serial port.

ip address 192.168.10.1 255.255.255.252:

Specifies the IP address and netmask for Serial0.

 # Set the default route via Serial0 using the device:

A comment inserted in the configuration file. Lines that begin with **#** or **!** are ignored by SAND when starting or reloading configurations.

#ip route add 0.0.0.0/0 dev Serial0

A route statement setting the default route to the Serial0 device. Note that this command is commented out, so it will be ignored by SAND.

#ip route add default via 192.168.10.2

A route statement setting the default route to the IP address of 192.168.10.2. Note that this command is commented out, so it will be ignored by SAND. This command also uses the alternate default route designator of **default** instead of the numeric **0.0.0.0/0**. The designators are equivalent.

Default Frame Relay Interface Configuration

The default values of cards that will be using frame relay encapsulation match the default card configurations of the synchronous serial or integrated CSU/DSU interface cards from Chapter 6 and Chapter 7.

Remember that default settings are not necessarily shown in the configuration file.

Customizing the Configuration

To customize the WAN port configurations, complete the following sections. The ordering of the commands is done by convention, but a specific order is not required. Likewise, all configurations are indented to make configurations easy to read, but indentation is not required. In general, ImageStream follows this ordering convention:

1. Comments
2. Port description
3. Bandwidth scaling statement
4. Other optional settings
5. IP address/netmask
6. Secondary IP addresses/netmasks
7. Subinterface configurations

Setting the port description

You can assign description to all WAN ports. Although this feature is optional, it may be particularly useful to assign names to facilitate administration. Setting a description does not change the operation or name of the port.

To assign a description to a port, enter this command in the **wan.conf** file in the Serial interface configuration section:

description *string*

Using the the example configuration below, we have modified the description for Serial0:

```
!
interface Serial0
 shutdown
 description Frame relay connection to New York
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
```

Setting the IP address and netmask

The frame relay master interface does not contain IP addressing information. All IP addresses are contained in the subinterfaces (logical interfaces) configured on the master interface. Using the default configuration above, we have deleted the **ip address** line.

```
!
interface Serial0
 shutdown
 description Frame relay connection to New York
 encapsulation hdlc
!
```

Setting serial transport encapsulation

The serial transport encapsulation must be set to frame relay for a frame relay interface. No other encapsulation type may be specified. The syntax of this command is:

encapsulation *frame-relay ietf*

In the default configuration above, we have changed the encapsulation to IETF frame relay. This encapsulation type corresponds to “encapsulation frame-relay ietf” on a Cisco router. Including the “ietf” keyword on a Cisco router when connecting to an ImageStream router is important, since Cisco routers default to a non-standard frame relay implementation.

```
!
interface Serial0
 shutdown
 description Frame relay connection to New York
 encapsulation frame-relay ietf
!
```

Enabling or disabling a Serial interface

To disable an interface, use the **shutdown** interface configuration command. Unlike other command line interfaces, the **wan.conf** file does not require a “no” version of a command to reverse the operation. Entering “no” followed by a command will be ignored by SAND.

By default, Serial0 is disabled in the default configuration above because the **shutdown** command has been entered. Disabling a master interface will also disable all subinterfaces configured on the master device.

```
!
interface Serial0
```

```
 shutdown
 description Frame relay connection to New York
 encapsulation frame-relay ietf
!
```

To enable Serial0 in the configuration, remove the **shutdown** command. Do not use "no shutdown", as this will be ignored by SAND. It is not necessary to enter "no" and a command to negate the command. Simply remove the command from the configuration file.

Adding comments to a Serial configuration

Comments may be added to the Serial configuration, or anywhere in the **wan.conf** file by inserting a line that begins with the **#** symbol. The contents of the line will be ignored by SAND. Comments may be used to place contact information, ticket numbers, circuit IDs or any other information into the **wan.conf** file. There are no limits on the number or length of comments that may be inserted.

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
 description Frame relay connection to New York
 encapsulation frame-relay ietf
!
```

Scaling the connection speed calculation

For some media, such as Ethernet and Token Ring, the bandwidth is fixed; for other media, such as serial lines, you can change the actual bandwidth by adjusting the hardware. For both classes of media, you can use the **bandwidth** configuration command to communicate the current bandwidth to the router's statistical output program and other programs. The **bandwidth** command sets an informational parameter only to communicate the current bandwidth to other programs.

The **bandwidth** command does not adjust the actual bandwidth of an interface. Ports with integrated CSU/DSUs automatically calculate the bandwidth value based on the number of timeslots configured. The syntax of the **bandwidth** command is:

bandwidth *bits per second*

In the example from above, we have added a bandwidth equal to a full T1 line (less overhead) to the Serial0 interface. This value is calculated automatically, so this command is optional:

```
!
interface Serial0
#NOC phone: 800-555-1212 – Our account #58935
```

```
 description Frame relay connection to New York
 encapsulation frame-relay ietf
 bandwidth 1536000
!
```

Setting Frame Relay Master Interface Parameters

The **frame-relay** command is used to configure the master interface parameters for an interface running frame relay encapsulation. In most cases, the defaults provided on the card will match the network configuration. Check with your line provider to determine if your line settings differ from the default configuration. The configurations in the interface configuration must match in two places: on the router and on the frame relay switch. If these settings do not match, your serial interface will not function correctly.

Configuring the local management interface (LMI)

Frame relay LMI is a frame relay control protocol sent to the router from the frame relay switch at the service provider and is not exchanged between routers. The LMI type at one location does NOT have to match the LMI type at other locations Your line provider will provide an LMI type to use. The syntax of this command is:

frame-relay lmi-type *{ ansi* | *cisco* | *ccitt* | *none }*

The *ansi*, *cisco*, *ccitt*, or *none* keyword specifies the type of LMI to use on this interface. ANSI (also known as “Annex D” or, regrettably, “LMI”) is the default and most common value. Using the *none* keyword will disable the use of LMI. Disabling LMI will turn off the status messages between the switch and the router, tying the frame relay protocol status to the physical hardware status. We have specified the default value in the configuration from above.

```
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial0
 description Frame relay connection to New York
 encapsulation frame-relay ietf
 bandwidth 1536000
 frame-relay lmi-type ansi
!
```

Configuring the LMI interval

When LMI is enabled, the router will begin to send status enquiries to the frame relay switch. The switch will respond with a status message. By default, these LMI messages are sent every 10 seconds. Check with your frame relay provider before changing this value. Setting a value that does not match the switch may cause outages on your frame relay line. To explicitly configure the LMI interval, include the LMI interval statement in the interface configuration for the serial device:

frame-relay interval *seconds*

In the default configuration from above, we have specified the default c-bit framing:

```
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial0
 description Frame relay connection to New York
 encapsulation frame-relay ietf
 bandwidth 1536000
 frame-relay lmi-type ansi
 frame-relay interval 10
!
```

Configuring A Frame Relay Subinterface

Frame Relay subinterfaces provide a mechanism for supporting partially meshed Frame Relay networks. Most protocols assume transitivity on a logical network; that is, if station A can talk to station B, and station B can talk to station C, then station A should be able to talk to station C directly. Transitivity is true on LANs, but not on Frame Relay networks unless A is directly connected to C.

Additionally, certain protocols, such as AppleTalk and transparent bridging, cannot be supported on partially meshed networks because they require "split horizon" in which a packet received on an interface cannot be transmitted out the same interface even if the packet is received and transmitted on different virtual circuits.

Configuring Frame Relay subinterfaces ensures that a single physical interface is treated as multiple virtual interfaces. This capability allows us to overcome split horizon rules. Packets received on one virtual interface can now be forwarded out another virtual interface, even if they are configured on the same physical interface.

Subinterfaces address the limitations of Frame Relay networks by providing a way to subdivide a partially meshed Frame Relay network into a number of smaller, fully meshed (or point-to-point) subnetworks. Each subnetwork is assigned its own network number and appears to the protocols as if it is reachable through a separate interface. (Note that point-to-point subinterfaces can be unnumbered for use with IP, reducing the addressing burden that might otherwise result).

Adding a frame relay subinterface to a configuration

Each virtual interface (frame relay Permanent Virtual Circuit, or PVC) is configured using a subinterface in the **wan.conf** file. Although the order of the devices in the file does not matter, ImageStream by convention keeps the interfaces in order.

Frame relay subinterfaces are configured in the same manner as Serial0 in our example configuration. Add an additional **interface** command for each frame relay serial interface, separating each section with a **!** symbol. The syntax of the **interface** command is:

interface *DeviceName.subinterface#*

This command creates a frame relay subinterface under the specified interface name. A subinterface is treated as a separate interface dedicated for a frame relay PVC to a remote site. In the example below, "Serial0" indicates that the subinterface belongs to the physical Serial0 interface and "1" is the unique subinterface ID number. The subinterface ID number can be any unique value between zero and 4,096 and does not have to be in any particular order (i.e. it is not necessary to begin with 1 and sequentially progress with 2, 3, 4…etc.). To reduce confusion, ImageStream recommends sequential progression or identifying a subinterface with the same number as the DLCI used on that subinterface.

In the default example from above, we have added a two frame relay subinterfaces. Note that we have set the encapsulation on the subinterfaces to match the master interface.

```
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial0
 description Frame relay connection to New York
 encapsulation frame-relay ietf
 bandwidth 1536000
 frame-relay lmi-type ansi
 frame-relay interval 10
!
interface Serial0.1
 description Connection to NYC office
 encapsulation frame-relay ietf
!
interface Serial0.2
 description Connection to Dallas office
 encapsulation frame-relay ietf
!
```

Configuring the DLCI for a frame relay subinterface

The configuration above is not yet complete. Each subinterface must contain a unique identifier used to send traffic across the frame relay network. Frame relay networks are connection oriented. This command assigns a Data Link Connection Identifier (DLCI) number to the corresponding frame-relay subinterface. A DLCI is assigned by the local frame relay provider for every Permanent Virtual Circuit (PVC) connected to the router. DLCI numbers are NOT exchanged between routers. DLCI numbering at one frame relay site is mutually exclusive from DLCI numbering at another site. When you are using frame relay encapsulation on an interface, you must map each subinterface to a DLCI assigned by your frame relay line provider.

To configure a DLCI on a point-to-point frame relay subinterface, include the **frame-relay interface-dlci** statement in the subinterface configuration. The syntax of the **frame-relay interface-dlci** command is:

frame-relay interface-dlci *{ dlci }*

For each subinterface, you must configure the DLCI identifier. Your line provider will assign a unique DLCI to each PVC. In the default example from above, we have added **frame-relay interface-dlci** statements. These settings must match those used on the frame relay network by your line provider or the frame relay interface will not function correctly.

```
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial0
 description Frame relay connection to New York
 encapsulation frame-relay ietf
 bandwidth 1536000
 frame-relay lmi-type ansi
 frame-relay interval 10
!
interface Serial0.1
 description Connection to NYC office
 encapsulation frame-relay ietf
 frame-relay interface-dlci 16
!
interface Serial0.2
 description Connection to Dallas office
 encapsulation frame-relay ietf
 frame-relay interface-dlci 17
!
```

Setting the IP address and netmask

During the subinterface setup process, you will set the IP address and netmask for the subinterface. To change the IP address and netmask of the Serial subinterface, modify the **ip address** command. The syntax of this command is:

ip address *ipaddress netmask*

Set the IP address to the address to be used by the frame relay subinterface of the router on your network. If you have divided your network into subnets, enter the subnet mask that identifies how your network addresses are divided between the network portion and the host portion.

Using the default configuration above, we have set the Serial0.1 IP address to 25.0.0.1 with a netmask of 255.255.255.252. We have also set Serial0.2 to use an IP address of 30.0.0.1 and a /30 subnet mask. Often, with numbered point-to-point Serial links, the netmask will be a /30 (a subnet with 2 valid addresses). You will need to substitute your address and netmask for your network.

```
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial0
 description Frame relay connection to New York
 encapsulation frame-relay ietf
 bandwidth 1536000
 frame-relay lmi-type ansi
 frame-relay interval 10
!
interface Serial0.1
 description Connection to NYC office
 encapsulation frame-relay ietf
 frame-relay interface-dlci 16
 ip address 25.0.0.1 255.255.255.252
!
interface Serial0.2
 description Connection to Dallas office
 encapsulation frame-relay ietf
 frame-relay interface-dlci 17
 ip address 30.0.0.1 255.255.255.252
!
```

Adding secondary Serial addresses

Although rarely necessary, depending on your network configuration, you may need to configure more than one address on a subinterface. This task is accomplished by adding the **secondary** keyword to the **ip address** line used previously. The **secondary** keyword is used for all addresses on a Serial device other than the primary address. Only one primary address can be configured on a Serial device. Configuring more than one primary address or leaving the **secondary** keyword off of a secondary address configuration will cause the last primary IP address to be used when the port is configured by SAND.

Using the default configuration above, we have added two secondary IP addresses to Serial0.1. Only a portion of the previous configuration is shown.

```
!
interface Serial0.1
 description Connection to NYC office
 encapsulation frame-relay ietf
 frame-relay interface-dlci 16
 ip address 25.0.0.1 255.255.255.252
 ip address 20.0.1.1 255.255.255.0 secondary
!
```

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

X. Configuring an ISDN BRI Interface

This chapter describes how to configure the ImageStream router serial WAN interfaces without integrated CSU/DSUs and includes the following topics:

- “WAN Port Uses”
- “Understanding the Network Interface Configuration File”
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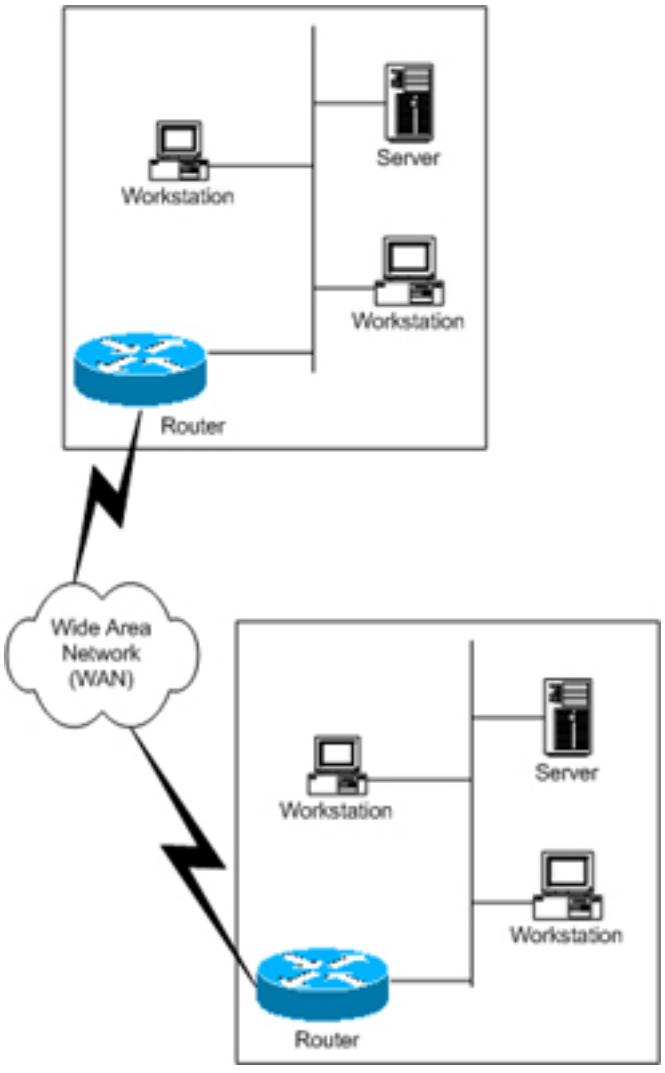
Before configuring the WAN interface, you must make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.



WAN Port Uses

WAN ports are used for high-speed dedicated connections between two local area networks (LANs). Once a connection is established between two sites, a wide area network (WAN) is achieved. WAN connections can be achieved through the use of dedicated leased lines such as T1, E1 or higher bandwidth lines, SONET/SDH connections, ATM connections, Frame Relay connections, or ISDN lines. Connection rates can range from 9600bps to 2.048Mbps (E1) to 2.488Gbps (OC-48). ImageStream routers support these connection types using one or more serial ports with or without integrated CSU/DSUs.

All WAN port connections are very similar and are represented in the diagram at left.

For most applications, a dedicated line connects two routers, each located on a separate remote network. The following examples describe various uses for synchronous ports.

Routing over Leased Lines. A serial port with or without integrated CSU/DSUs can be used to connect to synchronous leased lines from 9600bps to T1 (1.544Mbps) or E1 (2.048Mbps) to DS3 (44.736Mbps) or E3 (34.368Mbps) for continuous operation. Synchronous optical network (SONET) or Synchronous Digital Hierarchy (SDH) interfaces use optical instead of copper wiring and commonly operate at speeds from OC-3/STM-1 (155.52Mbps) to OC-48/STM-16 (2.488Gbps) and higher. A channel service unit/digital service unit (CSU/DSU) must be attached to the serial port, or integrated into the serial card. For more information about configuring cards with integrated CSU/DSUs, See the chapter "Configuring an Integrated CSU/DSU WAN Interface."

Routing over ATM. ATM (asynchronous transfer mode) is a dedicated-connection switching technology that organizes digital data into 53-byte cell units (48 bytes of data, 5 bytes of overhead) and transmits them over a physical medium using digital signal technology. Individually, a cell is processed asynchronously relative to other related cells. Like frame relay, two advantages over a leased line network are lower cost and the ability to have multiple virtual circuits (VCs) come into a single physical port. It is especially popular for DSL service and hub-and-spoke network arrangements. However, unlike frame relay, ATM is designed for easy implementation in hardware (rather than software) and is designed for optical links at higher speeds. For more information about configuring ATM, See the chapter "Configuring an ATM Interface."

Routing over Frame Relay. Frame Relay provides connectivity using a packet-switched network. Its two advantages over a leased line network are lower cost and the ability to have multiple permanent virtual circuits (PVCs) come into a single physical port. It is especially popular for hub-and-spoke network arrangements. For example, a dozen field offices with T1 or fractional T1 Frame Relay connections can connect to a central office using a single DS3, fractional DS3 or T1 Frame Relay connection. The central office requires only one CSU/DSU and serial port on the router, instead of twelve. For more information about configuring frame relay, See the chapter "Configuring a Frame Relay Interface."

Routing over ISDN. Integrated Services Digital Network (ISDN) provides fast dial-up connectivity for applications where the expense of a dedicated Frame Relay, ATM or leased line connection is not appropriate for the amount and nature of the traffic.

Configuring an ISDN BRI Interface

ISDN is most commonly used to provide low-cost connectivity between sites that cannot justify the cost of a dedicated high-speed leased line. However, ISDN connections provide more bandwidth than asynchronous dial-up connections can, as well as quicker call completion—approximately 1 second instead of 45 seconds.

ImageStream routers support manual dial-on-demand and automatic ISDN connections using a BRI interface card and the PPP protocol. BRI supports two 64Kbps B channels for data and one 16Kbps D channel for signaling. ISDN ports are available as either a U or S/T interface. The ISDN BRI U interface card has the NT1 device integrated in the port, meaning that no modem, CSU/DSU, or external terminal adapter is required. For the ISDN S/T interface, the BRI interface requires an external terminal adapter to connect from the S/T port to the ISDN line.

Once you have determined the type of synchronous connection to use between your remote locations, the synchronous port on each end of the connection must be configured. If your WAN interface is not an ISDN BRI interface, please see the appropriate chapter in this manual.

```
Configuration menu
------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the “Configuration menu”, select the “Network interface configuration” option by pressing **2** and **Enter**. This will open the ImageStream router’s primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Understanding the Network Interface Configuration File

wan.conf is the primary configuration file used by ImageStream’s open source Standard Architecture for Network Drivers (SAND). SAND handles configuration and management of all LAN and WAN devices on an ImageStream router. For more information about ImageStream’s SAND technology, visit the ImageStream Web site at **http://www.imagestream.com/SAND.html**. See the *Command Reference* for more detailed command descriptions and instructions.

The default **wan.conf** file is:

```
!
version 2.00
!
interface Ethernet0
 ip address 10.10.199.199 255.0.0.0
!
interface Serial0
 shutdown
 description Port 0
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
# Set the default route via Serial0 using the device
#ip route add 0.0.0.0/0 dev Serial0
# Set the default route via Serial0 using an IP
#ip route add default via 192.168.10.2
!
end
```

The values in the default file are explained below.

version 2.00:

Denotes the version number of the configuration file and driver set. This value is set by ImageStream and should not be changed or modified.

interface Ethernet0:

Denotes the start of the configuration section for the first Ethernet device in your system. All commands that follow this line until the next **!** mark will be applied to Ethernet0.

ip address 10.10.199.199 255.0.0.0:

Specifies the IP address and netmask for Ethernet0.

!, end:

Signifies the end of a configuration section or the end of the wan.conf file. *You must include a "!" to delimit each section of the configuration file and an "end" statement at the end of the file*.

interface Serial0:

Denotes the start of the configuration section for the first Serial port in your system. All commands that follow this line until the next **!** mark will be applied to Serial0.

shutdown:

Instructs the router not to start this port when SAND is started or reloaded.

description Port 0:

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

encapsulation hdlc:

Specifies the Cisco HDLC protocol for this serial port.

ip address 192.168.10.1 255.255.255.252:

Specifies the IP address and netmask for Serial0.

 # Set the default route via Serial0 using the device:

A comment inserted in the configuration file. Lines that begin with **#** or **!** are ignored by SAND when starting or reloading configurations.

#ip route add 0.0.0.0/0 dev Serial0

A route statement setting the default route to the Serial0 device. Note that this command is commented out, so it will be ignored by SAND.

#ip route add default via 192.168.10.2

A route statement setting the default route to the IP address of 192.168.10.2. Note that this command is commented out, so it will be ignored by SAND. This command also uses the alternate default route designator of **default** instead of the numeric **0.0.0.0/0**. The designators are equivalent.

Default ISDN BRI Interface Configuration

The default values of cards equipped with a basic rate ISDN (BRI) interface are as follows:

- U.S. NI-1 switch type is enabled.
- No port description is configured for any port.
- PPP encapsulation is enabled.
- Bridging is not configured.

Remember that default settings are not necessarily shown in the configuration file.

Customizing the Configuration

To customize the WAN port configurations, complete the following sections. The ordering of the commands is done by convention, but a specific order is not required. Likewise, all configurations are indented to make configurations easy to read, but indentation is not required. In general, ImageStream follows this ordering convention:

1. Comments
2. Port description
3. BRI ISDN configuration settings
4. PPP encapsulation settings
5. Other optional settings
6. IP address/netmask
7. Secondary IP addresses/netmasks

Setting the device name

The default configuration uses "Serial0" as the device name. In this chapter, we will discuss the configuration of ISDN BRI interfaces. The interface name used for BRI interfaces is "bri". To assign the proper device name to a port, enter this command in the **wan.conf** file in the Serial interface configuration section:

interface *briXX*

"XX" above denotes the number of the BRI interface. The first ISDN BRI port will be *bri0*, then *bri1* and so forth. Using the router's default configuration above, we have modified the interface name to reflect the use of ISDN BRI interface:

```
!
interface bri0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
```

Setting the port description

You can assign description to all WAN ports. Although this feature is optional, it may be particularly useful to assign names to facilitate administration. Setting a description does not change the operation or name of the port.

To assign a description to a port, enter this command in the **wan.conf** file in the Serial interface configuration section:

description *string*

Using the router's default configuration above, we have modified the description for Serial0:

```
!
interface bri0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 192.168.10.1 255.255.255.252
!
```

Setting the IP address and netmask

During the initial installation process, you will set the IP address and netmask for the Serial interface. To change the IP address and netmask of the Serial interface from the default, modify the **ip address** command. The syntax of this command is:

ip address *ipaddress netmask*

Set the IP address to the address to be used by the serial interface of the router on your network. If you have divided your network into subnets, enter the subnet mask that identifies how your network addresses are divided between the network portion and the host portion.

Using the default configuration above, we have set the Serial0 IP address to 20.0.0.2 with a netmask of 255.255.255.252. Often, with numbered point-to-point Serial links, the netmask will be a /30 (a subnet with 2 valid addresses). You will need to substitute your address and netmask for your network.

```
!
interface bri0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

Setting serial transport encapsulation

The serial transport encapsulation must be set to PPP for an ISDN BRI port. The syntax of this command is:

encapsulation *ppp*

In the default configuration below, we specified PPP encapsulation. This encapsulation type is the only valid type for ISDN BRI interfaces.

```
!
interface bri0
 shutdown
 description Connection to provider
 encapsulation ppp
 ip address 20.0.0.2 255.255.255.252
!
```

Enabling or disabling a Serial interface

To disable an interface, use the **shutdown** interface configuration command. Unlike other command line interfaces, the **wan.conf** file does not require a "no" version of a command to reverse the operation. Entering "no" followed by a command will be ignored by SAND.

By default, bri0 is disabled in the default configuration above because the **shutdown** command has been entered.

```
!
interface Serial0
 shutdown
 description Connection to provider
 encapsulation hdlc
 ip address 20.0.0.2 255.255.255.252
!
```

To enable bri0 in the configuration, remove the **shutdown** command. Do not use "no shutdown", as this will be ignored by SAND. It is not necessary to enter "no" and a command to negate the command. Simply remove the command from the configuration file.

Adding comments to a Serial configuration

Comments may be added to the Serial configuration, or anywhere in the **wan.conf** file by inserting a line that begins with the **#** symbol. The contents of the line will be ignored by SAND. Comments may be used to place contact information, ticket numbers, circuit IDs or any other information into the **wan.conf** file. There are no limits on the number or length of comments that may be inserted.

```
!
interface bri0
```

```
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 ip address 20.0.0.2 255.255.255.252
!
```

Scaling the connection speed calculation

For some media, such as Ethernet and Token Ring, the bandwidth is fixed; for other media, such as serial lines, you can change the actual bandwidth by adjusting the hardware. ISDN BRI interfaces automatically calculate the bandwidth setting based on the number and speed of ISDN B channels connected on the interface. The bandwidth statement is not used.

Configuring ISDN BRI Switch Settings

Configuring the ISDN switch type

ImageStream ISDN BRI interface cards are capable of interoperating with many different ISDN switches. The default setting is for the North American National ISDN, or NI-1, switch, but the BRI card can also support German 1tr6 and European EDSS-1/NET3 (Euro-ISDN) switches. For use in most other environments, a *none* option that does not set any specific ISDN switch variables is supported.

The **isdn switch-type** command is used to set the ISDN BRI card to use a particular ISDN switch configuration. The syntax of the **isdn switch-type** command is:

isdn switch-type *type*

where the type is either *1tr6* (or *basic-1tr6*, which is equivalent), *edss1* (or *basic-net3*, which is equivalent), *ni1* (or *basic-ni*, which is equivalent) or *none*. In the default example from above, we have set the **isdn switch-type** command to use Euro-ISDN.

```
!
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type edss1
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring the ISDN telephone numbers – North America

The service profile identifier (SPID) is a unique number assigned by the telephone company that identifies your ISDN equipment to the telephone company's switch. SPIDs are used only in the United States. A SPID can have up to 20 digits. Each B channel on an ISDN BRI interface will have a SPID, for a maximum of 2 per ISDN circuit. To configure SPIDs, use the **isdn spid1** and **isdn spid2** commands:

isdn spid1 *number*
isdn spid2 *number*

These numbers will be assigned by the telephone company. Enter the commands into the bri configuration, for example:

```
!
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type basic-ni
 isdn spid1 5551212
 isdn spid2 5551213
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring the ISDN telephone numbers – Europe/Germany

Euro-ISDN subscribers can assign more than one ISDN number to an ISDN line. For example, an ISDN line could have the numbers 1234567 and 1234568. Each of these numbers could be used to dial into the ISDN line. These numbers are referred to as Multiple Subscriber Numbers (MSN). German ISDN networking uses a similar concept called EAZ numbering.

For dial-out ISDN interfaces, the MSN/EAZ number specifies the outgoing phone number. For dial-in ISDN interfaces, the MSN/EAZ number specifies the phone number that will be answered. If you are unsure of your MSN/EAZ number, or do not know if you should use one, do not enter these commands. To configure an MSN or EAZ, use the **isdn msn** or equivalent **isdn eaz** command:

isdn msn *number*
isdn eaz *number*

This number will be assigned by the telephone company. Both commands function in the same manner. Enter the command into the bri configuration, for example:

```
!
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
```

```
 encapsulation ppp
 isdn switch-type edss1
 isdn msn 5551212
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring ISDN BRI Interface Characteristics

Configuring incoming call acceptance

By default BRI interface accept and answer all incoming calls. You can specify that the router verify the incoming phone number, if the number is delivered by the ISDN switch. To limit inbound calls to specific phone numbers, use the **isdn callin** command:

isdn callin [*phone1*, *phone2* …]

Enabling this command will limit accepted inbound calls to those numbers specified in the command only. Calls from other or unidentified numbers will be rejected when this command is enabled. In the configuration above, an **isdn callin** command has been added:

```
!
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type edss1
 isdn msn 5551212
 isdn callin 12345678
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring the PPP username and password for incoming calls

A username and password is used by the local router to authenticate the PPP peer. When the peer sends its username and password, the local router will check whether that username and password are configured locally. If there is a successful match, the peer is authenticated. To set the username and password, use the **username** command:

username *username* **password** *password*

In the configuration above, the **username** command has been added:

```
!
```

```
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type edss1
 isdn msn 5551212
 isdn callin 12345678
 username imagestream password isis
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring the PPP authentication method

PPP currently supports two authentication protocols: Password Authentication Protocol (PAP) and Challenge Handshake Authentication Protocol (CHAP). Both are specified in RFC 1334 and are supported on synchronous and asynchronous interfaces.

PAP is not a secure authentication protocol. Passwords are sent across the link in clear text and there is no protection from playback or trail-and-error attacks. The remote node is in control of the frequency and timing of the login attempts. CHAP is considered to be more secure because the user password is never sent across the connection. CHAP authentication will be used in the configuration examples in this chapter. See the *Command Reference* for PAP authentication commands.

The authentication method is set using the **ppp authentication** command:

ppp authentication [*pap* | *chap*]

Configuring the PPP username and password for remote authentication

A username and password can be used by the remote router to authenticate the local PPP peer. When the local peer sends its username and password, the remote router will check whether that username and password are configured locally. If there is a successful match, the peer is authenticated. This command is used when remote authentication is required upon dialin or with outgoing calls. To set the remote username and password for CHAP, use the **ppp chap hostname** command:

ppp chap hostname *username* **password** *password*

In the configuration above, the **ppp chap hostname** command has been added:

```
!
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type edss1
```

```
 isdn msn 5551212
 isdn callin 12345678
 username imagestream password isis
 ppp authentication chap
 ppp chap hostname remote password isis1234
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring Multilink PPP (MLPPP)

Defined by RFC 1990, Multilink PPP (MLPPP) allows devices to send data over multiple point-to-point data links to the same destination by implementing a virtual link. The MLPPP connection has a maximum bandwidth equal to the sum of the bandwidths of the component links. For ISDN BRI connections, MLPPP is used to bond both B channels together into a single 112 Kbps or 128 Kbps connection.

For MLPPP operation, enter the command **ppp multilink**.

Configuring ISDN BRI for Dial-On-Demand and Dial-Backup

A backup interface is an interface that stays idle until certain circumstances occur; then it is activated. A backup interface for a serial interface can be an ISDN interface or a different serial interface. A backup interface can be configured to be activated when any of the following three circumstances occurs:

1. The primary line goes down.
2. The load on the primary ISDN B channel reaches a certain threshold.
3. Traffic is sent to a particular IP address or the next hop address.

Configuring dial-on-demand for a second B channel

You can configure dial-on-demand to activate the secondary B channel based on the traffic load on the primary B channel. The router monitors the traffic load and computes a 5-minute moving average based on a value out of 255. If this average exceeds the value you set for the line, the secondary B channel is activated and, depending upon how the line is configured, some or all of the traffic will flow onto the secondary dialup line.
Use the **isdn load-threshold** command to set the load average that triggers the second B channel. The value is a number from 0 to 255, with 255 being the heaviest load:

isdn load-threshold *value*

In the example configuration from above, we have set the threshold to 100 out of 255, which is about 3137 bps (100/255 is .392 * 8000 Bps for a 64 Kbps B channel = 3137).

```
!
```

```
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type edss1
 isdn msn 5551212
 isdn callin 12345678
 username imagestream password isis
 ppp authentication chap
 ppp chap hostname remote password isis1234
 isdn load-threshold 100
 ip address 20.0.0.2 255.255.255.252
!
```

Enabling dial-backup for ISDN BRI

You can configure dial-on-demand to activate the ISDN BRI interface when traffic is sent to the interface. To specify that dial-on-demand routing is to be supported, use the **dialer in-band** command in interface configuration mode. Adding this command to the configuration will instruct the router to bring up this link when traffic is sent to the device. If **dialer in-band** is not specified, the router will assume that the BRI port is a dedicated line and will dial-out automatically and remain connected.

In the configuration above, we have removed the **isdn load-threshold** command and added **dialer in-band** for use with dial-on-demand routing.

```
!
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type edss1
 isdn msn 5551212
 isdn callin 12345678
 username imagestream password isis
 ppp authentication chap
 ppp chap hostname remote password isis1234
 dialer in-band
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring dial-backup parameters

To configure a serial interface or ISDN interface to call one or multiple sites or to receive calls from multiple sites, use a form of the **dialer map ip** command. This command instructs the dialer to authenticate or place a call when traffic is received for the specified IP address.

If the router will be connecting to a remote site, you can specify a dial string and an optional speed parameter using the **dialer map ip** command. This option informs the ISDN software whether it should place a call at 56 or 64 kbps. If you omit the ISDN speed parameter, the default is 64 kbps. The syntax of the **dialer map ip** command is:

dialer map ip *next-hop-address* [**broadcast**] [**name** *hostname*] [**speed 56** | **speed 64**] [dial-string]

In the example above, we have instructed the dialer to dial the remote system "core" using B channel speeds of 64 Kbps when traffic is received for the default gateway (0.0.0.0).

```
!
interface bri0
#NOC phone: 800-555-1212 – Our account #58935
 description Connection to provider
 encapsulation ppp
 isdn switch-type edss1
 isdn msn 5551212
 isdn callin 12345678
 username imagestream password isis
 ppp authentication chap
 ppp chap hostname remote password isis1234
 dialer in-band
 # First B channel dials 8675309
 dialer map ip 0.0.0.0 name core 8675309
 # Second B channel dials 8675308
 dialer map ip 0.0.0.0 name core 8675308
 ip address 20.0.0.2 255.255.255.252
!
```

Configuring dial-backup using routing

Instead of using the **dialer map ip** command, dial-on-demand routing can be configured using routing metrics on the interface. Specifying a secondary route with a higher metric value will also allow the ISDN BRI interface to operate in dial-on-demand mode. In the example below, the routing commands will add a primary default gateway through Serial0 and a lower priority route through bri0. This secondary route will only be used if Serial0 is unavailable. The first packet sent via this secondary route will cause the dialer to bring up the ISDN BRI link.

```
!
# Add the primary default gateway via the T1
ip route 0.0.0.0 0.0.0.0 Serial0
# Add a lower priority route via bri0
ip route 0.0.0.0 0.0.0.0 bri0 metric 10
!
```

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

XI. Configuring DHCP Services

This chapter describes how to configure the ImageStream router to act as a DHCP client or a DHCP relay by using SAND's **dhcp** commands in the main WAN interface configuration file.

This chapter includes the following topics:

- "Configuring an interface as a DHCP client"
- "Configuring DHCP relay services"

Before configuring DHCP services, you must configure your WAN interfaces and make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the "Configuration menu", select the "Network interface configuration" option by pressing **3** and **Enter**. This will open the ImageStream router's primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Configuring an interface as a DHCP client

Some routers, especially those connected to broadband Internet connections via an Ethernet port, may obtain an IP address from a DHCP server. To change the IP address and netmask of the interface to a dynamically assigned address, modify the **ip address** command to instruct the router to act as a DHCP client on this interface. The syntax of this DHCP client command is:

ip address dhcp *[client-id { your-client-id }] [client-name { your-client-name }]*

The **client-id** and **client-name** commands are optional. If your DHCP server, or your broadband provider, require a client ID or name, specify either one or both of these optional parameters as necessary.

Using the default configuration above, we have set the Ethernet0 IP address to a dynamic IP address. When the router boots, or when the SAND service is reloaded, the router will make a DHCP request on the Ethernet0 device and wait for a response from the DHCP server. The DHCP client will accept an IP address, netmask, default gateway IP, DNS server addresses, and domain name if supplied by the DHCP server.

```
!
interface Ethernet0
 description Dynamic IP connection
 duplex auto
 speed auto
 ip address dhcp
!
```

The example above uses the device Ethernet0, but the **ip address dhcp** command is valid on any network interface, including Serial, Tunnel, Bonder, frame relay subinterfaces, ATM subinterfaces and hardware multiplexing subinterfaces.

Configuring DHCP relay services

Networks that serve IP addresses from a single, centrally located DHCP server must have devices that relay DHCP address broadcast requests to the central DHCP server. Since DHCP/bootp broadcasts cannot travel over unicast networks natively, ImageStream routers support DHCP relaying. The DHCP relaying client embedded in ImageStream's Enterprise Linux reformulates the DHCP broadcast request into a special unicast packet and relays this request to a specified DHCP server. The DHCP server replies with a special unicast packet with a DHCP address assignment. The router accepts this packet, recreates the regular DHCP address reply broadcast and relays it to the network where the original request was made.

To enable DHCP relaying on one or more interfaces, add the **ip helper-address** command to the global configuration section of the router's main configuration file (wan.conf). The global configuration section normally appears at the bottom of the file after all interface declarations. The placement of the **ip helper-address** commands in the global section is done by convention for ease of configuration management. The actual placement of the command in the file is not important to the operation of the command.

The syntax of this DHCP relay command is:

ip helper-address *{ DHCP server IP address }* **server-device** *{ interface connected to DHCP server } [* **interfaces** *<interface list>] [* **agent-id** *{ agent-id }]*

The **interfaces** and **agent-id** commands are optional. The **interfaces** command allows you to limit DHCP relaying to a specific list of interfaces. If your DHCP server requires an agent ID to identify the requesting network, specify the **agent-id** optional parameter.

In the example below, we will use the **ip helper-address** command to relay DHCP requests from all interfaces to a DHCP server connected on Ethernet0 at the IP address 192.168.100.7:

```
!
interface Ethernet0
 description LAN segment #1
 duplex auto
 speed auto
 ip address 192.168.100.1 255.255.255.0
!
!
interface Ethernet1
 description LAN segment #2
 ip address 192.168.10.1 255.255.255.0
!
interface Ethernet2
 description LAN segment #3
 ip address 192.168.1.1 255.255.255.0
!
interface Ethernet3
description LAN segment - Dallas bridge
 bridge-group 1
 bridge-group 1 spanning-disabled
!
#NOC phone: 800-555-1212 - Our account #58935
interface Serial0
 description Connection to New York
 encapsulation hdlc
 bandwidth 1536000
 ip address 25.0.0.1 255.255.255.252
```

```
!
interface Serial1
 description Connection to Mexico City
 encapsulation ppp
 bandwidth 1536000
 ip address 25.0.0.5 255.255.255.252
!
interface Serial2
 description Connection to Dallas office
 encapsulation hdlc
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface bvi1
 ip address 30.0.0.1 255.255.255.0
!
ip helper-address 30.0.0.7 server-device bvi1
```

In the example above, any DHCP requests received on Ethernet1, Ethernet2, Serial0 or bvi1 will be relayed to the DHCP server at 30.0.0.7, using the device bvi1.

Using regular expressions, it is possible to restrict DHCP relaying to only selected interfaces. The regular expression must be comma-delimited with *no* whitespace, and may use wildcards ('*'). Using the same WAN configuration, the **ip helper-address** command below limits DHCP relaying to Ethernet devices only. Serial0 is excluded in this example:

```
ip helper-address 192.168.100.7 server-device bvi1 interfaces Ethernet*,Serial0
```

XII. Configuring Bonder for Load Balancing and Aggregation

This chapter describes how to configure the ImageStream router to use SAND's **Bonder** commands to load balance traffic across multiple circuits by aggregating multiple WAN devices. The **Bonder** commands are used to add aggregated devices on an interface-by-interface basis and to create the Bonder interface in the main WAN interface configuration file.

This chapter includes the following topics:

- "Configuring Load Balancing and Aggregation using bonder"
- "Valid interfaces for the bond command"

Before configuring Bonder devices, you must configure your WAN interfaces and make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the “Configuration menu”, select the “Network interface configuration” option by pressing **3** and **Enter**. This will open the ImageStream router’s primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Configuring Load Balancing and Aggregation using bonder

The **Bonder** interface for SAND devices allows multiple interfaces or subinterfaces to be treated as a single logical interface. A Bonder device is a standard network device and may be configured in the same manner as all physical devices and subinterfaces. This link aggregation/load balancing software is compatible with most similar tools on other manufacturer’s routers. *To use the bonder, all of the serial devices that you want to aggregate must have the same endpoint*.

A Bonder device can:

- aggregate multiple physical devices into a single logical device
- aggregate physical devices of different speeds (i.e. T1 and DS3)
- aggregate frame relay and ATM subinterfaces
- aggregate subinterfaces with physical devices (i.e. 256K ATM VC and T1)
- provide automatic, zero-downtime failover for multiple WAN devices
- interoperate with a Cisco router running per-packet CEF

Aggregated links are controlled by a virtual **Bonder** interface configured in the interface configuration file. The interface is configured similarly to a Serial WAN interface. For this example, we will use this configuration showing a point-to-point T1 and a frame relay PVC:

```
!
interface Serial0
 description Leased line to Mexico City
 encapsulation hdlc
 ip address 25.0.0.1 255.255.255.255
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial1
 encapsulation frame-relay ietf
 bandwidth 1536000
 frame-relay lmi-type ansi
 frame-relay interval 10
!
interface Serial1.1
 description Frame to Mexico City
 encapsulation frame-relay ietf
 frame-relay interface-dlci 16
 ip address 25.0.0.1 255.255.255.255
!
```

In this example, we will bond Serial0 and Serial1.1 together. For the link aggregation to function, both Serial0 and Serial1.1 must terminate on the same remote router.

The syntax of the **Bonder** interface command is:

interface Bonder*XX*

where *XX* is a device number. The location of a **Bonder** interface declaration in the interface configuration file is not important. By convention, the first **Bonder** device is **Bonder***0*, though you may assign any number. You do not need to specify an **encapsulation** type or **bandwidth**, as both will be ignored. You must specify an **ip address**. A **description** field is optional. To connect the Serial interfaces to the **Bonder** device that you have created, use the **bond** keyword. The syntax of the **bond** keyword is:

bond *Device Name*

In the example below, we have bonded the two Serial devices from above:

```
!
interface Bonder0
 description Bonded T1s to Mexico City
 bond Serial0
 bond Serial1.1
 ip address 192.168.10.1 255.255.255.252
!
```

The **Bonder** interface appears as a regular interface in the router, meaning you can make modifications to the **Bonder** device configuration without taking down other interfaces. You can use firewalling, bandwidth limiting, rule-based routing and other advanced features of the router with any **Bonder** device you create. Like other interfaces, the Bonder device is also available via SNMP for monitoring purposes.

The IP addresses on the individual T1s added to the bonded device using the **bond** keyword can be set to any valid IP address, and do not necessarily need to be identical. In the example above, both Serial interfaces use the same IP address. If you choose to use the same IP address on all of the bonded interfaces, you must use a host netmask (/32 or 255.255.255.255) on the individual serial devices.

Bonder distributes the load evenly based on each interface's bandwidth and the number of packets currently queued to that particular device. For example, a DS3 link bonded with a T1 line will send more traffic to the DS3 and will efficiently use the available bandwidth on both interfaces. Bonder automatically calculates bandwidth based on the active bonded interfaces and will not attempt to use any interface which has hardware or protocol down.

Valid interfaces for the bond command

The **bond** command can only be used in conjunction with a **Bonder** device. You may only bond SAND interfaces. You cannot bond the following:

- Ethernet interfaces
- Token ring interfaces
- Tunnel interfaces
- VPN interfaces
- VLAN interfaces

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

XIII. Configuring Multilink PPP for Load Balancing and Aggregation

This chapter describes how to configure the ImageStream router to use SAND's **Multilink PPP** commands to load balance traffic across multiple circuits by aggregating multiple WAN devices. The **Multilink** commands are used to add aggregated devices on an interface-by-interface basis and to create the Multilink interface in the main WAN interface configuration file.

This chapter includes the following topics:

- "Configuring Load Balancing and Aggregation using Multilink PPP"
- "Valid interfaces for Multilink devices"

Before configuring Multilink PPP devices, you must configure your WAN interfaces and make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the “Configuration menu”, select the “Network interface configuration” option by pressing **3** and **Enter**. This will open the ImageStream router’s primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Configuring Load Balancing and Aggregation using Multilink PPP

The **Multilink** interface for SAND devices allows multiple PPP encapsulated interfaces to be treated as a single logical interface. A Multilink device is a standard network device and may be configured in the same manner as all physical devices and subinterfaces. This link aggregation/load balancing software is compatible with Multilink PPP implementations on other manufacturer’s routers. *To use multilink PPP, all of the serial devices that you want to aggregate must run the PPP encapsulation, have the same endpoint and have MPPP configured on the remote router*.

A Multilink device can:

- aggregate multiple physical devices into a single logical device
- aggregate physical devices of different speeds (i.e. T1 and DS3)
- provide automatic, zero-downtime failover for multiple WAN devices
- interoperate with a Cisco router running MPPP

For compatibility with Cisco routers, the Cisco configuration must include the “ppp multilink interleave” command.

Aggregated links are controlled by a virtual **Multilink** interface configured in the interface configuration file. The interface is configured similarly to a Serial WAN interface. For this example, we will use this configuration showing two point-to-point T1 lines running PPP:

```
!
interface Serial0
 description Leased line to Mexico City
 encapsulation ppp
 ip address 25.0.0.1 255.255.255.252
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial1
 description Leased line to Mexico City
 encapsulation ppp
 ip address 25.0.0.5 255.255.255.252
!
```

In this example, we will bond Serial0 and Serial1 together. For the link aggregation to function, both Serial0 and Serial1 must terminate on the same remote router and the remote router must have MPPP configured.

The syntax of the **Multilink** interface command is:

interface Multilink*XX*

where *XX* is a device number. The location of a **Multilink** interface declaration in the interface configuration file is not important. By convention, the first **Multilink** device is **Multilink***0*, though you may assign any number. You do not need to specify an **encapsulation** type or **bandwidth**, as both will be ignored. You must specify an **ip address**. A **description** field is optional.

In the example below, we have created a Multilink0 interface:

```
!
interface Multilink0
 description MPPP Port
 ip address 216.146.78.1 255.255.255.252
!
```

To connect the Serial interfaces to the **Multilink** device that you have created, you must add two commands to each Serial interface. Use the **ppp multilink** keyword to indicate that the interface is part of a multilink PPP group. The syntax of the **ppp multilink** keyword is:

ppp multilink

The command accepts no parameters. To add the Serial device to the specific Multilink interface created in the previous step, use the **multilink-group** command.

The syntax of the **ppp multilink** keyword is:

multilink-group *XX*

where *XX* is the device number you used when creating the **Multilink** interface. Using the original Serial interfaces and Multilink interface from above, the configuration below creates a multilink PPP group from the two individual PPP interfaces:

```
!
interface Serial0
 description Leased line to Mexico City
 encapsulation ppp
 ppp multilink
 multilink-group 0
 ip address 25.0.0.1 255.255.255.252
!
#NOC phone: 800-555-1212 – Our account #58935
interface Serial1
 description Leased line to Mexico City
 encapsulation ppp
 ppp multilink
 multilink-group 0
 ip address 25.0.0.5 255.255.255.252
!
interface Multilink0
 description MPPP Port
 ip address 216.146.78.1 255.255.255.252
!
```

The **Multilink** interface appears as a regular interface in the router, meaning you can make modifications to the **Multilink** device configuration without taking down other interfaces. You can use firewalling, bandwidth limiting, rule-based routing and other advanced features of the router with any **Multilink** device you create. Like other interfaces, the bonder device is also available via SNMP for monitoring purposes.

The IP addresses on the individual T1s added to the Multilink device can be set to any valid IP address, and do not necessarily need to be identical. If you choose to use the same IP address on all of the individual PPP interfaces, you must use a host netmask (/32 or 255.255.255.255) on these devices.

Multilink PPP distributes the load evenly by fragmenting packets and sending the packet fragments down each T1 line before reassembling the packets at the remote end. Multilink interfaces automatically calculate bandwidth based on the active PPP interfaces in the group and will not attempt to use any interface which has hardware or protocol down.

Valid interfaces for the Multilink device

The **ppp multilink and multilink-group** command can only be used in conjunction with a **Multilink** device. You may only add SAND interfaces running PPP to Multilink devices.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

XIV. Configuring IP Tunnels

This chapter describes how to configure the ImageStream router to use SAND's **Tunnel** interface to create encrypted and unencrypted tunnels across physical devices.

This chapter includes the following topics:

- "Understanding Tunnel devices"
- "Configuring SSL Tunnels Using OpenVPN"
- "Configuring CIPE devices"

Understanding Tunnel devices

Tunneling provides a way to encapsulate packets of a foreign protocol or network inside a transport protocol. Tunneling is implemented as a virtual interface to provide a simple interface for configuration. A tunnel interface is not tied to specific protocols, devices or network transports. Tunnels provide an architecture that is designed to support any standard point-to-point encapsulation scheme. Because tunnels are point-to-point links, you must configure a separate tunnel for each link.

Tunnel devices can encapsulate a wide variety of protocol packet types inside IP tunnels, creating a virtual point-to-point link to routers at remote points over an IP internetwork. The **Tunnel** commands are used to create the Tunnel interface in the main WAN interface configuration file.

Before configuring Tunnel devices, you must configure your WAN interfaces and make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
```

```
-----------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the “Configuration menu”, select the “Network interface configuration” option by pressing **3** and **Enter**. This will open the ImageStream router’s primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Configuring A Simple SSL Tunnel Using OpenVPN

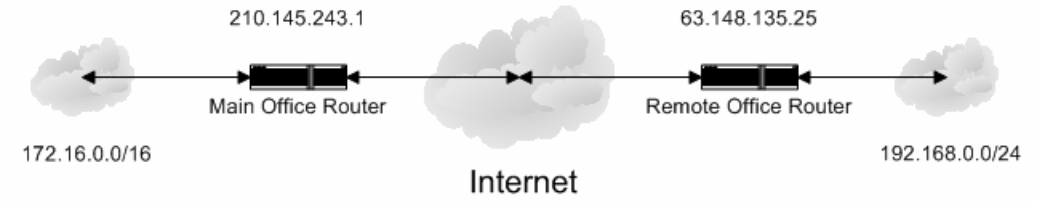
The SSL tunnel interface mode for SAND devices uses the OpenVPN suite and allows IP packet tunneling inside encrypted UDP or TCP packets. The protocol is designed to be lightweight and simple, and to work seamlessly with dynamic addresses, NAT and SOCKS proxies. An OpenVPN tunnel device is a standard network device and may be configured in the same manner as all physical devices and subinterfaces.

If your configuration requires dynamic routing (BGP, OSPF, RIP) or metric-based static routing failover configurations, you should use the OpenVPN SSL tunnels. Unlike CIPE tunnels or other tunnels supported by the ImageStream router, OpenVPN tunnels use the standard hardware and protocol status functions and may be used with configurations that rely on interface status.

ImageStream’s Enterprise Linux 4.2 or later releases provide support for OpenVPN tunnels. An ImageStream router’s OpenVPN implementation can interoperate with any OpenVPN client on any operating system.

The configurations listed in this section may not match ones suitable for use on your network. Any device names, IP addresses, tunnel keys or bandwidth values are provided as examples. You will need to change the commands in the examples below to match the settings suitable for your network.

OpenVPN tunnels are controlled by a virtual **Tunnel** interface configured in the interface configuration file. The interface is configured similarly to a Serial WAN interface. For this example, we will use this configuration showing a point-to-point between two routers.



In this example, we will create an encrypted tunnel between these two routers.

The syntax of the **Tunnel** interface command is:

interface Tunnel*XX*

where *XX* is a device number. The location of a **Tunnel** interface declaration in the interface configuration file is not important. By convention, the first **Tunnel** device is **Tunnel***0*, though you may assign any number. You do not need to specify an **encapsulation** type, as it will be ignored. You must specify an **ip address**. A **description** field is optional.

To configure each end of the point-to-point tunnel, you must configure the tunnel addresses, the tunnel source and destination, and the authentication key. The example below shows two local networks connected via an OpenVPN tunnel to form a VPN interconnecting the 172.16.0.0/16 and 192.168.0.0/24 reserved network blocks. In the example below, 172.16.0.0/16 is the network at the main office and 192.168.0.0/24 is the network at a remote office.

Main Office Router:

```
!
interface Tunnel0
 description Tunnel to Remote Office
 bandwidth 768000
 tunnel mode openvpn
 tunnel source 210.145.243.1 6061
 tunnel destination 63.148.135.25 6061
 tunnel key 8c34cdc8f4a2e1fb01dd5c0fdc9082e4
 ip address 192.168.150.1 255.255.255.252
 pointopoint address 192.168.150.2
!
ip route add 192.168.0.0/24 via 192.168.150.2
```

Remote Office Router:

```
!
interface Tunnel0
 description Tunnel to Remote Office
 bandwidth 768000
 tunnel mode openvpn
 tunnel source 63.148.135.25 6061
 tunnel destination 210.145.243.1 6061
 tunnel key 8c34cdc8f4a2e1fb01dd5c0fdc9082e4
 ip address 192.168.150.2 255.255.255.252
 pointopoint address 192.168.150.1
!
ip route add 172.16.0.0/16 via 192.168.150.1
```

The values in the example are explained below.

Interface Tunnel0

Denotes the start of the configuration section for the first Tunnel device in your system. All commands that follow this line until the next **!** mark will be applied to Tunnel0.

description Tunnel to Remote Office

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

bandwidth 768000

Scales the output of the realtime statistics program to 768 Kbps. This value is optional, and should be set either to the connected link speed or to the bandwidth limit allocated by QoS rules.

tunnel mode openvpn

Sets the encapsulation type on the tunnel to OpenVPN.

tunnel source 63.148.135.25 6061

Sets the source address of the tunnel and the UDP or TCP port used to receive the SSL tunnel's encapsulated packets. The command takes the form **tunnel source** *ipaddress port*. The IP address selected must be different from the ip address of the tunnel. The tunnel source address should be an address reachable on the network by the destination router.

tunnel destination 210.145.243.1 6061

Sets the destination address of the tunnel and the UDP or TCP port used to send the SSL tunnel's encapsulated packets. The command takes the form **tunnel destination** *ipaddress port*. The IP address and port must match the values configured as the source on the destination router.

tunnel key 8c34cdc8f4a2e1fb01dd5c0fdc9082e4

Sets the encryption key used by the tunnel. This command takes the form **tunnel key** *key*. This value must match the value configured on the destination router. OpenVPN uses a 2048-bit key. If the key specified is less than 2048 bits, the router will automatically replicate the value until the size reaches 2048 bits.

ip address 192.168.150.1 255.255.255.252

Specifies the IP address and netmask for the Tunnel device. The IP addresses on the source and destination ends of the tunnel must be different from the IP address and pointopoint address of the tunnel itself.

pointopoint address 192.168.150.2

Specifies the remote tunnel address. This IP address must match the value configured as the IP address on the destination router.

ip route add 192.168.0.0/24 via 192.168.150.2

Adds a static route to the 192.168.0.0 network through the Tunnel0 IP address on the main office router. Note that the command follows the Linux iproute2 syntax. Cisco IOS-style syntax commands are also accepted, as described in earlier sections.

ip route add 172.16.0.0/16 via 192.168.150.1

Adds a static route to the 172.16.0.0 network through the IP address of the remote end of the Tunnel device. This is an alternate method of specifying a static route, but has the same effect as adding a static route through the device itself

The **Tunnel** interface appears as a regular interface in the router, meaning you can make modifications to the **Tunnel** device configuration without taking down other interfaces. You can use firewalling, bandwidth limiting, rule-based routing and other advanced features of the router with any **Tunnel** device you create. Like other interfaces, the tunnel device is also available via SNMP for monitoring purposes.

For easier configuration of other OpenVPN devices, including Windows clients, the options files passed to the OpenVPN program are stored in the /etc/openvpn directory on the router's filesystem. Each tunnel has a separate options file. Use these files as a basis for configuring other OpenVPN devices.

Configuring A Dynamically Addressed SSL Tunnel Using OpenVPN

OpenVPN also supports dynamically addressed connections on one or both endpoints of a tunnel. Using the same network design from the previous example, the example below details how to configure an OpenVPN tunnel when the remote router endpoint has a dynamically assigned IP address. The main router still uses the same static IP address as in the previous example.

Main Office Router:

```
!
interface Tunnel0
 description Tunnel to Remote Office
 bandwidth 768000
 tunnel mode openvpn
 tunnel source 210.145.243.1 6061
 tunnel destination 0.0.0.0 6061
 tunnel options --passtos --secret /etc/openvpn/Tunnel0-key
 ip address 192.168.150.1 255.255.255.252
 pointopoint address 192.168.150.2
!
ip route add 192.168.0.0/24 via 192.168.150.2
```

Remote Office Router:

```
!
interface Tunnel0
 description Tunnel to Remote Office
 bandwidth 768000
 tunnel mode openvpn
 tunnel source 0.0.0.0 6061
 tunnel destination 210.145.243.1 6061
 tunnel options --passtos --secret /etc/openvpn/Tunnel0-key
 ip address 192.168.150.2 255.255.255.252
 pointopoint address 192.168.150.1
!
ip route add 172.16.0.0/16 via 192.168.150.1
```

The changed values in the example are explained below.

tunnel source 0.0.0.0 6061

Instructs OpenVPN to use the source address of the physical interface used when the router transmits traffic on the tunnel. This configuration option is used when the router has a dynamically assigned IP address.

tunnel destination 0.0.0.0 6061

Instructs OpenVPN to accept *any* source address. The OpenVPN tunnel will use the port number and the key to validate the connection.

tunnel options --passtos --secret /etc/openvpn/Tunnel0-key

The **tunnel options** command passes any advanced command line options to the OpenVPN program. Only *one* **tunnel options** command may be used for each tunnel. Any valid OpenVPN options can be passed to this command. In the example above, the
--passtos option is used to maintain any ToS settings on packets passed to the tunnel instead of stripping those options by default. The **--secret** option tells the router the path to the key file used for this tunnel. *The key specified in the file must match the key used on the other side of the tunnel*. A complete list of available options is available from the router's command line by typing **openvpn –help**.

ImageStream's Technical Support Web site has additional Technical Notes detailing additional advanced OpenVPN configurations. The notes include examples showing bridging over an OpenVPN tunnel, and connecting an ImageStream router to an OpenVPN Windows client.

Configuring CIPE (Crypto IP Encapsulation) Tunnels

The CIPE tunnel interface mode for SAND devices allows IP packet tunneling inside encrypted UDP packets. The protocol is designed to be lightweight and simple, and to work seamlessly with dynamic addresses, NAT and SOCKS proxies. A CIPE tunnel device is a standard network device and may be configured in the same manner as all physical devices and subinterfaces. *To use CIPE mode tunnels with another manufacturer's router, the other router must support CIPE (version 3).*

If your configuration requires dynamic routing (BGP, OSPF, RIP) or metric-based static routing failover configurations, you should use the OpenVPN SSL tunnels. Unlike CIPE tunnels or other tunnels supported by the ImageStream router, OpenVPN tunnels use the standard hardware and protocol status functions and may be used with configurations that rely on interface status.

CIPE tunnels are controlled by a virtual **Tunnel** interface configured in the interface configuration file. The interface is configured similarly to a Serial WAN interface. For this example, we will use this configuration showing a point-to-point between two routers:

Router A:

```
!
interface Serial0
 description Leased line to Mexico City
 encapsulation hdlc
 ip address 25.0.0.1 255.255.255.252
!
```

Router B:

```
!
interface Serial0
 description Leased line to New York City
 encapsulation hdlc
 ip address 25.0.0.2 255.255.255.252
!
```

In this example, we will create an encrypted tunnel between these two routers.

The syntax of the **Tunnel** interface command is:

interface Tunnel*XX*

where *XX* is a device number. The location of a **Tunnel** interface declaration in the interface configuration file is not important. By convention, the first **Tunnel** device is **Tunnel***0*, though you may assign any number. You do not need to specify an **encapsulation** type, as it will be ignored. You must specify an **ip address**. A **description** field is optional.

To configure each end of the point-to-point tunnel, you must configure the tunnel addresses, the tunnel source and destination, and the authentication key. The examples below show the tunnel configuration for a CIPE tunnel between Router A and Router B in the examples above.

Router A:

```
!
interface Serial0
 description Leased line to Mexico City
 encapsulation hdlc
 ip address 25.0.0.1 255.255.255.252
!
interface Tunnel0
 description VPN to Mexico City
 bandwidth 256000
 tunnel mode cipe
 tunnel source 25.0.0.1 4451
 tunnel destination 25.0.0.2 4451
```

```
 tunnel key abcdef001
 ip address 10.0.0.1 255.255.255.252
 pointopoint address 10.0.0.2
!
ip route 192.168.100.0 255.255.255.0 Tunnel0
```

Router B:

```
!
interface Serial0
 description Leased line to New York City
 encapsulation hdlc
 ip address 25.0.0.2 255.255.255.252
!
interface Tunnel0
 description VPN to New York City
 bandwidth 256000
 tunnel mode cipe
 tunnel source 25.0.0.2 4451
 tunnel destination 25.0.0.1 4451
 tunnel key abcdef001
 ip address 10.0.0.2 255.255.255.252
 pointopoint address 10.0.0.2
!
ip route 192.168.10.0 255.255.255.0 10.0.0.1
```

The values in the example are explained below.

Interface Tunnel0:

Denotes the start of the configuration section for the first Tunnel device in your system. All commands that follow this line until the next **!** mark will be applied to Tunnel0.

description VPN to New York City:

Sets a description for this device. The description is optional used for reporting purposes in other utilities. Setting a value here does not affect the operation of the port.

bandwidth 256000

Scales the output of the realtime statistics program to 256 Kbps. This value is optional, and should be set either to the connected link speed or to the bandwidth limit allocated by QoS rules.

tunnel mode cipe

Sets the encapsulation type on the tunnel to CIPE, which is the default value. This command is optional.

tunnel source 25.0.0.1 4451

Sets the source address of the tunnel and the UDP port used to receive the CIPE-encapsulated packets. The command takes the form **tunnel source** *ipaddress udpport*. The IP address selected must be different from the ip address of the tunnel. The tunnel source address should be an address reachable on the network by the destination router.

tunnel destination 25.0.0.2 4451

Sets the destination address of the tunnel and the UDP port used to send the CIPE-encapsulated packets. The command takes the form **tunnel destination** *ipaddress udpport*. The IP address and port must match the values configured as the source on the destination router.

tunnel key abcdef001

Sets the encryption key used by the tunnel. This command takes the form **tunnel key** *key*. This value must match the value configured on the destination router. A script to generate a 128-bit MD5 checksum for use as a more secure key is available from the router's Bash shell under the Advanced menu. Run the **gencipekey** command and cut and paste the output into the key value.

ip address 10.0.0.1 255.255.255.0:

Specifies the IP address and netmask for the Tunnel device.

pointopoint 10.0.0.2:

Specifies the remote tunnel address. This IP address must match the value configured as the IP address on the destination router.

ip route 192.168.100.0 255.255.255.0 Tunnel0:

Adds a static route to the 192.168.100.0 network through the Tunnel0 device.

ip route 192.168.10.0 255.255.255.0 10.0.0.1:

Adds a static route to the 192.168.10.0 network through the IP address of the remote end of the Tunnel device. This is an alternate method of specifying a static route, but has the same effect as adding a static route through the device.

The **Tunnel** interface appears as a regular interface in the router, meaning you can make modifications to the **Tunnel** device configuration without taking down other interfaces. You can use firewalling, bandwidth limiting, rule-based routing and other advanced features of the router with any **Tunnel** device you create. Like other interfaces, the tunnel device is also available via SNMP for monitoring purposes.

The IP addresses on the source and destination ends of the tunnel must be different from the IP address and pointopoint address of the tunnel itself.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

XV. Configuring Rate Limiting within SAND

This chapter describes how to configure the ImageStream router to use SAND's **rate-limit** commands to limit inbound and outbound traffic on a WAN device. The **rate-limit** commands are used to limit traffic on an interface-by-interface basis. To limit traffic on a network-by-network or service-by-service basis, see the chapter "Configuring Services: Quality of Service Menu."

This chapter includes the following topics:

- "Understanding the Rate Limiting Utilities"
- "Configuring Rate Limiting"

Before configuring rate limiting, you must configure the WAN interface and make the appropriate cabling connection for your needs. Refer to the hardware installation guide for your ImageStream product for information on making the WAN connection. See the *Command Reference* for more detailed command descriptions and instructions.

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

From the “Configuration menu”, select the “Network interface configuration” option by pressing **3** and **Enter**. This will open the ImageStream router’s primary configuration file, **wan.conf** in the default editor. The **wan.conf** file is also accessible from the command line in the **/usr/local/sand** directory.

Configuring Rate Limiting using rate-limit

The **rate-limit** command for SAND devices limits the input or output transmission rate on an interface or subinterface based on a flexible set of criteria. Unlike standard Differentiated Services QoS management tools, the **rate-limit** command can:

- limit both inbound and outbound traffic on a device
- add limits to a SAND device independent of traffic flows or network addresses

The **rate-limit** command allows you to control the maximum rate for traffic transmitted or received on an interface. Rate limiting is often configured on interfaces at the edge of a network to limit traffic into or out of the network. Traffic that falls within the rate parameters is transmitted, while packets that exceed the acceptable amount of traffic are dropped or transmitted with a different priority (latency).

The syntax of the **rate-limit** command is:

rate-limit *bits per second* **[input | output] [latency** *milliseconds* **| buffer** *kilobytes* **]**

Using the **input** keyword applies the rate limiting policy to packets received on the specified interface only. Using the **output** keyword applies the rate limiting policy to packets transmitted on the specified interface only. Specifying neither keyword will apply the rate limiting policy to both inbound and outbound traffic.

The optional **latency** keyword affects the maximum length of time allowed to transmit or receive a packet on the interface. Inserting a large value for this setting will result in fewer dropped packets, a larger buffer and higher potential traffic delays under load. Setting a small value for **latency** will result in more dropped packets and a smaller buffer, but fewer traffic delays under load.

Alternatively, the packet drop and latency values can be affected by setting the **buffer** keyword. Inserting a large value for the **buffer** will result in a higher latency and fewer dropped packets, but higher potential traffic delays. Setting a small value for the **buffer** will cause more dropped packets and a lower latency, but fewer traffic delays under load.

Only one input and one output rule are valid on each interface or subinterface. You can only specify one rate limit per interface or subinterface without the **input** or **output** keyword.

In the example below, we have limited the DS3 interface (**interface Serial1** below) to 10 Mbps for inbound traffic only. Outbound traffic is not affected.

```
!
interface Serial1
 description Connection to London office
 encapsulation hdlc
 service-module ds3 clocking internal
 rate-limit 10000000 input latency 50
 ip address 25.0.0.1 255.255.255.252
!
```

Note that we have set a low latency value. This will ensure faster data transfers, but will result in more dropped packets under load. Packets remaining in the input queue more than 50 milliseconds will be dropped from the queue if they cannot be processed.

In the next example, we have limited the DS3 interface (**interface Serial1** below) to 20 Mbps for both inbound and outbound traffic. All traffic on this interface will share a common 20 Mbps rate limit.

```
!
interface Serial1
 description Connection to London office
 encapsulation hdlc
 service-module ds3 clocking internal
 rate-limit 20000000 input latency 1000
 ip address 25.0.0.1 255.255.255.252
!
```

Note that we have set a very high latency value. This will increase the buffer size on the interface and ensure fewer packet drops. Packets will remain in the queue for up to 1000 milliseconds before being dropped. Only extremely heavy traffic loads will cause significant packet drops using this configuration.

Valid interfaces for the rate-limit command

The **rate-limit** command may be used on an interface or a subinterface. SAND's rate limiting is independent of the link encapsulation and the type of data and may be used with routed IP traffic or bridged traffic of any type. The **rate-limit** command is only valid for SAND interfaces, and may not be used on the following:

- Ethernet interfaces
- Token ring interfaces
- Tunnel interfaces
- VPN interfaces
- VLAN interfaces

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

XVI. Configuring Services: Quality of Service Menu

This chapter describes how to configure settings for the Quality of Service (QoS) utilities provided by the ImageStream router. This chapter describes how to configure the ImageStream router to use ImageStream's **bwinit** and **bwadd** utilities. The **bwinit** and **bwadd** utilities are user-friendly interfaces to the more in-depth DiffServ utility, **tc**, provided on the router.

This chapter discusses the following topics:

"Configuring Quality of Service using bwinit/bwadd filter method"
"Configuring Quality of Service using bwinit/bwadd classify method"
"Enabling QoS at boot-time"
"Disabling QoS at boot-time"
"Instating QoS rules"
"Clearing QoS rules"
"Restoring the factory default QoS configuration"

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the “Firewall and QOS configuration” menu by pressing **4** on the keyboard and press **Enter** to configure the router’s service configuration settings (again, your menu may look slightly different):

```
Firewall and QOS configuration
------------------------------------------------------------
1. QOS Menu (diffserv), (instated)
2. Firewall (iptables), (instated)
0. Configuration menu
```

Select the “Quality of Service” menu by pressing **1** on the keyboard and press **Enter** to configure the router’s Quality of Services settings (again, your menu may look slightly different):

```
QOS Menu (diffserv), (instated)
------------------------------------------------------------
1. Configure QoS management
2. Enable QoS on boot
3. Disable QoS on boot
4. Instate QoS Rules
5. Clear QoS Rules
6. Restore to default configuration
7. Firewall and QOS configuration
0. Quit
```

Select the “Configure QoS management” menu option by pressing **1** on the keyboard and press **Enter** to configure the router’s Quality of Services settings. This will open the default QoS configuration file in your default text editor. The first line of the file:

```
#!/bin/sh
```

must remain unchanged. This line indicates to the router that the lines in the file are part of a shell script. Lines that begin with a **#** are comments and will not be processed by the router. You may add comments anywhere in the file. There is no limit on the number of comments you may have in a particular file, provided that you have enough system memory and flash space to store the file.

Configuring Quality of Service using bwinit/bwadd filter method

Both ImageStream’s **bwinit** and **bwadd** utilities and standard Linux DiffServ **tc** commands are valid in this configuration file. See the *Linux Advanced Routing and Traffic Control* guide for information on using the **tc** commands and other advanced Linux routing utilities. Once you have successfully opened the file, you can initialize devices with **bwinit** and begin adding limits with the **bwadd** utility. The **bwinit** and **bwadd** utilities provide a more intuitive front-end to the **tc** utility for simple bandwidth limiting.

Remember that QoS may only be used for traffic that is being transmitted on the interface. In the real world, QoS works much like your postal mailbox for your organization. You cannot limit the amount of postal mail that is sent to your organization, but you can limit the amount of postal mail that you send out and the amount of mail you deliver within your organization. Similarly, QoS may only be used to limit traffic that is *sent* on an interface. If your router has two devices, Ethernet0 (LAN) and Serial0 (WAN), you would limit incoming traffic from the WAN destined for your LAN by adding limits to Ethernet0. Similarly, if you want to limit outbound traffic from your LAN to your WAN, you would add limits to Serial0.

The order of the commands entered into this file are important. Each device must be initialized first. The router checks for matches to the specified limits from the top to the bottom of the file. Once a traffic flow has been matched against a limit, the router will stop attempting to match limits and will not use any subsequent limits in the file.

The first step to implement bandwidth limiting for any interface in the system is to initialize the device using the **bwinit** command. The syntax for this command is:

bwinit --**dev** *device* --**bandwidth** *bandwidth*

The **--dev** option is used to specify the device in the interface configuration file (**wan.conf**) that you are initializing. You may use Linux's "eth" shorthand instead of "Ethernet" when working with Ethernet devices, though this is not required.

The **--bandwidth** option is used to specify the total amount of bandwidth available to the interface, regardless of any limits you wish to set. This value should be equal to the actual wire speed of the interface and must be a whole number. The value of **--bandwidth** should be abbreviated using "Mbit" or "Kbit" accordingly. *Specifying an incorrect or inaccurate value will cause bandwidth limiting results to be inaccurate*.

Initializing an interface using bwinit

Each interface to which you want to add bandwidth limiting rules must be initialized first. Failing to initialize a particular interface will prevent your bandwidth limiting rules from working properly. In the example below, we have initialized Ethernet0 with a bandwidth of 100 Mbps:

```
bwinit --dev Ethernet0 --bandwidth 100Mbit
```

The bandwidth above is expressed in abbreviated notation. For 10Mbps ethernet devices, use 10Mbit. Similarly, the example below shows initialization of a Serial interface at a T1 line rate:

```
bwinit --dev Serial1 --bandwidth 1544Kbit
```

The above command initializes Serial1. We have specified a full T1 connection of 1.544Mbps. Unlike SAND's **rate-limit** commands, you can initialize any valid interface defined in wan.conf, including subinterfaces, tunnels and VLAN devices.

Adding limits to initialized devices using bwadd

Once each interface you wish to manage has been initialized, you can add limiting rules. **bwadd** supports separate limits on inbound and outbound bandwidth, as well as combined inbound/outbound traffic limits. Various networks or IP addresses can be grouped together to share a single bandwidth limit.

When adding limits, **bwadd** uses the following structure:

bwadd --dev *device* **--bandwidth** *bandwidth* **{ --source | --destination | --ip }** *ip address*[*/bitmask*] **[--*priority* *priority*] [--group** *group number* **] [--fair-queue]**

The **--dev** option is used to specify the device in the interface configuration file (**wan.conf**) that you are initializing. You may use Linux's "eth" shorthand instead of "Ethernet" when working with Ethernet devices, though this is not required.

The **--bandwidth** option is used to specify the total amount of bandwidth allocated to the interface. The value of **--bandwidth** should be abbreviated using "Mbit" or "Kbit" accordingly.

The **[--source | --destination | --ip]** keywords are used to tell the router how to match the corresponding IP or network block. **--source** will match only a packet's source address, **--destination** will match only a packet's destination address and **--ip** will match either address. Optionally, you may specify *{/bitmask}* which is used when the limit is for a network and not a single IP address/host. A table is provided in Appendix B of this manual to convert between netmasks and bitmasks.

The **--priority** keyword specifies the limit's routing priority. The default value is 8. The valid range is 0 (highest) through 20 (lowest). The **--priority** keyword may be used to classify different networks, hosts or groups by level of importance. The network, host or group with the highest priority will always have the first access to the available interface bandwidth to the exclusion of other networks, hosts or groups.

The **--group** option allows you to add a limit to a particular group. Using groups allows multiple networks or hosts to share an aggregate bandwidth. See *Grouping hosts and networks* below.

Using the example Serial1 device from above, we have set a limit for the 192.168.10.0 class C network:

```
bwadd --dev Ethernet0 --bandwidth 512Kbit --ip 192.168.100.0/24 \
--group 3
```

When adding additional networks or hosts to an existing group, you do not need to respecify the bandwidth. Networks or hosts added to an existing group inherit the bandwidth limit previously specified.

Note that when your command wraps beyond the end of the line, you must end the first line with a backslash (\ ). Failing to end a wrapped line with a backslash will cause the router to interpret the next line as a new line and will generate an error.

The example command above would limit any host with a 192.168.10.xx address to 512Kbps of bandwidth inbound and outbound. By specifying the keyword **--ip**, hosts share a single 512Kbps bandwidth limit, regardless of whether the 192.168.10.xx address is in the source or destination fields of the IP packet. Additionally, a group number (3) has been specified. Other hosts or networks can now be added to the group and share the allocated bandwidth.

To limit destination traffic only to an aggregate bandwidth of 512Kbps, use the **--destination** keyword:

```
bwadd --dev Ethernet0 --bandwidth 512Kbit –destination \
192.168.100.0/24 --group 3
```

Similarly, to limit source traffic only to an aggregate bandwidth of 512Kbps, use the **--source** keyword:

```
bwadd --dev eth0 --bandwidth 512Kbit –source 192.168.100.0/24 \
--group 3
```

Again, note the use of the backslash to wrap at the end of the first line in both commands. The use of the backslash is only necessary when the commands wraps across more than one line in your display. We have also used the shorthand “eth0” notation in the second example. Either “Ethernet0” or “eth0” is acceptable.

Grouping hosts and networks

Using the group keyword allows other hosts and networks to share a common bandwidth limit. We have configured an example based on the Serial0 device initialized in our example above:

```
bwadd --dev Serial0 --bandwidth 1Mbit --ip 172.0.0.0/24 \
--group 2
bwadd --dev Serial0 --ip 172.1.1.0/24 --group 2
bwadd --dev Serial0 --bandwidth 512Kbit --ip 172.20.1.0/24
```

This example will limit 172.0.0.0/24 and 172.1.1.0/24 to 10Mbit and 172.0.1.0/24 to 1Mbit on the T1 link. Note that to add 172.1.1.0/24 to group 2, you only need to specify the device, address range and group number. 172.20.1.0/24 inherits the bandwidth limit specified in the previous command.

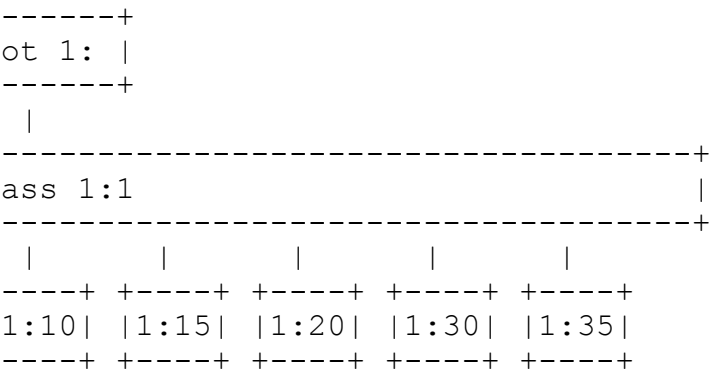
Configuring Quality of Service using bwinit/bwadd classify method

In this example, we are going to assume the following service classes:

- Voice over IP phone with highest priority at 192.168.1.5
- SSH/telnet (interactive character) traffic with high priority
- "Default" service class for all non-classified traffic
- Non-realtime e-mail traffic at low priority
- Security camera (192.168.1.6) FTP traffic at low priority

For detailed information on blocking or limiting Peer-to-Peer networking traffic, please see the Limiting P2P Traffic Technical Note on the ImageStream Web site.

The configuration will define five service classes under a common leaf class:



It is possible to configure classes under the root class, but this limits your ability to create additional leaf classes with different service classes and priorities. Using multiple classes can be important in networks that have differeing requirements for business and residential users, for example. The service classes will be identical on both Serial0 and Ethernet0.

ImageStream's bwinit and bwadd utilities allow users to define traffic control classes with a simpler utility than the advanced 'tc' utility provided with ImageStream routers. In this example, we will start with the rules for bandwidth allocation (please note the use of the shorthand "eth0" in the configurations below):

Bandwidth allocations:

- Total bandwidth available: 1.5 Mbps (limit of Serial0 speed)

- VoIP -- Minimum guarantee: 256 Kbps, Maximum allowed: 1 Mbps, Priority: 1

- SSH/telnet -- Minimum guarantee: 32 Kbps, Maximum allowed: 128 Kbps, Priority: 2
- "Default" -- Minimum guarantee: 128 Kbps, Maximum allowed: 1 Mbps, Priority: 3
- E-Mail -- Minimum guarantee: 128 Kbps, Maximum allowed: 512 Kbps, Priority: 4
- Security camera -- Minimum guarantee: 128 Kbps, Maximum allowed: 1500Kbps, Priority: 5

We have chosen to allocate a small amount of bandwidth to SSH/telnet, since these applications are character-oriented and depend on user typing speeds (typically only a few bits per second). Please note that if the VoIP requires 1 Mbps, the remaining classes will have very little bandwidth available. It is possible with this configuration for e-mail traffic and security camera traffic to receive no bandwidth during high traffic conditions in the VoIP or default classes. You may need to adjust the maximum guaranteed bandwidths to ensure available bandwidth for all classes. In this example, e-mail and security camera traffic are low priority and will not be guaranteed bandwidth if the higher priority classes require 1.5 Mbps of bandwidth.

As noted above, the configurations for Ethernet0 and Serial0 are identical. First, we must initialize the router's QoS layers and specify both the maximum bandwidth available to the device as well as the default traffic class. Use of the default traffic class is not required, but strongly recommended to avoid the possibility that traffic is not classified into a QoS queue. In the router's Quality of Service configuration, we will add the following statements:

```
bwinit --dev eth0 --bandwidth 1536Kbit --default 20
bwinit --dev Serial0 --bandwidth 1536Kbit --default 20
```

In the above configuration, we have specified a device (eth0 and Serial0, respectively), the total bandwidth available (1.5 Mbps, or T1 speeds) to both devices and a default traffic class (20, in both cases). The default class instructs the router to sort all unclassified traffic into class 20 automatically.

Next, we must configure the bandwidth allocations for each of the five classes specified above:

```
#Rules for Ethernet0
bwadd --dev eth0 --classid 10 --minimum 256Kbit \
--maximum 1Mbit --priority 1
bwadd --dev eth0 --classid 15 --minimum 32Kbit \
--maximum 128Kbit --priority 2
bwadd --dev eth0 --classid 20 --minimum 128Kbit \
--maximum 1Mbit --priority 3 --fair-queue
bwadd --dev eth0 --classid 30 --minimum 128Kbit \
--maximum 512Kbit --priority 4 --fair-queue
bwadd --dev eth0 --classid 35 --minimum 128Kbit \
--maximum 1500Kbit --priority 5 --fair-queue
```

```
#Rules for Serial0
bwadd --dev Serial0 --classid 10 --minimum 256Kbit \
--maximum 1Mbit --priority 1
bwadd --dev Serial 0 --classid 15 --minimum 32Kbit \
--maximum 128Kbit --priority 2
bwadd --dev Serial 0 --classid 20 --minimum 128Kbit \
--maximum 1Mbit --priority 3 --fair-queue
bwadd --dev Serial 0 --classid 30 --minimum 128Kbit \
--maximum 512Kbit --priority 4 --fair-queue
bwadd --dev Serial 0 --classid 35 --minimum 128Kbit \
--maximum 1500Kbit --priority 5 --fair-queue
```

Again, please note that the rules for Ethernet0 and Serial0 are identical. Each set of queues will apply only in the transmit direction ("upstream" traffic leaves on Serial0, "downstream" traffic leaves the router on Ethernet0). In most networks where upload and download speeds are symmetric, the rules for the inward-facing and outward-facing interfaces will be identical. The class identification numbers we have chosen for this example are arbitrary. You may select a range of valid integers, and the class identifiers do not have to match from interface to interface.

The rules follow a common format:

bwadd:
Specifies that the router is adding a rule to an initialized interface.

--dev DEVICE:
Specifies that the router is adding a rule to the device named DEVICE.

--classid XX:
Configures a QoS class with the identifier "XX". This class value is used later by iptables.

--minimum XX:
Configures the minimum guaranteed bandwidth ("XX") for this class. The router will attempt to always guarantee this amount of traffic to the class.

Kbit, Mbit:
Notation used to specify Kilobits and Megabits. Only whole numbers are valid, so 1.5 Megabit becomes 1500Kbit.

--maximum XX:
Configures the maximum allowed bandwidth ("XX") for this class. The router will not allow traffic in this class to exceed the specified maximum.

--priority XX:
Specifies an optional priority value ("XX") from 0 to 8 used to rank classes in order of bandwidth allocations.

The **--fair-queue** option enables Stochastic Fair Queuing (SFQ) for the class. This option accepts no configuration variables. The router will allocate bandwidth fairly to all class members. This is especially useful in busy classes where a combination of users with different bandwidth usage profiles share a common bandwidth limit. SFQs help to avoid a single user or small group of users from using all of the bandwidth available to a class to the exclusion of other class members.

Both the --minimum and --maximum values are not required. You may specify only a minimum or maximum, and the router will automatically set the two values equal to each other. The router will not attempt to check for oversubscriptions or overallocations. Please carefully check your configurations for proper bandwidth allocation for your network requirements. Save your Quality of Service configuration. It is not necessary to instate the rules immediately, but you will need to instate the rules before the configuration will take effect.

Classifying Traffic Using iptables CLASSIFY

Now that we have configured the Quality of Service queues, we must sort traffic into the proper queues. While it is possible to do this from within the 'tc' QoS utility, using the iptables CLASSIFY directive provides a simpler, more flexible and more powerful method. In the router's firewall configuration (Option 1, Option 4, Option 2, Option 1 from the main menu), we will add the following statements below. For our VoIP phone, we can match traffic based on the source or destination IP address. We will map traffic coming from (Serial0) or going to (Ethernet0) the address 192.168.69.5 and add that traffic to class 1:10, which we mapped out originally and configured in the previous step:

```
#Phone traffic
iptables -A POSTROUTING -t mangle -o eth0 -d 192.168.69.5 \
-j CLASSIFY --set-class 1:10
iptables -A POSTROUTING -t mangle -o Serial0 -s 192.168.69.5 \
-j CLASSIFY --set-class 1:10
```

iptables CLASSIFY directives are always added to the POSTROUTING chain's mangle table. For more information about the path a packet follows through iptables, please see ImageStream's iptables tutorial or the official iptables HOWTO. Please note the significant difference between the two rules: the location of the "192.168.69.5" address. For traffic leaving the network on Serial0, 192.168.69.5 will be the source address. For reply traffic returning to the network (Ethernet0), the 192.168.69.5 will appear as the destination address.

The rules use several different elements, explained below:

iptables:
Specifies that the router is adding an iptables rule

-A POSTROUTING:

Appends (-A) a rule to the router's POSTROUTING chain

-t mangle:
Appends the rule to the mangle (-t mangle) table inside the specified chain

-o eth0, -o Serial0:
Specifies that only packets that match the specified outbound (-o) interface will match the rule. CLASSIFY rules will always be applied to an outbound interface.

-d XX:
Specifies that only packets with a destination address of "XX" will match the rule.

-s XX:
Specifies that only packets with a source address of "XX" will match the rule.

-j CLASSIFY:
Instructs iptables to take an action (-j) on packets matching this rule, in this case to CLASSIFY them into a QoS queue

--set-class 1:XX:
Instructs iptables to add matching packets to class ID 1:XX.

Next, we will add rules for our interactive traffic class. First, add the rules for telnet traffic, which uses port 23:

```
#telnet traffic
iptables -A POSTROUTING -t mangle -o eth0 -p tcp --sport 23 \
-j CLASSIFY --set-class 1:15
iptables -A POSTROUTING -t mangle -o Serial0 -p tcp –dport \
23 -j CLASSIFY --set-class 1:15
```

Next, we will add rules for interactive SSH traffic. This traffic uses port 22, but we must also match the ToS bit for Minimize-Delay (0x10). Secure copy (SCP) traffic also uses port 22, but does not set the ToS bit. Please note that some SSH applications, such "putty" and "SecureCRT", do not set the ToS bit on interactive SSH traffic and will not match this rule. *There is no workaround for programs that do not properly set the ToS bit.*

```
#ssh traffic
iptables -A POSTROUTING -t mangle -o eth0 -p tcp -m tos \
--tos 0x10 --sport 22 -j CLASSIFY --set-class 1:15
iptables -A POSTROUTING -t mangle -o Serial0 -p tcp -m tos \
--tos 0x10 --dport 22 -j CLASSIFY --set-class 1:15
```

Notice that the above rules match both port 22 and the Minimize-Delay (0x10) ToS bit. The rules above use some additional elements, explained below:

-p tcp:

Specifies that only TCP packets will match the rule ("udp", "icmp" and others are accepted also). The -p directive must be included when using --dport or --sport.

--dport XX:

Specifies that only packets with a destination port number of "XX" will match the rule. Requires the use of -p.

--sport XX:

Specifies that only packets with a source port number of "XX" will match the rule. Requires the use of -p.

-m tos:

Load the Type of Service match module for iptables. The -m tos directive must be included when matching a ToS bit (--tos).

--tos XX:

Specifies that only packets with tos bit of "XX" will match the rule. Names such as "Minimize-Delay" are acceptable instead of binary values. Requires the use of -m tos.

Next, we will add rules for e-mail traffic class. We must match 3 ports: SMTP (25), POP (110) and IMAP (143):

```
#Mail traffic
iptables -A POSTROUTING -t mangle -o eth0 -p tcp --sport 25 \
-j CLASSIFY --set-class 1:30
iptables -A POSTROUTING -t mangle -o eth0 -p tcp --sport 110 \
-j CLASSIFY --set-class 1:30
iptables -A POSTROUTING -t mangle -o eth0 -p tcp --sport 143 \
-j CLASSIFY --set-class 1:30
iptables -A POSTROUTING -t mangle -o Serial0 -p tcp --dport \
25 -j CLASSIFY --set-class 1:30
iptables -A POSTROUTING -t mangle -o Serial0 -p tcp –dport \
110 -j CLASSIFY --set-class 1:30
iptables -A POSTROUTING -t mangle -o Serial0 -p tcp –dport \
143 -j CLASSIFY --set-class 1:30
```

Finally, we will add rules to match FTP traffic from our security camera at 192.168.1.6. The rule will match both the IP address and port numbers (20 and 21):

```
iptables -A POSTROUTING -t mangle -o eth0 -p tcp -d \
192.168.1.6 --sport 20:21 -j CLASSIFY --set-class 1:35
iptables -A POSTROUTING -t mangle -o Serial0 -p tcp –s \
192.168.1.6 --dport 20:21 -j CLASSIFY --set-class 1:35
```

Please note the use of port ranges ("20:21" or "20,21", which is equivalent). Be careful to match the correct source or destination port. When the FTP replies to the security camera, it will reply from ports 20 or 21 to the 192.168.1.6 IP address. Accordingly, we have used the "-d" and "--sport" directives. It is not necessary to instate the rules immediately, but you will need to instate the rules before the configuration will take effect.

Configuring Quality of Service using Differentiated Services (DiffServ)

ImageStream routers also provide the in-depth **tc** utility for Quality of Service management. This Differentiated Services (DiffServ) utility is the standard tool provided by Linux. **tc** commands may be specified in the QoS configuration file or directly on the command line. The **tc** commands entered by the **bwinit** and **bwadd** utilities are stored in the router's /tmp directory for reference by advanced users. See the *Linux Advanced Routing and Traffic Control* guide for information on using the **tc** commands and other advanced Linux routing utilities.

Once you have entered all of the Quality of Service rules in this file, save the file by pressing **Control-X**. If you have made changes to the file, the router will prompt you to save the file at the bottom of the screen:

```
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
 Y Yes
 N No         ^C Cancel
```

Press **Y** on your keyboard. The router will prompt you for a file name:

```
File Name to write: /etc/rc.d/rc.bwlimit
^C Cancel
```

You should accept the default filename. If you choose to save the file in a different location, the router will not automatically locate the file and instate any changes. Press **Enter** on the keyboard to accept the default. The **^C** notation indicates the key combination **Control-C**. You may press **Control-C** at any time during the save process to return to the file.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Once you have saved the file by pressing **Enter**, the router will display:

```
Instating QOS rules...done.
```

and return you to the Quality of Service menu:

```
QOS Menu (diffserv), (instated)
---------------------------------------------------------------
1. Configure QoS management
2. Enable QoS on boot
3. Disable QoS on boot
4. Instate QoS Rules
5. Clear QoS Rules
6. Restore to default configuration
0. Firewall and QOS configuration
```

Enabling QoS at boot-time

```
2. Enable QoS on boot
```

Selecting this menu option enables the QoS rules when the router is booted. This does not start QoS on the router if it is not running, unless the router is rebooted first. By default, the QoS configuration is enabled on boot. To enable QoS on boot, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
QOS enabled on boot.
```

If the QoS configuration has already been enabled on boot, the router will display the message:

```
QOS already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Quality of Service menu.

Disabling QoS at boot-time

```
3. Disable QoS on boot
```

Selecting this menu option disables the QoS rules when the router is booted. This does not stop QoS on the router if it is running, unless the router is rebooted first. To disable QoS on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
QOS disabled on boot.
```

If the QoS configuration has already been disabled on boot, the router will display the message:

```
QOS already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Quality of Service menu.

Instating QoS rules

```
4. Instate QoS Rules
```

Selecting this menu option instates the QoS configuration on the router. Instating the QoS configuration does not automatically enable QoS when the router is booted. To instate the QoS rules, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Instating QOS rules...done.
```

The message will be displayed for a few seconds, and you will be returned to the Quality of Service menu.

Clearing QoS rules

```
5. Clear QoS rules
```

Selecting menu option clears the QoS configuration on the router. Clearing the QoS configuration does not automatically disable QoS when the router is booted. To clear the QoS rules, select this menu option by pressing **5** on the keyboard and pressing **Enter**. The router will display the message:

```
Clearing QOS rules...done.
```

The message will be displayed for a few seconds, and you will be returned to the Quality of Service menu.

Restoring the factory default QoS configuration

```
6. Restore to default configuration
```

Selecting this menu option removes the stored QoS configuration from the router's non-volatile flash memory. Selecting this menu option and confirming your selection will remove any user-defined QoS configurations from the router. This will not instate or clear any of the rules, and will not enable or disable QoS rules. Selecting this option will restore the router to the factory default QoS configuration only.

To restore the factory default QoS rules, select this menu option by pressing **6** on the keyboard and pressing **Enter**. The router will display a confirmation menu:

```
Set default config for qos?
-------------------------------------------------------------
1. Yes
2. No
0. Quit
```

Pressing **2** or **0** and **Enter** will return you to the Quality of Service menu without making any changes to the configuration. Confirming your decision to restore the factory default QoS configuration by pressing **1** and **Enter** will display:

```
qos returned to default configuration.

Press enter/return to continue
```

Press **Enter** to return to the Quality of Service menu.

Returning to the Firewall/QOS configuration menu

```
0. Firewall and QOS configuration
```

Selecting this menu option returns you to the “Firewall and QOS configuration” menu. To return to the Service configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Service configuration menu:

```
Firewall and QOS configuration
-------------------------------------------------------------
1. QOS Menu (diffserv), (instated)
2. Firewall (iptables), (instated)
0. Configuration menu
```

XVII. Configuring Services: Dialout PPP Menu

This chapter describes how to configure settings for the Dialout PPP utilities provided by the ImageStream router. This chapter describes how to configure the ImageStream router to use a modem for dial-out WAN connectivity.

This chapter discusses the following topics:

“Configuring Dialout PPP”
“Enabling Dialout PPP at boot-time”
“Disabling Dialout PPP at boot-time”
“Instating Dialout PPP rules in the running configuration”
“Clearing Dialout PPP rules from the running configuration”
“Viewing dialer messages”

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the “Configuration menu” by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the “Service configuration” menu by pressing **5** on the keyboard and press **Enter** to configure the router’s service configuration settings (again, your menu may look slightly different):

```
Service configuration
-------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

Select the “Dialout PPP” menu by pressing **2** on the keyboard and press **Enter** to configure the router’s dialout PPP settings (again, your menu may look slightly different):

```
Dialout PPP, (stopped)
-------------------------------------------------------------
1. Configure Dialout PPP
2. Enable Dialout PPP on boot
3. Disable Dialout PPP on boot
4. Start Dialout PPP
5. Stop Dialout PPP
6. View Dialer Messages
0. Service configuration
```

Select the “Configure Dialout PPP” menu option by pressing **1** on the keyboard and press **Enter** to configure the router’s Dialout PPP settings. This will open the default Dialout PPP configuration file in your default text editor (your file may look slightly different):

Once you have entered all of the Dialout PPP rules in this file, save the file by pressing **Control-X**. If you have made changes to the file, the router will prompt you to save the file at the bottom of the screen:

```
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
 Y Yes
 N No        ^C Cancel
```

Press **Y** on your keyboard. The router will prompt you for a file name:

```
File Name to write: /etc/ppp/dialer_setup
^C Cancel
```

You should accept the default filename. If you choose to save the file in a different location, the router will not automatically locate the file and instate any changes. Press **Enter** on the keyboard to accept the default. The **^C** notation indicates the key combination **Control-C**. You may press **Control-C** at any time during the save process to return to the file.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Once you have saved the file by pressing **Enter**, the router will display return you to the Dialout PPP menu:

```
Dialout PPP, (stopped)
------------------------------------------------------------
1. Configure Dialout PPP
2. Enable Dialout PPP on boot
3. Disable Dialout PPP on boot
4. Start Dialout PPP
5. Stop Dialout PPP
6. View Dialer Messages
0. Service configuration
```

Enabling Dialout PPP at boot-time

```
2. Enable Dialout PPP on boot
```

Selecting this menu option enables the Dialout PPP configuration when the router is booted. This does not start Dialout PPP on the router if it is not running, unless the router is rebooted first. By default, the Dialout PPP configuration is enabled on boot. To enable Dialout PPP on boot, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
dialout-ppp enabled on boot.
```

If the Dialout PPP configuration has already been enabled on boot, the router will display the message:

```
dialout-ppp already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Dialout PPP menu.

Disabling Dialout PPP at boot-time

```
3. Disable Dialout PPP on boot
```

Selecting this menu option disables the Dialout PPP rules when the router is booted. This does not stop Dialout PPP on the router if it is running, unless the router is rebooted first. To disable Dialout PPP on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
Dialout PPP disabled on boot.
```

If the dialout PPP configuration has already been disabled on boot, the router will display the message:

```
Dialout PPP already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Dialout PPP menu.

Start Dialout PPP

```
4. Start Dialout PPP
```

Selecting this menu option starts the Dialout PPP service on the router. Starting the Dialout PPP configuration does not automatically enable Dialout PPP when the router is booted. To start the Dialout PPP service, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Starting Dialout PPP...done.
```

The message will be displayed for a few seconds, and you will be returned to the Dialout PPP menu.

Stop Dialout PPP

```
5. Stop Dialout PPP
```

Selecting this menu option stop the Dialout PPP service on the router. Stopping the Dialout PPP configuration does not automatically disable Dialout PPP when the router is booted. To stop the Dialout PPP service, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Stopping Dialout PPP...done.
```

The message will be displayed for a few seconds, and you will be returned to the Dialout PPP menu.

Viewing dialer messages

```
6. View dialer messages
```

Selecting this menu option will display any PPP dialer messages stored in the dialer log. If there are no messages in the log, the screen will display:

```
No messages.
```

Otherwise, the contents of the dialer log will be display using the **less** program. **less** allows you to scroll through the contents of the file using the arrow keys. At the bottom of the output, you will see the message:

```
Hit Q to exit.
```

Press **q** on the keyboard to exit the log output and return to the Dialout PPP menu.

Returning to the Service configuration menu

```
0. Service configuration
```

Selecting this menu option returns you to the “Service configuration” menu. To return to the Service configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Service configuration menu:

```
Service configuration
------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

XVIII. Configuring Services: Firewall Menu

This chapter describes how to configure the ImageStream router to use Linux's standard **iptables** utility. **iptables** is used for network and router security, traffic filtering including proxy redirection and firewalling using Network Address Translation (NAT). This chapter includes the following topics:

"Configuring firewalls using iptables"
"Enabling firewall at boot-time"
"Disabling firewall at boot-time"
"Instating firewall rules"
"Clearing firewall rules"
"Restoring the factory default firewall configuration"

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the "Firewall and QOS configuration" menu by pressing **4** on the keyboard and press **Enter** to configure the router's firewall and QOS configuration settings (again, your menu may look slightly different):

```
Firewall and QOS configuration
---------------------------------------------------------------
1. QOS Menu (diffserv), (instated)
2. Firewall (iptables), (instated)
0. Configuration menu
```

Select the “Firewall” menu by pressing **2** on the keyboard and press **Enter** to configure the router’s firewall settings (again, your menu may look slightly different):

```
Firewall (iptables), (instated)
---------------------------------------------------------------
1. Configure firewall rules
2. Enable firewall on boot
3. Disable firewall on boot
4. Instate firewall rules
5. Clear firewall rules
6. Display rules and packet counters
7. Restore to default configuration
0. Firewall and QOS configuration
```

Select the “Configure firewall rules” menu option by pressing **1** on the keyboard and press **Enter** to configure the router’s firewall settings. This will open the default firewall configuration file in your default text editor (your file may look slightly different):

The first line of the file:

```
#!/bin/sh
```

must remain unchanged. This line indicates to the router that the lines in the file are part of a shell script. Lines that begin with a **#** are comments and will not be processed by the router. You may add comments anywhere in the file. There is no limit on the number of comments you may have in a particular file, provided that you have enough system memory and flash space to store the file.

Configuring firewalls and packet filtering using iptables

ImageStream provides several complete tutorials in the Technical Notes section of its support Web site to assist you in configuring your firewall settings. The default configuration file includes some common examples also.

Once you have entered all of the firewall and packet filtering rules in this file, save the file by pressing **Control-X**. If you have made changes to the file, the router will prompt you to save the file at the bottom of the screen:

```
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
 Y Yes
```

```
 N No         ^C Cancel
```

Press **Y** on your keyboard. The router will prompt you for a file name:

```
File Name to write: /etc/rc.d/rc.firewall
^C Cancel
```

You should accept the default filename. If you choose to save the file in a different location, the router will not automatically locate the file and instate any changes. Press **Enter** on the keyboard to accept the default. The **^C** notation indicates the key combination **Control-C**. You may press **Control-C** at any time during the save process to return to the file.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Once you have saved the file by pressing **Enter**, the router will display:

```
Instating firewall rules...done.
```

and return you to the firewall menu:

```
Firewall (iptables), (instated)
---------------------------------------------------------------
1. Configure firewall rules
2. Enable firewall on boot
3. Disable firewall on boot
4. Instate firewall rules
5. Clear firewall rules
6. Display rules and packet counters
7. Restore to default configuration
0. Firewall and QOS configuration
```

Enabling firewall rules at boot-time

```
2. Enable firewall on boot
```

Selecting this menu option enables the firewall rules when the router is booted. This does not instate the firewall rules on the router if it is not running, unless the router is rebooted first. By default, the firewall configuration is enabled on boot. To enable firewall on boot, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
firewall enabled on boot.
```

If the firewall configuration has already been enabled on boot, the router will display the message:

```
firewall already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Firewall menu.

Disabling firewall rules at boot-time

```
3. Disable firewall on boot
```

Selecting this menu option disables the firewall rules when the router is booted. This does not remove the firewall rules on the router if it is running, unless the router is rebooted first. To disable the firewall rules on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
firewall disabled on boot.
```

If the firewall configuration has already been disabled on boot, the router will display the message:

```
firewall already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Firewall menu.

Instating firewall rules

```
4. Instate firewall rules
```

Selecting this menu option instates the firewall configuration on the router. Instating the firewall configuration does not automatically enable the firewall rules when the router is booted. To instate the firewall rules, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Instating firewall rules...done.
```

The message will be displayed for a few seconds, and you will be returned to the Firewall menu.

Clearing firewall rules

```
5. Clear firewall rules
```

Selecting menu option clears the firewall configuration on the router. Clearing the firewall configuration does not automatically disable the firewall rules when the router is booted. To clear the firewall rules, select this menu option by pressing **5** on the keyboard and pressing **Enter**. The router will display the message:

```
Clearing firewall rules...done.
```

The message will be displayed for a few seconds, and you will be returned to the Firewall menu.

Restoring the factory default firewall configuration

```
6. Restore to default configuration
```

Selecting this menu option removes the stored firewall configuration from the router's non-volatile flash memory. Selecting this menu option and confirming your selection will remove any user-defined firewall configurations from the router. This will not instate or clear any of the rules, and will not enable or disable firewall rules. Selecting this option will restore the router to the factory default firewall configuration only.

To restore the factory default firewall rules, select this menu option by pressing **6** on the keyboard and pressing **Enter**. The router will display a confirmation menu:

```
Set default config for firewall?
------------------------------------------------------------
1. Yes
2. No
0. Quit
```

Pressing **2** or **0** and **Enter** will return you to the Firewall menu without making any changes to the configuration. Confirming your decision to restore the factory default firewall configuration by pressing **1** and **Enter** will display:

```
firewall returned to default configuration.

Press enter/return to continue
```

Press **Enter** to return to the Firewall menu.

Returning to the Firewall and QOS menu

```
0. Firewall and QOS configuration
```

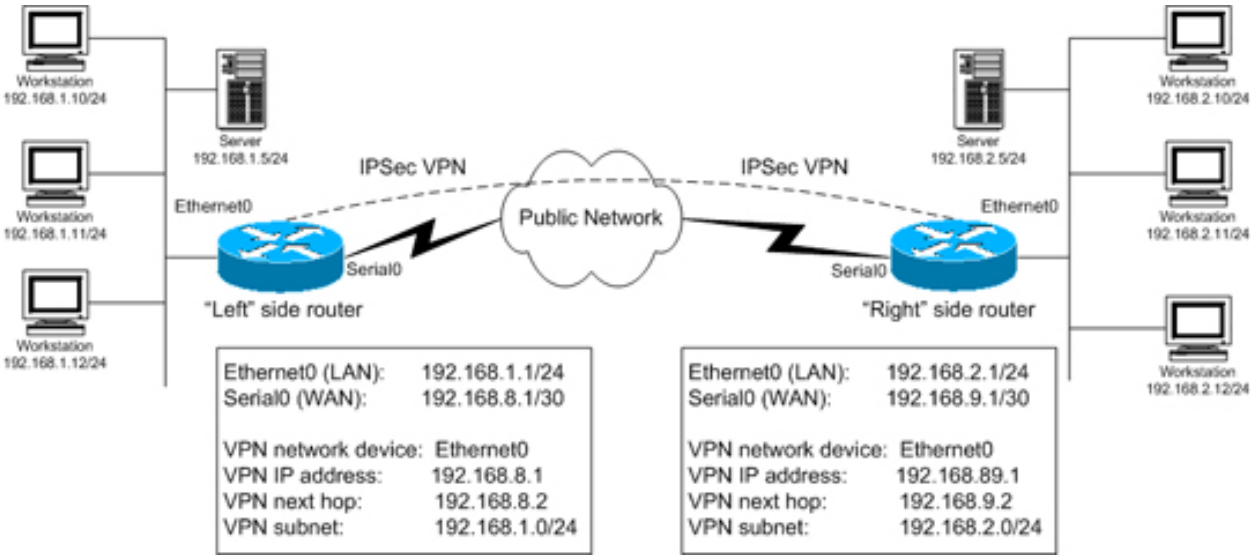
Selecting this menu option returns you to the "Firewall and QOS configuration" menu. To return to the Firewall and QOS configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Firewall and QOS configuration menu:

```
Firewall and QOS configuration
------------------------------------------------------------------
1. QOS Menu (diffserv), (instated)
2. Firewall (iptables), (instated)
0. Configuration menu
```

XIX. Configuring Services: IPSec VPN Menu

This chapter describes how to configure the IPSec Virtual Private Network (VPN) service on the ImageStream router. IPSec is Internet Protocol SECurity. It uses strong cryptography to provide both authentication and encryption services. Authentication ensures that packets are from the proper sender and have not been altered in transit. Encryption prevents unauthorized reading of packet contents.

These services allow you to build secure tunnels through untrusted networks, such as a public Frame Relay network or Internet backbone network. All traffic passing through the untrusted network is encrypted by the IPSec gateway and decrypted by the gateway at the other end. The result is Virtual Private Network or VPN. This is a network which is effectively private even though it includes machines at several different sites connected by an insecure network. This chapter outlines a simple network-to-network connection.



More advanced configurations are possible. This chapter includes the following topics:

"Configuring the IPSec VPN service"
"Enabling the IPSec VPN service at boot-time"
"Disabling the IPSec VPN service at boot-time"
"Starting the IPSec VPN service"
"Stopping the IPSec VPN service"

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
```

```
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the “Configuration menu” by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the “Service configuration” menu by pressing **5** on the keyboard and press **Enter** to configure the router’s service configuration settings (again, your menu may look slightly different):

```
Service configuration
------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

Select the “IPSec VPN” menu by pressing **4** on the keyboard and press **Enter** to configure the router’s IPSec VPN settings (again, your menu may look slightly different):

```
IPSec VPN (Free S/Wan), (stopped)
------------------------------------------------------------
1. Configure IPSec (Free S/Wan)
2. Generate a new Signature Key
3. Configure a basic IPSec VPN
4. Enable IPSec on boot
5. Disable IPSec on boot
6. Start IPSec
7. Stop IPSec
0. Service configuration
```

To configure the network-to-network VPN connection, you will need two IPSec-capable gateways with static IP addresses. The IP addresses must be the addresses connecting the gateways to the insecure network. For example, on a router with a LAN connected to Ethernet0 and a WAN connection through Serial0, the static IP would be the IP address of the Serial0 device. You will also need a network behind each gateway with non-overlapping IP ranges. Generally, this will be a LAN or a device that connects the gateway to a private, secure network.

Refer to the VPN diagram above if you do not understand the terms used in the table below. Before attempting to complete your VPN configuration, you should have the following information ready:

IPSec VPN Pre-Configuration Information

Have the following information ready before you start configuring the VPN

Parameter	Where to find it	Description
Left side VPN device	Network diagram	The router on the left side of the VPN tunnel diagram. This router will always be the “left” side endpoint for the purposes of configuring a VPN connection.
Right side VPN device	Network diagram	The router on the right side of the VPN tunnel diagram. This router will always be the “right” side endpoint for the purposes of configuring a VPN connection.

Left and right side network devices	Network diagram	The LAN or WAN interfaces used as the endpoints of the VPN tunnel. These devices are typically the WAN or LAN devices closest to the external network and not internal LAN or WAN devices.
Left and right side IP addresses	Line Provider or network administrator	The left and right side IP addresses will be the IP addresses of the left and right side network devices used for the VPN tunnel endpoints.
Left and right side next hop addresses	Line Provider or network administrator	The left and right side next hop addresses will be the gateway addresses for the VPN tunnel endpoints.
Left and right side subnets	Network diagram or network administrator	The left and right side subnets will be the networks to be connected across the VPN tunnel. These subnets must be non-overlapping.

Using the built-in automated script to configure a VPN tunnel

To configure a simple IPSec VPN, select the "Configure a basic IPSec VPN" menu option by pressing **3** on the keyboard and pressing **Enter**. This will start an interactive script that displays:

```
Now generating a key for this host (May take some time)...done.
Please see the ImageStream Technical Support Web site
or the ImageStream Router Installation Guide
for details on the information requested by this script.
```

The router will have generated a signature key used to authenticate the VPN connection. The router will then display:

```
Will this router be the [L]eft or [R]ight side tunnel endpoint
(L/r) ?
```

Enter the correct side for this router. The left and right side designations are not relative to the router. This router will always be either the left side or right side router. Use your network diagram to determine whether this router will act as the left or right side router. For example, if you want to configure this router as the left side router, enter **L** at this prompt and press **Enter**.

The router will then ask you to confirm your choice. In the example below, we have accepted the default configuration and set this router as the left side:

```
This router will be configured as the left side for this IPSec
configuration.  Is this correct (Y/n) :
```

If these values are correct, press **Y** or leave the entry blank and press **Enter**. If you have made a mistake, press **N** and **Enter** and the router will reprompt you for the information.

The script will then display:

```
Retrieving the public RSA key for this router...done
```

The router will retreive the public signature key generated earlier. This key will be used in the IPSec configuration file and as part of the authentication process with the other router.

The router will then display:

```
What interface will this router use as the VPN device (default:
Ethernet0) ?
```

At this prompt, enter the interface you want to use as the VPN device. Typically, this will be the device closest to the upstream Internet connection on your network. You can press **Enter** to accept the default value, or enter a device name. For example, to use Serial0 as the VPN device, enter **Serial0** at this prompt and press **Enter**.

The router will then ask you to confirm your choice. In the example below, we have set Serial0 as the VPN device:

```
This router will use Serial0 as the VPN device for this IPSec
configuration.  Is this correct (Y/n) :
```

If these values are correct, press **Y** or leave the entry blank and press **Enter**. If you have made a mistake, press **N** and **Enter** and the router will reprompt you for the information.

Based on our example above, the script will then display:

```
What is the IP address of Serial0 used for IPSec?
```

Enter the primary or secondary IP address used for the VPN tunnel endpoint. For example, to use 192.168.8.1 as the IP address for this side, enter **192.168.8.1** at this prompt and press **Enter**.

The router will then ask you to confirm your choice. In the example below, we have entered 192.168.8.1:

```
This router will use 192.168.8.1 as the IP address for this IPSec
configuration.  Is this correct (Y/n) :
```

If these values are correct, press **Y** or leave the entry blank and press **Enter**. If you have made a mistake, press **N** and **Enter** and the router will reprompt you for the information.

Based on our example above, the script will then display:

```
What is the next hop address for this router?
```

Enter the gateway IP address for this VPN tunnel endpoint. This address should be the one used by the router when traffic leaves the router for the other VPN tunnel endpoint. For example, to use 192.168.8.2 as the IP address for this side, enter **192.168.8.2** at this prompt and press **Enter**.

The router will then ask you to confirm your choice. In the example below, we have entered 192.168.8.2:

```
This router will use 192.168.8.2 as the next hop address for this
IPSec configuration.  Is this correct (Y/n) :
```

If these values are correct, press **Y** or leave the entry blank and press **Enter**. If you have made a mistake, press **N** and **Enter** and the router will reprompt you for the information.

The script will then display:

```
What is the subnet on this router that is to be accessible across
the VPN?

For the next question, please enter the value in the format of
"ipnetwork/bitmask"

For example, the Class C 192.168.1.x would be entered as
192.168.1.0/24.

Enter the subnet on this router to be accessible across the VPN :
```

Enter the subnet address for this side of the VPN tunnel. This subnet should be the network you want to make accessible from the other side of the VPN tunnel. For example, to use 192.168.1.0/24 as the subnet for this side, enter **192.168.1.0/24** at this prompt and press **Enter**.

The router will then ask you to confirm your choice. In the example below, we have entered 192.168.1.0/24:

```
This router will use 192.168.1.0/24 as the subnet on this router
to be accessible across the VPN.  Is this correct (Y/n) :
```

If these values are correct, press **Y** or leave the entry blank and press **Enter**. If you have made a mistake, press **N** and **Enter** and the router will reprompt you for the information.

Once you have entered the correct values for the first side, the router will then prompt you for the information on the other side of the VPN tunnel. Again, remember that the left and right side designations are not relative to the router. The left side router will always be the left side router and vice versa.

In the example above, the router will display:

```
Next, we will enter the values for the right side router...
```

The router will then prompt you for the identical information for the other side of the VPN tunnel. Please refer to the above section for assistance in answering the questions.

Once you have entered the values for the other endpoint, the router, based on our example, will display:

```
If the right side router is an ImageStream router, do you want to
attempt to get the right side router's public RSA key
automatically?  (Y/n) :
```

If the remote router is an ImageStream router, you can configure it for the IPSec VPN connection automatically. To use this feature, the router you are configuring must have a network connection to the remote router and the remote router must have a signature key already generated. If you want to attempt to get the remote router's public key, press **Y** or leave the entry blank and press **Enter**. If the remote router is not an ImageStream router, or if you do not have access or a connection to it, press **N** and **Enter** and the script will not attempt to automatically configure the remote router.

Autoconfiguring a VPN tunnel on a remote ImageStream router

If you have entered **Y** or left the entry blank and pressed **Enter** when prompted to get the remote router's public RSA key, the router will prompt you for the IP address of the remote router:

```
Enter the IP address of the right side router :
```

Enter the IP address of the remote router. This address must be accessible to the local router, and the remote router must have SSH enabled and accessible. If you enter an address that is not accessible, or your connection hangs, you will have an opportunity to terminate the connection. In the example below, we have entered 192.168.100.140 as the remote router:

```
Attempting to contact the right side router...
Press Control-\ at any time to interrupt the connection process.
Attempting to contact the right side router.  You will be
prompted for the password...
Warning: Permanently added '192.168.100.140' (RSA) to the list of
known hosts.
root@192.168.100.140's password:
```

Enter the password for the remote router and press **Enter**. The script will then download the remote router's RSA signature key for use in the VPN configuration process. The router will then display, based on our example:

```
ipsec.secrets        100% |*********************|  3814     00:00
Retrieving the public RSA key for the right side router...done
Successfully retrieved public RSA key.

Now creating the tunnel configuration for this router...done
```

If there is an error retreiving the key, either because an incorrect IP address was given or the ipsec.secrets file was not located, the router will display:

```
Unable to locate the IPSec keyfile on the right side router.
You must generate a key on the remote router!

Would you like to try again? (Y/n) :
```

You can generate an RSA signature key on the remote router, or check the connection to the remote router and try again by pressing **Y** or by leaving the entry blank and pressing **Enter**. Pressing **N** and **Enter** will put the router in manual configuration mode. Please see the section below on manual configuration of a VPN tunnel.

The router will then prompt you to configure the remote ImageStream router, assuming that the RSA signature key was retreived successfully:

```
The right side router is an ImageStream router.  Do you want to
attempt to configure the right side router also?  (Y/n) :
```

If you want to attempt to configure the remote router for the VPN tunnel, press **Y** or leave the entry blank and press **Enter**. If you do not want to configure the remote router, press **N** and **Enter** and the script will not attempt to automatically configure the remote router.

The router will then display, based on our example:

```
Now creating the tunnel configuration for the right side
router...done
Attempting to contact the right side router.  You will be
prompted for the password...
Press Control-\ at any time to interrupt the connection process.
root@192.168.100.140's password:
```

Enter the password for the remote router and press **Enter**. The script will then upload the proper VPN configuration file to the remote router. The router will then display:

```
ipsec.conf-right     100% |****************|  1581    00:00
Successfully copied the configuration file to the right side
router.

You must start the IPSec service before your configuration will
be active.  Remember to save your configuration to flash, or the
changes made in the IPSec configuration file will be lost.

Press enter/return to quit
```

If you have entered **N** when prompted to configure the remote router, the script will save a copy of the remote configuration and display:

```
A copy of the configuration file for the right side router has
been saved in: /tmp/ipsec.conf-right

You must start the IPSec service before your configuration will
be active.  Remember to save your configuration to flash, or the
changes made in the IPSec configuration file will be lost.

Press enter/return to quit
```

If the remote router is an ImageStream router or uses a FreeSWan implementation, you will find a copy of the configuration for that router in the /tmp directory. A copy of the local router's configuration, based on your entries, has been saved on the local router. Using this script does not start the IPSec service, nor will it enable the service on boot. Use the IPSec menu to start or stop IPSec or to enable or disable the service at boot-time.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Selecting manual configuration for a VPN tunnel

If you have entered **N** when prompted to get the remote router's public RSA key, the router will proceed with manual entry of the VPN tunnel configuration and will display, based on our example above:

```
Proceeding with manual entry...
Please paste the public key from the right side router.
Include only the key and NO other characters
When you are finished, press Enter/Return, then press Control-D
```

Enter the public RSA key only with no other special characters or values. The router will automatically remove any line breaks from the input. If you are pasting the public key from another ImageStream router or a FreeSWan implementation, do not include the "pubkey=" when you paste the value. If you are using a standard key, it will look similar to:

```
0sAQNnhVz28e6wHj0IAJzQQiJOTYKfE/+zJbLr86ZbJjfGNMP4gXLm3pf4XFYLCqH
bpYYQoYAq1GJiyTUnXe4k0glELTIqLCoM46U6AwRu9g1hA/NSnHPQD2KF+tlwKGYO
G3tD0pu79q6ks+52p7FO8UzdRxUvSYGtP0bs4XQnB1ZeT8g5uyt7ugmlYZh72W5Xe
qR7LCji29h5n2rR64WG385TiNPG60VOmyNHHKzhrR0IDs39hgxezNLW4QeVwb4SX6
/eYZUXGKv2R56R804OTZ0PyzlYQumMzB/KtUBfbwmAKGBAZTY5ODhwQYVL2LrW/Zg
3AAyhkn4lvcEfY8sV316H
```

The key for your routers will be unique and will not match the above example. Press **Enter** and then press **Control-D** when you are finished entering the key. The router will then process your input and display, based on our example:

```
Successfully parsed right side public RSA key.

Now creating the tunnel configuration for this router...done
A copy of the configuration file for the right side router has
been saved in: /tmp/ipsec.conf-right

You must start the IPSec service before your configuration will
be active.  Remember to save your configuration to flash, or the
changes made in the IPSec configuration file will be lost.


Press enter/return to quit
```

If the remote router is an ImageStream router or uses a FreeSWan implementation, you will find a copy of the configuration for that router in the /tmp directory. A copy of the local router's configuration, based on your entries, has been saved on the local router. Using this script does not start the IPSec service, nor will it enable the service on boot. Use the IPSec menu to start or stop IPSec or to enable or disable the service at boot-time.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Managing the IPSec service

Once you have exited the script by pressing **Enter**, the router will return you to the IPSec menu:

```
IPSec VPN (Free S/Wan), (stopped)
-------------------------------------------------------------
1. Configure IPSec (Free S/Wan)
2. Generate a new Signature Key
3. Configure a basic IPSec VPN
4. Enable IPSec on boot
5. Disable IPSec on boot
6. Start IPSec
7. Stop IPSec
0. Service configuration
```

Enabling IPSec at boot-time

```
4. Enable IPSec on boot
```

Selecting this menu option enables the IPSec service when the router is booted. This does not start the IPSec service on the router if it is not running, unless the router is rebooted first. By default, IPSec is disabled on boot. To enable IPSec at boot-time, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
ipsec enabled on boot.
```

If IPSec has already been enabled on boot, the router will display the message:

```
ipsec already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the SNMP menu.

Disabling IPSec at boot-time

```
5. Disable IPSec on boot
```

Selecting this menu option disables the IPSec service when the router is booted. This does not stop the IPSec service if it is running, unless the router is rebooted first. To disable IPSec on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
ipsec disabled on boot.
```

If IPSec has already been disabled on boot, the router will display the message:

```
ipsec already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the IPSec menu.

Starting the IPSec service

```
6. Start IPSec
```

Selecting this menu option starts the IPSec service on the router. Starting IPSec does not automatically enable the IPSec service when the router is booted. To start the IPSec service, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Starting ipsec...done.
```

The message will be displayed for a few seconds, and you will be returned to the IPSEc menu.

Stopping the IPSec service

```
7. Stopping IPSec
```

Selecting this menu option stops the IPSec service on the router. Stopping IPSec does not automatically disable the IPSec service when the router is booted. To stop the IPSec service, select this menu option by pressing **5** on the keyboard and pressing **Enter**. The router will display the message:

```
Stopping ipsec...done.
```

The message will be displayed for a few seconds, and you will be returned to the IPSec menu.

Returning to the Service configuration menu

```
0. Service configuration
```

Selecting this menu option returns you to the “Service configuration” menu. To return to the Service configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Service configuration menu:

```
Service configuration
-----------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

XX. Configuring Services: Network Interfaces Menu

This chapter describes how to operate the ImageStream router's SAND service. Configuration information for LAN and WAN devices is contained in previous chapters. This chapter includes the following topics:

"Configuring network interfaces using SAND"
"Enabling network interfaces at boot-time"
"Disabling network interfaces at boot-time"
"Starting the network interface service"
"Stopping the network interface service"

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

You may select "Network interface configuration" by pressing **3** on the keyboard and pressing **Enter**. Otherwise, select the "Service configuration" menu by pressing **5** on the keyboard and press **Enter** to configure the router's service configuration settings (again, your menu may look slightly different):

```
Service configuration
-------------------------------------------------------------
```

```
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

Select the "Network interfaces" menu by pressing **5** on the keyboard and press **Enter** to configure the router's network interface settings (again, your menu may look slightly different):

```
network interfaces (sand), (running)
------------------------------------------------------------
1. Configure network interfaces
2. Enable network interfaces on boot
3. Disable network interfaces on boot
4. Start network interfaces
5. Stop network interfaces
0. Service configuration
```

To configure SAND, select the "Configure network interfaces" menu option by pressing **1** on the keyboard and pressing **Enter**. This will open the default network interface configuration file (wan.conf) in your default text editor. See earlier chapters for information on configuring LAN and WAN devices on an ImageStream router.

Enabling network interfaces at boot-time

```
2. Enable network interfaces on boot
```

Selecting this menu option enables the network interface configurations when the router is booted. This does not start the network interface service on the router if it is not running, unless the router is rebooted first. By default, the network interface configuration is enabled on boot. To enable network interfaces on boot, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
sand enabled on boot.
```

If the network interface configuration has already been enabled on boot, the router will display the message:

```
sand already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Network interfaces menu.

Disabling network interfaces at boot-time

```
3. Disable network interfaces on boot
```

Selecting this menu option disables the network interfaces when the router is booted. This does not stop the network interface service if it is running, unless the router is rebooted first. To disable the network interface service on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
sand disabled on boot.
```

If the network interface service has already been disabled on boot, the router will display the message:

```
sand already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Network interfaces menu.

Starting the network interface service

```
4. Start network interfaces
```

Selecting this menu option starts the network interface service on the router. Starting the network interface configuration does not automatically enable the network interfaces when the router is booted. To start the network interface service, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Starting sand...done.
```

The message will be displayed for a few seconds, and you will be returned to the Network interfaces menu.

Stopping the network interface service

```
5. Stopping network interfaces
```

Selecting this menu option stops the network interface service on the router. Stopping the network interface configuration does not automatically disable the network interfaces when the router is booted. To stop the network interface service, select this menu option by pressing **5** on the keyboard and pressing **Enter**. The router will display the message:

```
Stopping sand...done.
```

The message will be displayed for a few seconds, and you will be returned to the Network interfaces menu.

Returning to the Service configuration menu

```
0. Service configuration
```

Selecting this menu option returns you to the “Service configuration” menu. To return to the Service configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Service configuration menu:

```
Service configuration
-------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

XXI. Configuring Services: Serial Console (sconsole) Menu

This chapter describes how to operate the ImageStream router's serial console service. The serial console service allows you to connect a modem, dumb terminal, terminal program such as minicom, TeraTerm or Hyperterminal to the router for out-of-band console management and configuration. This chapter includes the following topics:

"Configuring the serial console for use with a terminal or terminal program"
"Configuring the serial console for use with a modem"
"Enabling the serial console at boot-time"
"Disabling the serial console at boot-time"
"Starting the serial console service"
"Stopping the serial console service"

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the "Service configuration" menu by pressing **5** on the keyboard and press **Enter** to configure the router's service configuration settings (again, your menu may look slightly different):

```
Service configuration
------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

Select the “sconsole” menu by pressing **6** on the keyboard and press **Enter** to configure the router’s serial console settings (again, your menu may look slightly different):

```
sconsole (mgetty), (running)
------------------------------------------------------------
1. Configure sconsole options
2. Enable sconsole on boot
3. Disable sconsole on boot
4. Start sconsole
5. Stop sconsole
0. Service configuration
```

To configure sconsole, select the “Configure sconsole options” menu option by pressing **1** on the keyboard and pressing **Enter**. This will open the default sconsole configuration file in your default text editor (your file may look slightly different):

```
getty /bin/mgetty
tty   ttyS0
speed 9600
debug 0
```

Configuring the serial console for use with a terminal or terminal program

The order of the commands entered into this file is not important. The first step is to specify the Linux utility used to provide console services. Use the **getty** keyword to specify this program. The syntax for this command is:

getty { *path to program* }

Unless you have loaded your own serial tty control program onto the router, use the default value in the file.

The **tty** keyword specifies the serial port to use for serial console services. The **tty** command’s syntax is:

tty { *serial login terminal name* }

Unless you want to use a secondary serial port, and your router is equipped with a secondary port, use the default value in the file.

The **speed** keyword specifies the baud rate to use with the serial console. The default value is 9600 baud, which is a common setting for most dumb terminals and other programs. The **speed** keyword uses the syntax:

speed { *bps* }

Acceptable baud rates are *2400*, *4800*, *9600*, *19200*, *38400*, *57600*, and *115200*. The serial port uses 8 data bits, no parity bit, 1 stop bit and provides hardware flow control. These settings are not configurable.

Configuring the serial console for use with a modem

If you want to connect a modem to the router's serial port, you must add the **modem** keyword. This keyword will instruct the serial console program to initialize the attached modem and to automatically answer any inbound calls to the modem. Your modem must not be set to auto answer. The syntax of this command is:

modem

This command requires no parameters.

Once you have entered all of the configurations for your site in this file, save the file by pressing **Control-X**. If you have made changes to the file, the router will prompt you to save the file at the bottom of the screen:

```
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
 Y Yes
 N No          ^C Cancel
```

Press **Y** on your keyboard. The router will prompt you for a file name:

```
File Name to write: /etc/sconsoled.conf
^C Cancel
```

You should accept the default filename. If you choose to save the file in a different location, the router will not automatically locate the file and instate any changes. Press **Enter** on the keyboard to accept the default. The **^C** notation indicates the key combination **Control-C**. You may press **Control-C** at any time during the save process to return to the file.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Once you have saved the file by pressing **Enter**, the router will display:

```
Stopping sconsole...done
Starting sconsole...done
```

and return you to the Serial console menu:

```
sconsole (mgetty), (running)
------------------------------------------------------------
1. Configure sconsole options
2. Enable sconsole on boot
3. Disable sconsole on boot
4. Start sconsole
5. Stop sconsole
0. Service configuration
```

Enabling the serial console at boot-time

```
2. Enable sconsole on boot
```

Selecting this menu option enables the serial console when the router is booted. This does not start the serial console service on the router if it is not running, unless the router is rebooted first. By default, the serial console is enabled on boot. To enable the serial console boot, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
sconsole enabled on boot.
```

If the serial console has already been enabled on boot, the router will display the message:

```
sconsole already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Serial console menu.

Disabling the serial console at boot-time

```
3. Disable sconsole on boot
```

Selecting this menu option disables the serial console when the router is booted. This does not stop the serial console service if it is running, unless the router is rebooted first. To disable the serial console on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
sconsole disabled on boot.
```

If the serial console has already been disabled on boot, the router will display the message:

```
sconsole already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the Serial console menu.

Starting the serial console service

```
4. Start sconsole
```

Selecting this menu option starts the serial console service on the router. Starting the serial console does not automatically enable the serial console when the router is booted. To start the serial console service, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Starting sconsole...done.
```

The message will be displayed for a few seconds, and you will be returned to the Serial console menu.

Stopping the serial console service

```
5. Stopping sconsole
```

Selecting this menu option stops the serial console service on the router. Stopping the serial console configuration does not automatically disable the serial console when the router is booted. To stop the serial console service, select this menu option by pressing **5** on the keyboard and pressing **Enter**. The router will display the message:

```
Stopping sconsole...done.
```

The message will be displayed for a few seconds, and you will be returned to the Serial console menu.

Returning to the Service configuration menu

```
0. Service configuration
```

Selecting this menu option returns you to the “Service configuration” menu. To return to the Service configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Service configuration menu:

```
Service configuration
------------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

XXII. Configuring Services: SNMP Menu

This chapter describes how to configure the Simple Network Management Protocol (SNMP) service on the ImageStream router. The SNMP service allows you to access link status, traffic and configuration information via a standard MIB-II-compliant SNMP interface. The simple network management protocol (SNMP) is an application-layer protocol that allows devices to communicate management information. This chapter describes the basic configuration of the syslocation, syscontact and community variables. More advanced configurations are possible. This chapter includes the following topics:

"Configuring the SNMP service"
"Enabling SNMP at boot-time"
"Disabling SNMP at boot-time"
"Starting the SNMP service"
"Stopping the SNMP service"

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration and update menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the "Service configuration" menu by pressing **5** on the keyboard and press **Enter** to configure the router's service configuration settings (again, your menu may look slightly different):

```
Service configuration
------------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

Select the “snmp” menu by pressing **7** on the keyboard and press **Enter** to configure the router’s SNMP settings (again, your menu may look slightly different):

```
snmp, (running)
------------------------------------------------------------------
1. Configure snmp (net-snmp)
2. Enable snmp on boot (Does not start snmp)
3. Disable snmp on boot (Does not kill snmp)
4. Start snmp
5. Stop snmp
0. Service configuration
```

To configure SNMP, select the “Configure snmp” menu option by pressing **1** on the keyboard and pressing **Enter**. This will open the default SNMP configuration file in your default text editor (your file may look slightly different):

```
##############################################################
#
# snmpd.conf
#
#   - created by the snmpconf configuration program
#
##############################################################
# SECTION: System Information Setup
#
#   This section defines some of the information reported in
#   the "system" mib group in the mibII tree.

# syslocation: The [typically physical] location of the system.
#   arguments:  location_string

syslocation  Unknown
```

```
# syscontact: The contact information for the administrator
#   arguments:  contact_string

syscontact  root@localhost



##############################################################
# SECTION: Access Control Setup
#
#   This section defines who is allowed to talk to your running
#   snmp agent.

# rocommunity: a SNMPv1/SNMPv2c read-only access community name
#   arguments:  community [default|hostname|network/bits] [oid]

rocommunity  public
```

Configuring the SNMP service

Simple network management protocol (SNMP) monitoring is used to set and collect information on SNMP-capable devices. This feature is most often used to monitor network statistics such as usage and error rate. If SNMP monitoring is on, the router accepts SNMP queries. If SNMP monitoring is off, all SNMP queries are ignored.

The order of the commands entered into this file is not important. The first step is to set the location variable used by SNMP. This is an optional variable that can be used to identify location, configuration or other information about the system when it is queried via SNMP. The system location variable does not affect the operation of SNMP or the router. Use the **syslocation** keyword to specify this value. The syntax for this command is:

syslocation { *string* }

The first part of the entry (**syslocation**) specifies the variable to be set. The second part is the value of the variable. The length of this value should not exceed 256 characters. If more than a single word is used, the value must be quoted. For example:

```
syslocation  "Co-Lo Row 3, Rack 4"
```

The **syscontact** keyword typically specifies the e-mail address, telephone number or other contact responsible for the system. This keyword is also optional and can be up to 256 characters in length. The **syscontact** command's syntax is:

syscontact { *string* }

If more than a single word is used, the value must be quoted. For example:

```
syscontact  "root@localhost Joe Smith 800-555-1212"
```

Configuring the SNMP community string

Community strings allow you to control access to the MIB information on selected SNMP devices. The read community strings acts like a simple password to permit access to the SNMP agent information. Any device that is allowed to read or access the MIB information must know the community string specified in the SNMP configuration file. The default read community string is *public*. The command syntax is:

rocommunity { *string* }

Again, the string may be up to 256 characters and should be limited to a single word. Some SNMP readers do not support community names with space or other non-printable characters. For example:

```
rocommunity  router
```

sets the read community string to *router*.

Due to security and network transport issues inherent in SNMP, ImageStream routers do not support write communities. Community strings must be set on SNMP agents so that unauthorized users do not view configuration and status information.

Once you have entered all of the configurations for your site in this file, save the file by pressing **Control-X**. If you have made changes to the file, the router will prompt you to save the file at the bottom of the screen:

```
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
 Y Yes
 N No         ^C Cancel
```

Press **Y** on your keyboard. The router will prompt you for a file name:

```
File Name to write: /etc/snmp/snmpd.conf
^C Cancel
```

You should accept the default filename. If you choose to save the file in a different location, the router will not automatically locate the file and instate any changes. Press **Enter** on the keyboard to accept the default. The **^C** notation indicates the key combination **Control-C**. You may press **Control-C** at any time during the save process to return to the file.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Once you have saved the file by pressing **Enter**, the router will return you to the SNMP menu:

```
snmp, (running)
---------------------------------------------------------------
1. Configure snmp (net-snmp)
2. Enable snmp on boot (Does not start snmp)
3. Disable snmp on boot (Does not kill snmp)
4. Start snmp
5. Stop snmp
0. Service configuration
```

Enabling SNMP at boot-time

```
2. Enable snmp on boot
```

Selecting this menu option enables the SNMP service when the router is booted. This does not start the SNMP service on the router if it is not running, unless the router is rebooted first. By default, SNMP is disabled on boot. To enable SNMP at boot-time, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
snmp enabled on boot.
```

If SNMP has already been enabled on boot, the router will display the message:

```
snmp already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the SNMP menu.

Disabling SNMP at boot-time

```
3. Disable snmp on boot
```

Selecting this menu option disables the SNMP service when the router is booted. This does not stop the SNMP service if it is running, unless the router is rebooted first. To disable SNMP on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
snmp disabled on boot.
```

If SNMP has already been disabled on boot, the router will display the message:

```
snmp already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the SNMP menu.

Starting the SNMP service

```
4. Start snmp
```

Selecting this menu option starts the SNMP service on the router. Starting SNMP does not automatically enable the SNMP service when the router is booted. To start the SNMP service, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Starting snmp...done.
```

The message will be displayed for a few seconds, and you will be returned to the SNMP menu.

Stopping the SNMP service

```
5. Stopping snmp
```

Selecting this menu option stops the SNMP service on the router. Stopping SNMP does not automatically disable the SNMP service when the router is booted. To stop the SNMP service, select this menu option by pressing **5** on the keyboard and pressing **Enter**. The router will display the message:

```
Stopping snmp...done.
```

The message will be displayed for a few seconds, and you will be returned to the SNMP menu.

Returning to the Service configuration menu

```
0. Service configuration
```

Selecting this menu option returns you to the “Service configuration” menu. To return to the Service configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Service configuration menu:

```
Service configuration
-------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

XXIII. Configuring Services: SSH Menu

This chapter describes how to configure the secure shell (SSH) service on the ImageStream router. The secure shell service allows you to access the ImageStream router across a secure, encrypted link. SSH is generally used as an alternative to telnet and FTP for remote access. This chapter describes the basic configuration of the SSH service, including the port, IP address used by SSH, and other information. More advanced configurations are possible. This chapter includes the following topics:

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Configuration menu" by pressing **1** on the keyboard and press **Enter** to configure the router. The next menu should appear (your menu may look slightly different):

```
Configuration menu
-------------------------------------------------------------
1. AAA (Password) Configuration
2. Global configuration
3. Network interface configuration
4. Firewall and QOS configuration
5. Service configuration
6. Dynamic routing configuration
7. Save configuration to flash
0. ISis-Router main menu
```

Select the "Service configuration" menu by pressing **5** on the keyboard and press **Enter** to configure the router's service configuration settings (again, your menu may look slightly different):

```
Service configuration
------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

Select the “ssh” menu by pressing **8** on the keyboard and press **Enter** to configure the router’s SSH settings (again, your menu may look slightly different):

```
ssh (OpenSSH), (running)
------------------------------------------------------------
1. Configure ssh (OpenSSH)
2. Enable ssh on boot
3. Disable OpenSSH on boot
4. Start ssh
5. Stop ssh
6. Restore to default configuration
0. Service configuration
```

To configure SSH, select the “Configure ssh (OpenSSH)” menu option by pressing **1** on the keyboard and pressing **Enter**. This will open the default SSH configuration file in your default text editor (your file may look slightly different):

```
# This is ssh server systemwide configuration file.

Port 22
ListenAddress 0.0.0.0
HostKey /etc/ssh/ssh_host_key
ServerKeyBits 768
LoginGraceTime 600
KeyRegenerationInterval 3600
PermitRootLogin yes
StrictModes yes
X11Forwarding no
X11DisplayOffset 10
PrintMotd yes
KeepAlive yes
UseLogin no

#
# Loglevel replaces QuietMode and FascistLogging
#
```

```
SyslogFacility AUTH
#LogLevel INFO

#
# For this to work you will also need host keys in
/etc/ssh/ssh_known_hosts
#
RhostsRSAAuthentication no

#
# Don't read ~/.rhosts and ~/.shosts files
#
IgnoreRhosts yes
RhostsAuthentication no

#
# Uncomment if you don't trust ~/.ssh/known_hosts for
RhostsRSAAuthentication
#
#IgnoreUserKnownHosts yes

RSAAuthentication yes

# To disable tunneled clear text passwords, change to no here!
PasswordAuthentication yes
PermitEmptyPasswords no
HostKey /etc/ssh/ssh_host_rsa_key
HostKey /etc/ssh/ssh_host_dsa_key
```

Configuring the SSH service

ImageStream routers use OpenSSH. OpenSSH is an open source version of the SSH suite of network connectivity tools. Unlike telnet and ftp, ssh and the companion scp tool encrypt all traffic (including passwords) to effectively eliminate eavesdropping, connection hijacking, and other network-level attacks.

The order of the commands entered into this file is not important. **In most cases, the default configuration file is sufficient. Do not make changes in this file unless you are an advanced user experienced with OpenSSH.**

The first step is to configure the port used by the SSH service. By convention, port 22 has been reserved for SSH. Use the **Port** keyword to specify this value. The syntax for this command is:

Port { number }

The first part of the entry (**Port**) specifies the variable to be set. The second part is the value of the variable. Select an unused port. A list of ports is available on the router in the /etc/services file.

The other basic configuration keyword is the **ListenAddress** keyword. By default, the SSH service will repond on all addresses configured on the router. To restrict SSH access to a particular IP address, specify that address in this keyword. The **ListenAddress** keyword syntax is:

ListenAddress { *IP address* } *: [port]*

For example:

```
ListenAddress 192.168.100.1
```

Multiple **ListenAddress** options are permitted. If a port is not specified, the **Port** keyword described above must appear before the **ListenAddress** directive.

Many other keywords, both the ones listed in the default configuration and others, are supported. These additional keywords should only be adjusted by experienced administrators. If you have not used OpenSSH or similar SSH implementations, do not change any other values in this file.

Once you have entered all of the configurations for your site in this file, save the file by pressing **Control-X**. If you have made changes to the file, the router will prompt you to save the file at the bottom of the screen:

```
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
 Y Yes
 N No         ^C Cancel
```

Press **Y** on your keyboard. The router will prompt you for a file name:

```
File Name to write: /etc/ssh/sshd_config
^C Cancel
```

You should accept the default filename. If you choose to save the file in a different location, the router will not automatically locate the file and instate any changes. Press **Enter** on the keyboard to accept the default. The **^C** notation indicates the key combination **Control-C**. You may press **Control-C** at any time during the save process to return to the file.

Note: You must save the settings to the router's non-volatile flash memory! If the router is rebooted before saving, your changes will be lost! See the chapter "Backup/Restore Menu: Managing Configurations" for more information.

Once you have saved the file by pressing **Enter**, the router will return you to the SSH menu:

```
ssh (OpenSSH), (running)
------------------------------------------------------------
1. Configure ssh (OpenSSH)
2. Enable ssh on boot
3. Disable OpenSSH on boot
4. Start ssh
5. Stop ssh
6. Restore to default configuration
0. Service configuration
```

Enabling SSH at boot-time

```
2. Enable ssh on boot
```

Selecting this menu option enables the SSH service when the router is booted. This does not start the SSH service on the router if it is not running, unless the router is rebooted first. By default, SSH is disabled on boot. To enable SSH at boot-time, select this menu option by pressing **2** on the keyboard and pressing **Enter**. The router will display the message:

```
ssh enabled on boot.
```

If SNMP has already been enabled on boot, the router will display the message:

```
sssh already enabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the SSH menu.

Disabling SSH at boot-time

```
3. Disable ssh on boot
```

Selecting this menu option disables the SSH service when the router is booted. This does not stop the SSH service if it is running, unless the router is rebooted first. To disable SSH on boot, select this menu option by pressing **3** on the keyboard and pressing **Enter**. The router will display the message:

```
ssh disabled on boot.
```

If SSH has already been disabled on boot, the router will display the message:

```
ssh already disabled on boot.
```

The resulting message will be displayed for a few seconds, and you will be returned to the SSH menu.

Starting the SSH service

```
4. Start ssh
```

Selecting this menu option starts the SSH service on the router. Starting SSH does not automatically enable the SSH service when the router is booted. To start the SSH service, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will display the message:

```
Starting ssh...done.
```

The message will be displayed for a few seconds, and you will be returned to the SSH menu.

Stopping the SSH service

```
5. Stopping ssh
```

Selecting this menu option stops the SSH service on the router. Stopping SSH does not automatically disable the SSH service when the router is booted. To stop the SSH service, select this menu option by pressing **5** on the keyboard and pressing **Enter**. The router will display the message:

```
Stopping ssh...done.
```

The message will be displayed for a few seconds, and you will be returned to the SSH menu.

Returning to the Service configuration menu

```
0. Service configuration
```

Selecting this menu option returns you to the “Service configuration” menu. To return to the Service configuration menu, press **0** on the keyboard and press **Enter**. The router will display the Service configuration menu:

```
Service configuration
-------------------------------------------------------------
1. System scheduler (cron), (running)
2. Dialout PPP, (stopped)
3. IPSec VPN (Free S/Wan), (stopped)
4. NetFlow exporter (nprobe), (stopped)
5. network interfaces (sand), (running)
6. sconsole (mgetty), (running)
7. snmp (net-snmp), (stopped)
8. ssh (OpenSSH), (running)
0. Configuration menu
```

XXIV. Backup/Restore Menu: Managing Configurations

This chapter describes how to manage router configurations. ImageStream routers are equipped with flash storage for managing the user-defined configurations on the router. The router also provides other tools to allow for configuration backup and restoration on remote systems. This chapter includes the following topics:

"Backing up configurations to floppy disk"
"Backing up configurations to a remote machine using ftp"
"Backing up configurations to a remote machine using scp"
"Backing up configurations to the flash device"
"Backing up configurations to a file"
"Backing up configurations through a terminal program using ZMODEM"
"Restoring configurations from a floppy disk"
"Restoring configurations from a remote machine using ftp"
"Restoring configurations from a remote machine using scp"
"Restoring configurations from the flash device"
"Restoring configurations from a file"
"Restoring configurations through a terminal program using ZMODEM"

The user-defined configuration backup procedure is configurable. The **backup** utility on the router uses a pre-defined file list to determine which files will be archived. You can archive additional configurations or programs that you have stored on your ImageStream router. The **backup** utility checks the */root/FileListing* file available from the Bash shell. Any directory paths or files listed in this file will be archived.

Note: You should only change the */root/FileListing* file if you are an advanced user. The default values in this file will back up all user-defined configurations automatically, and there is generally no need to change them.

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Backup/Restore" option by pressing **4** on the keyboard and press **Enter**. The next menu should appear:

```
Backup/Restore
-------------------------------------------------------------
1. Backup methods
2. Restore methods
0. ISis-Router main menu
```

Using the Backup menu

Select the “Backup methods” option by pressing **1** on the keyboard and press **Enter**. The “Backup methods” menu should appear:

```
Backup methods
-------------------------------------------------------------
1. Backup configuration to floppy
2. Backup configuration to another machine via ftp
3. Backup configuration to another machine via scp
4. Backup configuration to flash
5. Backup configuration to file
6. Backup configuration to another machine via zmodem
0. Backup/Restore
```

Backing up configurations to a floppy disk

```
1. Backup configuration to floppy
```

To use this option, your router must be a model that is equipped with a 3.5” floppy drive. If your router does not have a floppy drive, you cannot use this backup option. To backup your configurations to a floppy disk, insert a floppy disk into the drive and select this menu option by pressing **1** on the keyboard and pressing **Enter**. The floppy disk does not have to be formatted. The backup process will delete any pre-existing data on the floppy disk. After selecting this option, the router will display the message:

```
Insert a floppy diskette then hit <Enter>.
```

Press **Enter** once you have inserted the floppy disk. The router will then format the floppy disk and backup the running configuration from memory to the floppy disk:

```
Formatting floppy diskette...done
Configuration saved to floppy
```

The message will be displayed for a few seconds, and you will be returned to the Backup methods menu.

Backing up configurations to a remote machine using ftp

```
2. Backup configuration to another machine via ftp
```

The router configurations can be backed up on a remote machine using the FTP service. To backup your configurations, select this menu option by pressing **2** on the keyboard and pressing **Enter**. To use this option, you must have access to a remote machine with a functioning FTP server and user account. After selecting this option, the router will display the message:

```
Enter destination to backup to "<user>@<hostname>:<directory>" :
```

Enter the login name, hostname or IP address, and path where the configuration archive should be stored at this prompt. For example, if the remote FTP server is located at the IP address **192.168.100.10**, your user account is **support**, and you want to store the configuration archive in the **/tmp** directory, you would enter:

```
support@192.168.100.10:/tmp
```

at the prompt. Press **Enter** once you have entered the remote server's login and path information. Once the router has connected to the remote FTP server, you will be prompted for a password.

The router will then copy a file named **ISisConfig.tar.gz** to the specified location on the FTP server. This file has been archived and compressed using the tar and gzip utilities, respectively. When the file has been copied successfully, a status message will be displayed for a few seconds (your message will look slightly different):

```
/tmp/ISisConfig.tar.gz:                    114.28 kB    2.75 MB/s
```

The message will be displayed for a few seconds, and you will be returned to the Backup methods menu.

Backing up configurations to a remote machine using scp

```
3. Backup configuration to another machine via scp
```

The router configurations can be backed up on a remote machine using the scp (secure copy) service. To use this option, you must have access to a remote machine with a functioning SSH server and user account. To backup your configurations, select this menu option by pressing **3** on the keyboard and pressing **Enter**. After selecting this option, the router will display the message:

```
Enter destination to backup to "<user>@<hostname>:<directory>" :
```

Enter the login name, hostname or IP address, and path where the configuration archive should be stored at this prompt. For example, if the remote FTP server is located at the IP address **192.168.100.10**, your user account is **support**, and you want to store the configuration archive in the **/tmp** directory, you would enter:

```
support@192.168.100.10:/tmp
```

at the prompt. Press **Enter** once you have entered the remote server's login and path information. The router will temporarily save the configuration archive in the **/tmp** directory and then attempt to copy it to the remote server you specificed. Once the router has connected to the remote machine, you will be prompted for a password.

The router will then copy a file named **ISisConfig.tar.gz** to the specified location on the remote machine. This file has been archived and compressed using the tar and gzip utilities, respectively. When the file has been copied successfully, a status message will be displayed for a few seconds (your message will look slightly different):

```
ISisConfig.tar.gz    100% |******************|   114 KB    00:00
Configuration saved to
support@192.168.100.10:/tmp/ISisConfig.tar.gz
```

The message will be displayed for a few seconds, and you will be returned to the Backup methods menu.

Backing up configurations to the flash device

```
4. Backup configuration to flash
```

To backup your configurations to the router's built-in flash storage device, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will then backup the running configuration from memory to the flash device and display the message:

```
Configuration saved to flash
```

The message will be displayed for a few seconds, and you will be returned to the Backup methods menu.

Backing up configurations to a file

```
5. Backup configuration to file
```

To backup your configurations to a file stored temporarily in the running memory, select this menu option by pressing **5** on the keyboard and pressing **Enter**. Selecting this option will allow you to save your configurations to a file, which can be used to quickly restore a configuration or to copy to a remote machine. After selecting this option, the router will display the message:

```
Enter filename to backup configuration to :
```

Enter the path to the location where you want to store the configuration archive. For example, it you want to store the configuration tar archive in the **/tmp** directory in a file called **ISisConfig.tar.gz**, you would enter:

```
/tmp/ISisConfig.tar.gz
```

at the prompt. Remember that the configuration archive created by the router is a gzipped tar archive, regardless of any file extensions you choose. By convention, ImageStream recommends using the .tar.gz extension on any configuration archive. Press **Enter** once you have entered the path information.

The router will then backup the running configuration from memory to the flash device and display the message (your message may differ):

```
Settings saved to /tmp/ISisConfig.tar.gz
```

The message will be displayed for a few seconds, and you will be returned to the Backup methods menu.

Backing up configurations through a terminal program using ZMODEM

```
6. Backup configuration to another machine via zmodem
```

The router configurations can be backed up on a remote machine using the ZMODEM, XMODEM or YMODEM services. To use this option, your terminal program must support at least one of ZMODEM, XMODEM or YMODEM transfer services. Common programs such as minicom or HyperTerminal support ZMODEM transfers. Many popular SSH and telnet clients support ZMODEM transfers also. Refer to the documentation of your terminal program to determine if it supports this transfer function.

ImageStream recommends using the ZMODEM protocol whenever possible, since this protocol will transfer files the most quickly. To backup your configurations, select this menu option by pressing **6** on the keyboard and pressing **Enter**. After selecting this option, the router will display the message:

```
Enter filename to create and send to remote system :
```

Enter the filename that you want to use for the configuration. Remember that the configuration archive created by the router is a gzipped tar archive, regardless of any file extensions you choose. By convention, ImageStream recommends using the .tar.gz extension on any configuration archive. For example, if you want to store the file **router.tar.gz**, you would enter:

```
router.tar.gz
```

at the prompt. Press **Enter** once you have entered the filename information. The router will temporarily save the configuration archive in the **/tmp** directory and then will display the message:

```
Use X, Y or ZMODEM protocol (Default: ZMODEM)? (x/y/Z)
```

Select the file transfer protocol that you want to use and that is supported by your terminal program. If you are unsure, select the default, ZMODEM, by pressing **Z** and **Enter**. The router will pause to allow you to set up your terminal program, if necessary (in most cases, terminal programs require no advance setup to receive files using ZMODEM). When you are ready to copy the file to the remote machine, press **Enter**.

The router will then copy a file using the name you specified in the first step to your local machine. Your terminal program may prompt you for a location to save this file, or the program may save the file automatically. Please refer to the documentation of your terminal program to determine where the backup archive will be stored. When the file has been copied successfully, you will be returned to the Backup methods menu.

Returning to the Backup/Restore menu

```
0. Backup/Restore
```

Selecting this menu option returns you to the “Backup/Restore” menu. To return to the Backup/Restore menu, press **0** on the keyboard and press **Enter**. The router will display the Backup/Restore menu:

```
Backup/Restore
------------------------------------------------------------
1. Backup methods
2. Restore methods
0. ISis-Router main menu
```

Using the Restore menu

Select the “Restore methods” option by pressing **2** on the keyboard and press **Enter**. ImageStream router configurations are portable between router models. You can restore configurations from any ImageStream router onto any other ImageStream router. After selecting the “Restore methods” option, “Restore methods” menu should appear:

```
Restore methods
---------------------------------------------------------------
1. Restore configuration from floppy
2. Restore configuration from another machine via ftp
3. Restore configuration from another machine via scp
4. Restore configuration from flash
5. Restore configuration from file
6. Restore configuration from another machine via zmodem
7. Restore router to factory defaults
0. Backup/Restore
```

Restoring configurations from a floppy disk

```
1. Restore configuration from floppy
```

To use this option, your router must be a model that is equipped with a 3.5” floppy drive. If your router does not have a floppy drive, you cannot use this restore option. To restore your configurations from a floppy disk, insert a floppy disk with a configuration saved from an ImageStream router into the drive and select this menu option by pressing **1** on the keyboard and pressing **Enter**. The floppy disk must be one created by a **backup floppy** command (or menu option) on an ImageStream router. If a floppy disk without a valid configuration archive is inserted, the router will display the message:

```
Error: Not a backup configuration. Please insert proper floppy.
```

Once you have inserted a valid floppy disk, the router will copy the configuration from the floppy disk to the running configuration in memory and display the message:

```
Configuration restored from floppy
```

The message will be displayed for a few seconds, and you will be returned to the Restore methods menu. You must backup your configurations to flash after using this method. The restoration process only affects the running configuration, and not the one stored in the router’s nonvolatile flash device.

Restoring configurations from a remote machine using ftp

```
2. Restore configuration from another machine via ftp
```

The router configurations can be restored from an archive stored on a remote machine by using the FTP service. To restore your configurations via FTP, select this menu option by pressing **2** on the keyboard and pressing **Enter**. To use this option, you must have access to a stored configuration on a remote machine with a functioning FTP server and user account. After selecting this option, the router will display the message:

```
Enter where to restore backup from
"<user>@<hostname>:<directory>" :
```

Enter the login name, hostname or IP address, and path where the configuration archive named **ISisConfig.tar.gz** is located at this prompt. For example, if the remote FTP server is located at the IP address **192.168.100.10**, your user account is **support**, and you want to restore the configuration archive from the **/tmp** directory, you would enter:

```
support@192.168.100.10:/tmp
```

at the prompt. Press **Enter** once you have entered the remote server's login and path information. Once the router has connected to the remote FTP server, you will be prompted for a password. When the file has been copied successfully, the router will copy the configuration from the configuration archive to the running configuration in memory. The router will display a status message (your message will look slightly different):

```
/tmp/ISisConfig.tar.gz:                    114.28 kB    2.75 MB/s
```

The message will be displayed for a few seconds, and you will be returned to the Restore methods menu. You must backup your configurations to flash after using this method. The restoration process only affects the running configuration, and not the one stored in the router's nonvolatile flash device.

Restoring configurations from a remote machine using scp

```
3. Restore configuration from another machine via scp
```

The router configurations can be restored from an archive stored on a remote machine by using the scp (secure copy) service. To restore your configurations via scp, select this menu option by pressing **3** on the keyboard and pressing **Enter**. To use this option, you must have access to a stored configuration on a remote machine with a functioning SSH server and user account. After selecting this option, the router will display the message:

```
Enter where to restore backup from
"<user>@<hostname>:<directory>" :
```

Enter the login name, hostname or IP address, and path where the configuration archive named **ISisConfig.tar.gz** is located at this prompt. For example, if the remote server is located at the IP address **192.168.100.10**, your user account is **support**, and you want to restore the configuration archive from the **/tmp** directory, you would enter:

```
support@192.168.100.10:/tmp
```

at the prompt. Press **Enter** once you have entered the remote server's login and path information. Once the router has connected to the remote server, you will be prompted for a password. When the file has been copied successfully, the router will copy the configuration from the configuration archive to the running configuration in memory. The router will display a status message (your message will look slightly different):

```
ISisConfig.tar.gz    100% |*****************|   114 KB    00:00
Configuration restored from support@192.168.100.10:/tmp
```

The message will be displayed for a few seconds, and you will be returned to the Restore methods menu. You must backup your configurations to flash after using this method. The restoration process only affects the running configuration, and not the one stored in the router's nonvolatile flash device.

Restore configurations from the flash device

```
4. Restore configuration from flash
```

To restore your configurations from the router's built-in flash storage device, select this menu option by pressing **4** on the keyboard and pressing **Enter**. The router will then copy the stored configuration from the flash device to the running configuration in memory display the message:

```
Configuration restored from flash
```

The message will be displayed for a few seconds, and you will be returned to the Restore methods menu.

Restore configurations from a file

```
5. Backup configuration to file
```

To restore your configurations from a file stored temporarily in the running memory, select this menu option by pressing **5** on the keyboard and pressing **Enter**. Selecting this option will allow you to restore your configurations from a file. After selecting this option, the router will display the message:

```
Enter filename to restore configuration from :
```

Enter the path to the location where you want to store the configuration archive. For example, it you want to store the configuration tar archive in the **/tmp** directory in a file called **ISisConfig.tar.gz**, you would enter:

```
/tmp/ISisConfig.tar.gz
```

at the prompt. Remember that the configuration archive created by the router is a gzipped tar archive, regardless of any file extensions you choose. By convention, ImageStream recommends using the .tar.gz extension on any configuration archive. Press **Enter** once you have entered the path information.

The router will then restore the running configuration using the configuration archive you specified and display the message (your message may differ):

```
Settings restored from /tmp/ISisConfig.tar.gz
```

The message will be displayed for a few seconds, and you will be returned to the Restore methods menu.

Backing up configurations through a terminal program using ZMODEM

```
6. Restore configuration from another machine via zmodem
```

The router configurations can be restored from a remote machine using the ZMODEM, XMODEM or YMODEM services. To use this option, your terminal program must support at least one of ZMODEM, XMODEM or YMODEM transfer services. Common programs such as minicom or HyperTerminal support ZMODEM transfers. Many popular SSH and telnet clients support ZMODEM transfers also. Refer to the documentation of your terminal program to determine if it supports this transfer function.

ImageStream recommends using the ZMODEM protocol whenever possible, since this protocol will transfer files the most quickly. To restore your configurations, select this menu option by pressing **6** on the keyboard and pressing **Enter**. After selecting this option, the router will display the message:

```
Use X, Y or ZMODEM protocol (Default: ZMODEM)? (x/y/Z)
```

Select the file transfer protocol that you want to use and that is supported by your terminal program. If you are unsure, select the default, ZMODEM, by pressing **Z** and **Enter**. The router will pause to allow you to set up your terminal program, if necessary (in most cases, terminal programs require no advance setup to receive files using ZMODEM). When you are ready to copy the file from the remote machine, press **Enter**.

The router will then restore the running configuration using the configuration archive you specified and display the message (your message may differ):

```
Configuration restored from ISisConfig.tar.gz
```

The message will be displayed for a few seconds, and you will be returned to the Restore methods menu.

Restore router to factory defaults

```
7. Restore router to factory defaults
```

To restore your router's flash device to its factory default settings, select this menu option by pressing **7** on the keyboard and pressing **Enter**. Selecting this option will clear all user-defined configurations from the flash device on the router. This option does not affect the running configuration. After selecting this option, the router will display a menu:

```
Restore router to factory defaults
------------------------------------------------------------
1. Yes
0. No
```

Press **1** on the keyboard and press **Enter** to confirm that you want to restore the router to factory defaults. The router will display the message:

```
1+0 records in
1+0 records out
Router restored to factory defaults

Press enter/return to quit
```

Press **Enter** on the keyboard to return to the menu. Press **0** on the keyboard and press **Enter** to return to the Restore methods menu:

```
Restore methods
------------------------------------------------------------
1. Restore configuration from floppy
2. Restore configuration from another machine via ftp
3. Restore configuration from another machine via scp
4. Restore configuration from flash
5. Restore configuration from file
6. Restore configuration from another machine via zmodem
7. Restore router to factory defaults
0. Backup/Restore
```

Returning to the Backup/Restore menu

```
0. Backup/Restore
```

Selecting this menu option returns you to the “Backup/Restore” menu. To return to the Backup/Restore menu, press **0** on the keyboard and press **Enter**. The router will display the Backup/Restore menu:

```
Backup/Restore
------------------------------------------------------------
1. Backup methods
2. Restore methods
0. ISis-Router main menu
```

XXV. Using The Interface Statistics (stats) Program

This chapter describes how to use the real-time interface statistics program (stats) on the ImageStream router. The stats program allows you to access detailed information about the LAN, WAN and virtual interfaces on an ImageStream router in an easy-to-use, real-time layout. This chapter describes the basic operation of the stats program, including the summary, detail, and CSU/DSU screen and sorting options. This chapter includes the following topics:

After logging in, the main menu is displayed (your menu may look slightly different):

```
ISis-Router main menu
-------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

Select the "Show interface status" option by pressing **2** on the keyboard and press **Enter**. This will display a screen with one-line summaries of each interface and sub-interface in your system.

Understanding the summary screen

Once you have selected the "Show interface status" option, the router will display the summary statistics screen (your exact display will differ):

```
17:27:21              Interface Summary                                  router
#  Port      Description          Encaps       Bandwidth    HW  Proto  In   Out
 0 Ethernet0 100Mb Ethernet       100baseTx-FD 100.00 Mbit  up   up     3%   2%
 1 Serial0   ISis PCI 604-T1 Port 0                         down shut
 2 Serial1   ISis PCI 604-T1 Port 1                         down shut
 3 Serial2   Qwest T1             Cisco HDLC     1.54 Mbit  up   up    18%  41%
 4 Serial3   Qwest T1             Cisco HDLC     1.54 Mbit  up   up    20%  41%
 5 Serial4   ISis PCI 522-T1 Port Frame Relay    1.54 Mbit  up   up    63%  19%
 6   Serial4.1   Sprintlink T1                   1.54 Mbit  up   up    63%  19%
 7 Serial5   ISis PCI 522-T1 Port Frame Relay    1.54 Mbit  up  down   00:00:12
 8   Serial5.1   Office to TNT                   1.54 Mbit  up  down   00:00:12
 9 Bonder0   Qwest T1s            none           3.07 Mbit  up   up    19%  41%
-------------------------------------------------------------------------------
d Detail | s Sleep interval | n Next | p Previous | h Help | q Quit
```

Each line of the output is described below, beginning with the first line:

17:27:21

The current system time. This timestamp is updated according to the Sleep interval. The default interval is 3 seconds.

Interface Summary

A label indicating that you are viewing the summary screen.

router

The hostname configured on the router.

Line two contains the column labels explaining the statistics output.

#

Indicates the line number in the summary output. When selecting the detail option, you will be prompted for this line number.

Port

This column shows the name of the corresponding device configured in the interface configuration file (wan.conf) file.

Description

This column shows the value configured by the description keyword (if any) in the interface configuration file (wan.conf) file. A default description is displayed if one has not been manually configured.

Encapsulation

Displays the configured encapsulation for the device. Ethernet devices will show the configured or negotiated link speed, according to the Ethernet port's MII registers. Devices that have not been configured or that are administratively shut down will not display a value. **Bonder** and other special devices will not display a value.

Bandwidth

Indicates the bandwidth value or channel group configured in the interface configuration file (wan.conf) or learned from the integrated CSU/DSU on the port. Devices that have not been configured or that are administratively shut down will not display a value. **Bonder** devices will display the combined bandwidth of all active bonded devices.

HW

Indicates whether or not the interface hardware connection to the telephone company network or external CSU/DSU is active. If a carrier signal is detected on the line, this column will display **up**. If carrier is not detected on the line, or if the interface has not been configured or administratively shut down, the column will display **down**.

Proto

Indicates whether the software processes that handle the device's protocol consider the line usable (that is, whether keepalives are successful) or if it has been taken down by an administrator. If a usable connection has been established, this column will display **up**. If a connection has not been established, the column will display **down**. If the device is administratively shut down, the column will display **shut**. Protocols, such as *rawip* or *frame-relay ietf* with LMI disabled, will always display **up** if the hardware connection is **up**.

In/Out

Displays the amount of traffic currently on the interface. The percentage displayed is calculated using the sleep interval and bandwidth value on the interface. If the device has not been up since the router was booted or the SAND service started, the columns will display **never up**. If the device is administratively shut down, the columns will not display any values. If the hardware or protocol is down on the device, the length of time since the device's status changed to down will be displayed in the columns.

For example, we'll examine lines 2, 3 and 8:

`2 Serial1`	`ISis PCI 604-T1 Port 1`		`down shut`	
Line number and device name	Default description field. No value is set in wan.conf	No encapsulation or bandwidth, since device is not enabled.	Interface is administratively down (shutdown command used in wan.conf, or port left unconfigured).	
`3 Serial2`	`Qwest T1`	`Cisco HDLC 1.54 Mbit`	`up up`	`18% 41%`
Line number and device name	Configured value from Serial2 section in wan.conf	Cisco HDLC encapsulation. Bandwidth determined from integrated CSU/DSU or **bandwidth** keyword.	Both the carrier signal and the HDLC protocol keepalives are detected.	Current inbound and outbound traffic percentages
`8 Serial5.1`	`Office to TNT`	`1.54 Mbit`	`up down`	`00:00:12`
Line number and subinterface name	Configured value from Serial5.1 section in wan.conf	No encapsulation, since device is a frame relay subinterface. Bandwidth is learned from the master interface.	Frame relay protocol keepalives are not detected, and line protocol is down. In the above example, the line has been down for 12 seconds.	

The last line of output on the summary screen displays commonly used commands:

```
d Detail | s Sleep interval | n Next | p Previous | h Help | q Quit
```

d Detail

Pressing **d** on the keyboard and entering a line number at the prompt will display the detailed statistical and configuration information for the port. See "Understanding the detail screen" for more information.

s Sleep interval

Pressing **s** on the keyboard and entering a time interval in seconds at the prompt will set the interval between screen updates. The default interval is 3 seconds, meaning that the statistics will be updated and the screen refreshed every 3 seconds.

n Next | p Previous

If your router has more interfaces than the terminal can display on a single page, these options will appear. Pressing **n** on the keyboard will advance the display to the next page of summary information, if any. Pressing **p** on the keyword will return the display to the previous page of summary information, if any. If all of the router interfaces are displayed on the page, these options will not appear.

h Help

Pressing **h** on the keyboard and entering a line number at the prompt will display a screen listing all of the available commands in the interface statistics program.

q Quit

Pressing **q** on the keyboard will exit the interface statistics program and return you to the router menu.

Understanding the detail screen for Ethernet devices

Selecting **d** and choosing an interface number, when prompted, on the summary screen will display the detailed statistical and configuration information for that particular device (your display will differ):

```
18:40:44              Ethernet0 Detail                                      lab1
-------------------------------------------------------------------------------
Ethernet0 is  up , protocol is  up
     Description       : 100Mb Ethernet
     Encapsulation     : 100baseTx-FD
     IP address        : 192.168.100.140 255.255.255.0
     Broadcast address : 192.168.100.255

     Link status: Link beat established
     Auto-negotiation: disabled (Forced speed is 100 Mbps, full-duplex)
     Partner capabilities: 100baseTx-FD, 100baseTx, 10baseT-FD, 10baseT

     Bandwidth: 100.00 Mbit  Load in:   0% Load out:   0%
     3 second average input rate :    0.94 Kb/s,   117.91 B/s, 2 packets/s
     3 second average output rate:    3.40 Kb/s,    0.42 KB/s, 1 packets/s
          Rx Packets            8,797          764,424 bytes
          Tx Packets            8,145        4,326,005 bytes
          Rx Errors: 0  (0 CRC  0 frame  0 fifo  0 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)

-------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

The last line of output on the detail screen displays commonly used commands:

```
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

c CSU

Pressing **c** on the keyboard will display the detailed statistical information for the integrated CSU/DSU on a port. Selecting this option for an Ethernet device will display a “CSU statistics not available” message.

y Summary

Pressing **y** on the keyboard will return you to the statistical summary output. See "Understanding the summary screen" for more information.

n Next | p Previous

Pressing **n** on the keyboard will advance the display to the next interface in the router, if any. Pressing **p** on the keyword will return the display to the previous interface in the router, if any.

h Help

Pressing **h** on the keyboard and entering a line number at the prompt will display a screen listing all of the available commands in the interface statistics program.

z Zero

Pressing **z** on the keyboard will temporarily clear the statistics on the interface. This will only clear the output until you quit the interface statistics program.

q Quit

Pressing **q** on the keyboard will exit the interface statistics program and return you to the router menu.

The table below shows the significant fields in the example display above.

Field	**Description**
Ethernet… is {up | down}	Indicates whether the interface hardware is currently active (whether a link beat is present).
protocol is {up | down | administratively down}	Indicates whether the Ethernet device's MII registers consider the line usable (that is, whether a link has been established).
Description	Displays the value of the description parameter specified in the interface configuration file (wan.conf) or a default description for the port.
Encapsulation	Displays the link speed and duplex configuration negotiated or set in the Ethernet device's MII registers.
IP address	Indicates the Internet address and subnet

	mask configured on the interface in the interface configuration file (wan.conf).
Broadcast address	Specifies the broadcast address determined by the IP address/netmask combination configured on the interface.
Link status	Displays the MII link status of the Ethernet interfaces. This status should correspond to the link status indication on the connected device.
Auto-negotiation	Displays **enabled** and the negotiated value when MII negotiation is enabled on the port. Displays **disabled** and the forced configuration speed when MII negotiation is disabled on the port.
Partner capabilities	Displays the MII-advertised capabilities of the connected devices.
Bandwidth	Indicates the value of the bandwidth parameter that has been determined automatically by autonegotiation or a forced configuration.
Load in	Indicates the inbound load on the interface as a fraction of the bandwidth, calculated as an average over the current sleep interval.
Load out	Indicates the outbound load on the interface as a fraction of the bandwidth, calculated as an average over the current sleep interval
…second average input rate	Indicates the actual inbound data rate load on the interface, calculated as an average over the specified sleep interval
…second average output rate	Indicates the actual outbound data rate load on the interface, calculated as an average over the specified sleep interval
Rx/Tx Packets	Displays the total number of error-free packets received/sent by the system and total number of bytes, including data and MAC encapsulation in the error-free packets received/sent by the system.
Rx/Tx Errors	Displays the total number of no buffer (fifo), CRC, frame, overrun, ignored, and abort error counts recorded on the interface.
CRC	Indicates the number of cyclic redundancy checksum errors generated by the originating station or far-end device that

	did not match the checksum calculated from the data received. On a serial link, CRCs usually indicate noise, gain hits, or other transmission problems.
Frame	Indicates the number of packets received with a CRC error and a noninteger number of octets. On a serial line, this is usually the result of noise or other transmission problems.
Fifo	Indicates the number of received packets discarded because there was no buffer space in the main system.
dropped	Indicates the number of received packets ignored by the interface because the interface hardware ran low on internal buffers.
Collisions	Indicates the number of packet collisions detected by the interface on the connected Ethernet network. Normally, collisions will only occur on an interface running in half-duplex mode.

Understanding the detail screen for other devices

Selecting **d** and choosing an interface number, when prompted, on the summary screen will display the detailed statistical and configuration information for that particular device (your display will differ):

```
18:08:37              Serial2 Detail                                    router
-------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 0  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
-------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

The last line of output on the detail screen displays commonly used commands:

c CSU

Pressing **c** on the keyboard will display the detailed statistical information for the integrated CSU/DSU on a port. See “Understanding the CSU/DSU detail screen” for more information. Selecting this option for a device without an integrated CSU/DSU will display a “CSU statistics not available” message.

y Summary

Pressing **y** on the keyboard will return you to the statistical summary output. See “Understanding the summary screen” for more information.

n Next | p Previous

Pressing **n** on the keyboard will advance the display to the next interface in the router, if any. Pressing **p** on the keyword will return the display to the previous interface in the router, if any.

h Help

Pressing **h** on the keyboard and entering a line number at the prompt will display a screen listing all of the available commands in the interface statistics program.

z Zero

Pressing **z** on the keyboard will temporarily clear the statistics on the interface. This will only clear the output until you quit the interface statistics program.

q Quit

Pressing **q** on the keyboard will exit the interface statistics program and return you to the router menu.

The table below shows the significant fields in the example display above.

Field	Description
Serial… is {up | down}	Indicates whether the interface hardware is currently active (whether a carrier signal

	is present).
protocol is {up | down | administratively down}	Indicates whether the software processes that handle the line protocol consider the line usable (that is, whether keepalives are successful) or if it has been taken down by an administrator.
Description	Displays the value of the description parameter specified in the interface configuration file (wan.conf) or a default description for the port.
MTU	Displays the maximum transmission unit of the interface.
Encapsulation	Displays the encapsulation method configured on the interface.
IP address	Indicates the Internet address and subnet mask configured on the interface in the interface configuration file (wan.conf).
Broadcast address	Specifies the broadcast address determined by the IP address/netmask combination configured on the interface.
Line has been { up | down } since…	Number of hours, minutes, and seconds since the status of the interface last changed. When the number of hours since the last status change exceeds 24 hours, the number of days and hours is displayed in parenthesis. If the number of days exceeds 7, the number of weeks, days and hours is displayed in parenthesis. Interfaces that have never been up will specify “Line has not been up since the drivers were loaded.”
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface.
Last output	Number of hours, minutes, and seconds since the last packet was successfully transmitted by an interface.
Bandwidth	Indicates the value of the bandwidth parameter that has been configured for the interface or that has been determined automatically. If the interface is attached to a serial line with a line speed that does not match the default, use the **bandwidth** command in the interface configuration file (wan.conf) to specify the correct line speed for this serial line.

Load in	Indicates the inbound load on the interface as a fraction of the bandwidth, calculated as an average over the current sleep interval.
Load out	Indicates the outbound load on the interface as a fraction of the bandwidth, calculated as an average over the current sleep interval
…second average input rate	Indicates the actual inbound data rate load on the interface, calculated as an average over the specified sleep interval
…second average output rate	Indicates the actual outbound data rate load on the interface, calculated as an average over the specified sleep interval
Rx/Tx Packets	Displays the total number of error-free packets received/sent by the system and total number of bytes, including data and MAC encapsulation in the error-free packets received/sent by the system.
Rx/Tx Errors	Displays the total number of no buffer (fifo), CRC, frame, overrun, ignored, and abort error counts recorded on the interface.
CRC	Indicates the number of cyclic redundancy checksum errors generated by the originating station or far-end device that did not match the checksum calculated from the data received. On a serial link, CRCs usually indicate noise, gain hits, or other transmission problems.
frame	Indicates the number of packets received with a CRC error and a noninteger number of octets. On a serial line, this is usually the result of noise or other transmission problems.
fifo	Indicates the number of received packets discarded because there was no buffer space in the main system.
Dropped	Indicates the number of received packets ignored by the interface because the interface hardware ran low on internal buffers.
Carrier transitions	Indicates the number of times the carrier signal of an interface has changed state. For example, if data carrier detect (DCD) goes down and comes up, the carrier

	transition counter will increment two times. Indicates line problems if the carrier signal is changing state often.
DCD/DSR/DTR/RTS/CTS	Displays the status of signals tracked by the serial card or integrated CSU/DSU. If a signal is not tracked by the interface, the signal will display “N/A”.

Understanding the CSU/DSU detail screen for other devices

Selecting **c** on the detail screen will display the detailed statistical information for the integrated CSU/DSU on that particular device. Not all CSU/DSUs provide statistical reporting. It is not possible to modify the sleep interval for the CSU/DSU detail screen. The sleep interval is fixed at 15 seconds (your display will differ):

```
19:02:22              Serial0.1 CSU Statistics                            router
--------------------------------------------------------------------------------
Firmware version: 0.14
CSU self test: no failures
Rx status: no alarms
Tx status: no alarms
Far end CSU status: normal
Loopback: csu will respond to loop up command, not currently looped up

Statistics for current interval (2 seconds elapsed):


                 Errored seconds: 0     Controlled slip seconds: 0
          Bursty errored seconds: 0            Degraded minutes: 0
        Severely errored seconds: 0        Path code violations: 0
Severely errored framing seconds: 0        Line errored seconds: 0
             Unavailable seconds: 0        Line code violations: 0

Line status information:
  The line appears to be up.
--------------------------------------------------------------------------------
y Summary | d Detail | z Zero | h Help | q Quit
```

The last line of output on the detail screen displays commonly used commands:

```
y Summary | d Detail | z Zero | h Help | q Quit
```

y Summary

Pressing **y** on the keyboard will return you to the statistical summary output. See “Understanding the summary screen” for more information.

d Detail

Pressing **d** on the keyboard and entering a line number at the prompt will display the detailed statistical and configuration information for the port. See “Understanding the detail screen” for more information.

z Zero

Pressing **z** on the keyboard will temporarily clear the statistics on the interface. This will only clear the output until you quit the interface statistics program.

h Help

Pressing **h** on the keyboard and entering a line number at the prompt will display a screen listing all of the available commands in the interface statistics program.

q Quit

Pressing **q** on the keyboard will exit the interface statistics program and return you to the router menu.

The table below shows the significant fields in the example display above.

Field	Description
Firmware version	Displays the software version of the integrated CSU/DSU. This software version does not correspond to the installed router distribution and is not user-serviceable.
CSU self test	Indicates whether or not the CSU/DSU passed its internal test when first initialized. If the test has failed, contact ImageStream technical support for assistance.
Rx status	Displays any active alarms on the CSU/DSU's receiver. Displays **no alarms** under normal operation. The status is generally only affected by local cabling between the CSU/DSU and telephone company demarcation point.
Tx status	Displays any active alarms on the CSU/DSU's transmitter. Displays **no alarms** under normal operation. The status is generally only affected by local cabling between the CSU/DSU and telephone company demarcation point.

Far end CSU status	Displays any active alarms reported by the remote CSU/DSU. Remote CSU/DSUs that do not support performance monitoring will cause a **PRM – Performance monitoring failure** message to be displayed. This error alone will not affect the operation of the CSU/DSU.
Loopback	Indicates the loop status of the CSU/DSU. Will display **Looped** when the CSU/DSU is placed into remote loopback mode by a remote CSU/DSU or other test equipment.
Errored seconds	The number of 1-second periods within the current interval with one or more errored blocks of any type.
Bursty errored seconds	The number of 1-second periods within the current interval with at least one errored block but less than 320 CRC errors.
Severely errored seconds	The number of 1-second periods within the current interval with more than 320 errored blocks (T1/E1) or 44 errored blocks (DS3/E3).
Severely errored framing seconds	The number of 1-second periods within the current interval with one or more Out Of Frame (OOF) errors.
Unavailable seconds	The number of 1-second periods within the current interval with a Loss Of Signal (LOS) error or periods that are a part of 10 consecutive severely errored seconds.
Controlled slip seconds	The number of 1-second periods within the current interval with replication or deletion of the payload bits in a frame. Generally, this error indicates a synchronization problem between the line signal and the CSU/DSU.
Degraded minutes	The number of 1-minute periods where the number of errors exceeds 1,000,000.
Path code violations	The number of CRC or frame synchronization errors in the current interval.
Line errored seconds	The number of 1-second periods within the current interval in which one or more Line Code Violations (LCVs) are detected.

Line code violations	The number of Bipolar Violations (BPVs), or the occurrence of a pulse of the same polarity as the previous pulse, and Excessive Zeroes (EXZ) errors, or the occurrence of more than 7 contiguous zeroes (15 in AMI encoding), detected.
Line status information	Messages generated by SAND to assist in troubleshooting alarm and error conditions.

Returning to the Main menu

To return to the router's Main menu, press **q** on the keyboard at any time in the interface statistics program. The router will display the Main menu:

```
ISis-Router main menu
-------------------------------------------------------------------
1. Configuration menu
2. Show interface status
3. Advanced
4. Router software management
5. Backup/Restore
6. halt/reboot
0. Log off
```

XXVI. Troubleshooting

This chapter presents general troubleshooting information and a discussion of tools and techniques for troubleshooting serial connections. The chapter includes the following topics:

“Troubleshooting with the interface statistics detail screen”
“Serial Lines: Line Status Conditions”
“Serial Lines: Increasing Output Drops On Serial Link”
“Serial Lines: Increasing Input FIFO Buffer Drops on Serial Link”
“Serial Lines: Increasing Input Non-FIFO Buffer Drops on Serial Link”
“Serial Lines: Input Errors Of Over 1% Of Total Interface Traffic”
“Serial Lines: Troubleshooting Serial Line Input Errors”
“Serial Lines: Increasing Carrier Transitions Count on Serial Link”
“Troubleshooting Clocking Problems”
“Troubleshooting T1/E1 CSU/DSU Problems”

Troubleshooting with the interface statistics detail screen

The output of the interface statistics detail screen displays information specific to the serial interface or subinterface. Please See the chapter “Using The Interface Statistics (stats) Program”, for more information on accessing this program. The example below shows the output of the detail page for a High-Level Data Link Control (HDLC) serial interface.

This section describes how to use this screen to diagnose serial line connectivity problems in a wide area network (WAN) environment. The following sections describe some of the important fields of the command output. For detailed descriptions of each field, See the chapter “Using The Interface Statistics (stats) Program”.

Serial Lines: Line Status Conditions

```
18:08:37              Serial2 Detail                                    router
-------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 568  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
```

```
------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

You can identify four possible states in the interface status line (in **bold**) of the example display above:

Serial2 is up, line protocol is up
Serial2 is down, line protocol is down
Serial2 is up, line protocol is down
Serial2 is administratively down, line protocol is down

The table below shows the interface status conditions for the example “Serial2” device, possible problems associated with the conditions, and potential solutions to those problems.

Status Condition	Possible Problem	Solution
Serial2 is up, line protocol is up	• None	1. This is the normal line condition. No action required.
Serial2 is down, line protocol is down	• Local router is misconfigured • Typically indicates that the router is not sensing a carrier signal, except with X.21 serial interfaces and unstructured mode E1, where there is no carrier signal • Telephone company problem-Line is down or line is not connected to CSU/DSU • Faulty or incorrect cabling • Hardware failure (CSU/DSU)	1. Check the **DCD =** section near the bottom of the output to see if the carrier detect signal is active, or insert a breakout box on the line to check for the CD signal. 2. Verify that you are using the proper cable and interface (see the *Hardware Installation Guide*). 3. Insert a breakout box and check all control leads. 4. Contact your leased line provider or other carrier service to see if there is a problem. 5. If you suspect faulty router hardware, change the serial line to another port. If the connection comes up, the previously connected interface has a problem. 6. Swap faulty parts.
Serial2 is up, line protocol is down	• Local or remote router is misconfigured • Remote router is not using IETF frame relay (when using frame relay encapsulation) • Remote router is not using proper ATM encapsulation (when using ATM encapsulation) • Keepalives are not being sent by remote router • Leased line provider or other carrier service problem-Noisy line, or misconfigured or failed switch	7. Insert a loopback plug into the CSU/DSU (or crossover the coaxial cable from the transmit to the receive side) and see if the router receives its own packets normally. You should see a received packet for each transmitted packet. 8. If data is being received normally, a telephone company problem or a misconfigured/failed remote router is the likely problem. 9. If the problem appears to be on the remote end, repeat Step 1

	• Failed local or remote CSU/DSU • Router hardware failure (local or remote)	on the remote CSU/DSU. 10. Verify all cabling. Make sure that the cable is attached to the correct interface, the correct CSU/DSU, and the correct telephone company network termination point. 11. Enable the **debug protocol** command in the interface configuration. The **debug protocol** command displays all protocol negotiation packets to the router's debug log, available from the Advanced menu. 12. **Caution:** Because debugging output is assigned a high priority in the CPU process, it can use considerable system resources. For this reason, use **debug** commands only to troubleshoot specific problems or during troubleshooting sessions with ImageStream's technical support staff. Moreover, it is best to use **debug** commands during periods of low network traffic and fewer users. Debugging during these periods decreases the likelihood that increased **debug** command processing overhead will affect system use. 13. If the port does not receive its own packets back when looped, a router hardware problem is likely. 14. If you suspect faulty router hardware, change the serial line to an unused port. If the connection comes up, the previously connected interface has a problem. 15. If the line protocol comes up and the keepalive counter increments in the debug log, the problem is *not* in the local router. Troubleshoot the serial line as described in the section "Troubleshooting clocking Problems" later in this chapter. 16. Swap faulty parts.
Serial2 is up, line protocol is down	• Missing internal **clock source** interface configuration command • Missing **timeslots** interface configuration command	1. Add the **service-module XX clock source** *internal* interface configuration command on the serial interface. See the *Command Reference* for the correct syntax.

	• Failed remote CSU/DSU • Failed or incorrect cable • Router hardware failure	2. Add the **service-module XX timeslots** interface configuration command on the serial interface. See the *Command Reference* for the correct syntax. 3. Verify that the correct cable is being used. 4. If the line protocol is still down, there is a possible hardware failure or cabling problem. Insert a breakout box and observe leads. 5. If you suspect faulty router hardware, change the serial line to an unused port. If the connection comes up, the previously connected interface has a problem. 6. Swap faulty parts.
Serial2 is administratively down, line protocol is down	• Router configuration includes the **shutdown** interface configuration command	1. Check the interface configuration for the **shutdown** command. 2. Delete the **shutdown** interface configuration command.

Serial Lines: Increasing Output Drops on Serial Link

```
18:08:37              Serial2 Detail                                    router
------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 568  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

Output drops appear in the Tx Errors section (in **bold**) of the interface detail screen when the router is attempting to hand off a packet to a transmit buffer but no buffers are available. The table below shows the possible problems that may cause an increasing number of output drops on a serial link, and potential solutions to those problems.

Possible Problem	Solution
• Output (Tx) rate to serial interface exceeds bandwidth available on serial link	1. Minimize periodic broadcast traffic (such as routing updates, or spanning tree bridging algorithm updates) by using firewall/filtering rules or by disabling unneeded services. For example, to disable the spanning tree algorithm, use the command **spanning-tree disabled** in the interface configuration. 2. Implement queuing and prioritization using quality of service (QoS) tools. For information on configuring QoS, see the chapter “Configuring Services: Quality of Service Menu”. 3. **Note:** Output drops are acceptable under certain conditions. For instance, if a link is known to be overused (with no way to remedy the situation), it is often preferable to drop packets than to queue them. This is true for protocols that support flow control and can retransmit data (such as TCP/IP). However, some protocols, such as UDP (ping, SNMP, etc.) are sensitive to dropped packets and often do not accommodate retransmission.

Serial Lines: Increasing Input FIFO Buffer Drops on Serial Link

```
18:08:37              Serial2 Detail                                    router
------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 568  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

Input FIFO buffer drops appear in the Rx Errors section (in **bold**) of the interface detail screen when too many packets from that interface are being processed by the router. The table below shows the possible problems that may cause an increasing number of input drops on a serial link, and potential solutions to those problems.

Possible Problem	Solution
• Input rate exceeds the capacity of the router or input queues exceed the size of output queues	1. **Note**: Input drop problems are typically seen when traffic is being routed between faster interfaces (such as Ethernet and serial interfaces. When traffic is light, no drops occur. As traffic rates increase, packet backlogs start occurring. Routers drop packets during these congested periods. 2. Implement queuing and prioritization using quality of service

(QoS) tools. For information on configuring QoS, see the chapter “Configuring Services: Quality of Service Menu”.

3. **Note:** Input drops are acceptable under certain conditions. For instance, if a link is known to be overused (with no way to remedy the situation), it is often preferable to drop packets than to queue them. This is true for protocols that support flow control and can retransmit data (such as TCP/IP). However, some protocols, such as UDP (ping, SNMP, etc.) are sensitive to dropped packets and often do not accommodate retransmission.

Serial Lines: Increasing Non-FIFO Input Drops on Serial Link

```
18:08:37              Serial2 Detail                                  router
-------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 568  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
-------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

Non-FIFO input drops appear in the Rx Errors section (in **bold**) of the interface detail screen when the router receives a packet that cannot be processed. The table below shows the possible problems that may cause an increasing number of non-FIFO input drops on a serial link, and potential solutions to those problems.

Possible Problem	Solution
• Non-IP/SNAP packets being processed by IP/SNAP interface	1. Check remote router configuration to ensure that only supported data types are being transmitted across the serial link. Disable forwarding of non-supported data types. 2. **Note:** Input drops do not necessarily denote a problem that must be addressed if the drop percentage is small compared to the total interface traffic.
• Proprietary diagnostic packet types being sent by remote router	1. Disable proprietary diagnostic packets such as Nortel “Breath of Life” and Cisco Discovery Protocol. 2. **Note:** Input drops do not necessarily denote a problem that must be addressed if the drop percentage is small compared to the total interface traffic.

Serial Lines: Input Errors Of Over 1% Of Total Interface Traffic

```
18:08:37              Serial2 Detail                                    router
-------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 568  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
-------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

If input errors appear in the Rx Errors section (in **bold**) of the interface detail screen, there are several possible sources of those errors. An input error (Rx Errors) value for CRC (cyclic redundancy check) and/or frame above one percent of the total input (Rx Packets) traffic indicates a line problem that should be isolated and corrected. The table below shows the possible problems that may cause input drops to exceed 1% of total traffic on a serial link, and potential solutions to those problems.

Possible Problem	Solution
The following problems can result in this symptom: • Faulty telephone company equipment • Noisy serial line • Incorrect clocking configuration • Incorrect cable or cable too long • Faulty cable or connection • Faulty CSU/DSU • Faulty router hardware • Improper or malfunctioning media converter, line tap or other device being used between router and CSU/DSU	1. Use a serial analyzer to isolate the source of the input errors. If you detect errors, it is likely that there is a hardware problem or a clock mismatch in a device that is external to the router. 2. Use a loopback plug (or cross over a coaxial cable) to isolate the router and CSU/DSU from the telephone company equipment or other carrier equipment. 3. Look for patterns. For example, if errors occur at a consistent interval, they could be related to a periodic function such as the sending of routing updates or broadcast traffic. 4. Check for any errors or alarms on the telephone company equipment or other carrier equipment. 5. If the problem can be isolated to the telephone company equipment or other carrier equipment, ask your provider to fully test the line. If simple automated tests do not locate the problem, ask the provider to run the following tests in order: • All 0's for 5-20 minutes with no errors • All 1's for 5-20 minutes with no errors • Quasi-random word (QRW) for 5-20 minutes with no errors

Serial Lines: Troubleshooting Serial Line Input Errors

```
18:08:37              Serial2 Detail                                    router
--------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 568  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
--------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

If input errors appear in the Rx Errors section (in **bold**) of the interface detail screen, there are several possible problems that may be causing these errors. The table below shows the possible problems that may cause input drops to exceed 1% of total traffic on a serial link, and potential solutions to those problems.

Input Error Type	Possible Problem	Solution
CRC errors (CRC)	Cyclic Redundancy Check errors occur when the CRC calculation produces an error-indicating that data is corrupted-for one of the following reasons: • Noisy serial line • Serial cable is too long, or the cable is not shielded (interference or signal loss problems) • CSU/DSU clocking is incorrectly configured • "Ones density" problem on T1 link (incorrect framing or encoding configuration)	1. Ensure that the line is clean enough for transmission requirements. Shield the cable if necessary. 2. Make sure the cable is within the recommended length-ideally, no more than 50 feet (15.24 meters) from the telephone company or carrier equipment. 3. Make sure the cable between the CSU/DSU and the router is within the recommended length-ideally, no more than 25 feet (7.62 meters) for V.35. 4. Ensure that all devices are properly configured for a common and single line clock. Each line must have one and only one clock source configured on

		all devices. In most cases, the leased line provider will provide the clocking for the line. 5. Make certain that the local and remote CSU/DSU are configured for the same framing and encoding scheme as that used by the leased-line or other carrier service (for example, ESF/B8ZS or CCS/HDB3). 6. Contact your leased-line or other carrier service and have it perform integrity tests on the line. If simple automated tests do not locate the problem, ask the provider to run the following tests in order: • All 0's for 5-20 minutes with no errors • All 1's for 5-20 minutes with no errors • Quasi-random word (QRW) for 5-20 minutes with no errors
Framing errors (frame)	A framing error occurs when a packet does not end on an 8-bit byte boundary for one of the following reasons: • Noisy serial line • Improperly designed cable; serial cable is too long; the cable is not shielded (interference or signal loss problems) • The CSU/DSU line clock is incorrectly configured; more than one clock source is configured on the line • "Ones density" problem on T1 link (incorrect framing or encoding specification)	1. Ensure that the line is clean enough for transmission requirements. Shield the cable if necessary. Make certain you are using the correct cable. 2. Make sure the cable is within the recommended length-ideally, no more than 50 feet (15.24 meters) from the telephone company or carrier equipment. 3. Make sure the cable between the CSU/DSU and the router is within the recommended length-ideally, no more than 25 feet (7.62 meters) for V.35. 4. Ensure that all devices are properly configured for a common and single line clock. Each line must have one and only one clock source configured on all devices. In most

cases, the leased line provider will provide the clocking for the line.

5. Make certain that the local and remote CSU/DSU are configured for the same framing and encoding scheme as that used by the leased-line or other carrier service (for example, ESF/B8ZS or CCS/HDB3).
6. Contact your leased-line or other carrier service and have it perform integrity tests on the line. If simple automated tests do not locate the problem, ask the provider to run the following tests in order:
   - All 0's for 5-20 minutes with no errors
   - All 1's for 5-20 minutes with no errors
   - Quasi-random word (QRW) for 5-20 minutes with no errors

Serial Lines: Increasing Carrier Transitions Count on Serial Link

```
18:08:37              Serial2 Detail                                    router
-------------------------------------------------------------------------------
Serial2 is  up , protocol is  up
     Description       : Qwest T1
     Encapsulation     : Cisco HDLC
     IP address        : 63.148.112.74 255.255.255.252
     Broadcast address : 63.148.112.75

     Line has been up since Mon Oct 28 14:59:54 2002 (1w3h)
     Last input :   00:00:00    Last output:   00:00:00

     Bandwidth:   1.54 Mbit  Load in:  23% Load out:  37%
     3 second average input rate :  354.58 Kb/s,   44.32 KB/s, 112 packets/s
     3 second average output rate:    0.57 Mb/s,   71.64 KB/s, 142 packets/s
          Rx Packets      265,482,595        7,851,846 bytes
          Tx Packets      378,208,552      388,020,255 bytes
          Rx Errors: 568  (0 CRC  235 frame  0 fifo  333 dropped)
          Tx Errors: 0  (0 collisions  0 fifo  0 dropped)
          Carrier transitions 7
          DCD =  up  DSR =  n/a DTR =  n/a RTS =  n/a CTS =  n/a
-------------------------------------------------------------------------------
c CSU | y Summary | n Next | p Previous | z Zero | h Help | q Quit
```

If carrier transitions (in **bold**) appear in the interface detail screen, there are several possible problems that may be causing these errors. Carrier transitions appear whenever there is an interruption in the carrier signal (such as an interface reset at the remote end of a link, or a line problem). The table below shows the possible problems that may cause carrier transitions, and potential solutions to those problems.

Possible Problem	Solution
• Line interruptions due to an external source (such as physical separation of cabling, red or yellow T1 alarms, or lightning striking somewhere along the network) • Bad line causing carrier detection transitions • Congestion on link (typically associated with output drops) • Faulty switch, CSU/DSU, or router hardware	1. If there is a high number of output drops in the interface statistics detail screen, see the section "Serial Lines: Increasing Output Drops on Serial Link," earlier in this chapter. 2. If the carrier transitions are coupled with input errors, the problem is probably a bad link or bad CSU/DSU. Contact your leased line or other carrier service and swap faulty equipment as necessary. 3. Check hardware at both ends of the link. Attach a breakout box or a serial analyzer and test to determine source of problems. 4. If an analyzer or breakout box is unable to identify any external problems, check the router hardware. 5. Swap faulty equipment as necessary.

Troubleshooting Clocking Problems

Clocking conflicts in serial connections can lead either to chronic loss of connection service or to degraded performance. This section discusses the important aspects of clocking problems: clocking problem causes, detecting clocking problems, isolating clocking problems, and clocking problem solutions.

Clocking Overview

The CSU/DSU derives the data clock from the data that passes through it. In order to recover the clock, the CSU/DSU hardware must receive at least one 1-bit value for every 8 bits of data that pass through it; this is known as “ones density”. Maintaining ones density allows the hardware to recover the data clock reliably.

Newer T1 implementations commonly use Extended Superframe Format (ESF) framing with binary eight-zero substitution (B8ZS) coding. B8ZS provides a scheme by which a special code is substituted whenever eight consecutive zeros are sent through the serial link. This code is then interpreted at the remote end of the connection. This technique guarantees ones density independent of the data stream.

Older T1 implementations use D4-also known as Superframe Format (SF) framing and Alternate Mark Inversion (AMI) coding. AMI does not utilize a coding scheme like B8ZS. This restricts the type of data that can be transmitted because ones density is not maintained independent of the data stream.

Obviously, the line can have only one timing source. If more than one data clock exists on a line, synchronization of frames is impossible and line errors will result. If no data clock exists, similar problems result.

Clocking Problem Causes

In general, clocking problems in serial WAN interconnections can be attributed to one of the following causes:

- Incorrect CSU/DSU configuration
- Multiple or no clock source
- Cables out of specification-that is, longer than 50 feet (15.24 meters) or unshielded
- Noisy or poor patch panel connections
- Several cables connected together in a row

Detecting Clocking Problems

To detect clocking conflicts on a serial interface, look for input errors as follows:

1. Use the interface statistics program on the routers at both ends of the link.
2. Examine the detail screen output for CRC, framing errors, and fifo drops.
3. If either of these steps indicates errors exceeding approximately 1 percent of traffic on the interface, clocking problems likely exist somewhere in the WAN.
4. Isolate the source of the clocking conflicts as outlined in the following section, "Isolating Clocking Problems."
5. Repair or replace any faulty equipment or cabling.

Isolating Clocking Problems

After you determine that clocking conflicts are the most likely cause of input errors, the following procedure will help you isolate the source of those errors:

1. Use the interface statistics detail screen to determine if input error counts are increasing and where they are accumulating.
2. Determine the end of the connection that is the source of the problem, or if the problem is in the line. Use a loopback plug (or loop the coaxial cable) to verify proper transmittal and receipt of traffic. This step isolates the router and CSU/DSU hardware from the line.

If input errors are accumulating on both ends of the connection, clocking of the CSU is the most likely problem. If only one end is experiencing input errors, there is probably a CSU/DSU clocking or cabling problem. Drops on one end suggests that the other end is sending bad information or that there is a line problem.

Note: Always refer to the interface statistics detail screen output and note any changes in error counts or note if the error count does not change.

Clocking Problem Solutions

The table below shows the possible clocking problems that may cause service outages, and potential solutions to those problems.

Possible Problem	Solution
• Incorrect CSU/DSU configuration	1. Determine if the CSU/DSUs at both ends agree on the clock source (local or line). 2. If the CSU/DSUs do not agree, configure them so that they do. Usually the line is the source. 3. Check the LBO setting on the CSU/DSUs to ensure that the impedance matches that of the physical line. On integrated CSU/DSUs, use the **service-module XX lbo** command. See the *Command Reference* for details on using this interface command. **Note:** In general, the line build out setting should remain at zero (the default). 4. Make sure that ones density is maintained. This requires that the DSU use the same framing and encoding schemes (for example, ESF and B8ZS) used by the leased line or other carrier service. Check with your leased line provider for information on its framing and coding schemes. Many leased line providers use autosensing switch cards that will automatically match the framing and encoding schemes used by the router. 5. If your carrier service uses AMI encoding, try inverting the data encoding on both sides of the link. On integrated CSU/DSUs, use the **service-module XX data-coding** *inverted* interface command.
• Cable to router is out of specification	1. If the cable is longer than 50 feet (15.24 meters), use a shorter cable. If the cable is unshielded, try replacing it with shielded cable.

Troubleshooting T1/E1 CSU/DSU Problems

```
19:02:22              Serial0.1 CSU Statistics                          router
--------------------------------------------------------------------------------
Firmware version: 0.14
CSU self test: no failures
Rx status: no alarms
Tx status: no alarms
Far end CSU status: normal
Loopback: csu will respond to loop up command, not currently looped up

Statistics for current interval (2 seconds elapsed):


                 Errored seconds: 0     Controlled slip seconds: 0
          Bursty errored seconds: 0            Degraded minutes: 0
        Severely errored seconds: 0        Path code violations: 0
Severely errored framing seconds: 0        Line errored seconds: 0
             Unavailable seconds: 0        Line code violations: 0

Line status information:
  The line appears to be up.
--------------------------------------------------------------------------------
y Summary | d Detail | z Zero | h Help | q Quit
```

This section outlines procedures for troubleshooting T1 and E1 circuits based on the error messages in the CSU/DSU detail screen of the interface statistics program. The information displayed is generally useful for diagnostic tasks performed by technical personnel only. The CSU/DSU detail screen displays statistics for the current 15-minute period and updates the display every 15 seconds. This detail screen provides information to logically troubleshoot physical layer and data link layer problems.

Note: Most T1 errors are caused by misconfigured lines. Ensure that line encoding, framing and clock source are configured according to what the service provider recommends.

The table below shows the possible integrated CSU/DSU messages and descriptions of each.

Detail Screen Message	Explanation/Solution
`CSU is initializing`	1. The CSU/DSU is still initializing. The port has recently been enabled or reloaded.

`ROM checksum failure`
`EEPROM checksum failure`
`Framer type is incorrect`
`Framer hardware failure`
`Internal loopback failure`
	1. The on-board CSU/DSU has failed its initial self-tests.
	2. If the problem persists, it may indicate a hardware problem. Contact ImageStream technical support for assistance.
	
	1. The CSU/DSU has failed its internal loopback test.
	2. If the problem persists, it may indicate a hardware problem. Contact ImageStream technical support for assistance.
	3. An internal loopback failure alone is generally not the cause of a line problem.

`csu will respond to loop up command, not currently looped up`	1. The CSU/DSU has passed its initial self-tests and is operational. 2. The CSU/DSU is ready to accept loop up commands, but is not currently in a loopback state. 3. This is the most common state of the CSU/DSU.
`Your CSU is currently looped up. No data can be received by your router while the CSU is looped up.`	1. The CSU/DSU has received a “loop up” command from a remote device or test set. 2. The CSU/DSU is currently in a payload loopback mode and is reflecting all received data back to the network. 3. The router will receive no data from the integrated CSU/DSU while it is in payload loopback.
`RAI - remote alarm indication (yellow alarm) on Rx Status`	1. The CSU/DSU is receiving a signal from the remote end that the remote CSU/DSU has lost signal. 2. If there are no local errors (AIS, LOS, OOF), this indicates a problem on the far end and not with the local CSU/DSU. 3. The line is generally down if a yellow alarm is encountered and indicates a remote problem.
`RAI – remote alarm indication (yellow alarm) on Tx Status`	4. The CSU/DSU transmitting a signal to the remote end that the local CSU/DSU has lost signal. 5. Other local errors (AIS, LOS, OOF) will accompany this Tx Status error. 6. The other local errors will indicate the nature of the problem that the local CSU/DSU is having with the remote end.

AIS – alarm indication signal (blue alarm)	1. The CSU/DSU is transmitting and/or receving a continuity signal to indicate that there is a transmission fault upstream of the CSU/DSU. 2. The line is down if a blue alarm is encountered and generally indicates a line problem. 3. Check to see that the framing format configured on the CSU/DSU matches the format used on the line. 4. If the problem persists, contact the leased line provider.
PDE – pulse density error	1. The CSU/DSU is not transmitting and/or receiving at least one pulse in every 8 bits from the line. 2. This error often appears along with a yellow alarm, and indicates that the line is down due to a remote problem.
LOS – loss of signal	1. The CSU/DSU has not received a pulse in 175 consecutive pulse positions. 2. This error, also referred to as a red alarm, usually indicates that the CSU/DSU has lost connectivity with the local loop of the leased line. 3. Often this error occurs because the CSU/DSU has been disconnected from the line. LOS is a local problem and not with the far end CSU/DSU. 4. Make sure that the cable between the CSU/DSU and the T1 or E1 terminal equipment is connected correctly. Check to see that the cable is connected to the correct ports. 5. Check cable integrity. Look for breaks or other physical abnormalities in the cable. Over short distances, it is acceptable to use a standard, straight-through Cat3 or Cat5 Ethernet cable instead of a standard T1 or E1 cable.
OOF – out of frame	1. The CSU/DSU has received 4 consecutive frames out of alignment. This error generally indicates a clocking or framing problem. 2. Check to see that the framing format configured on the CSU/DSU matches the format used on the line and on the remote CSU/DSU. 3. Check the line buildout setting in the interface configuration file.
PRM – performance report monitoring failure	1. The remote CSU/DSU is not reporting performance data. 2. This error by itself does not indicate a problem with the line, as some equipment does not provide PRM data, or has the service disabled.
Payload loopback	1. The remote CSU/DSU has received a loop up command and is reflecting received data back onto the link.

Troubleshooting Questions – Getting Technical Support

If you cannot get your router to work, or have difficulty understanding error messages or diagnosing problems with your line, and the documentation does not address the problem you are seeing, please visit our support Web site at http://support.imagestream.com/. If you cannot find an answer to your question there, send e-mail to support@imagestream.com or contact us by telephone or fax. We will be happy to assist you.

Please have the following information ready before you contact ImageStream:

1. The serial number of your router
2. Your contact information
3. A brief description of your problem
4. The full text of any error messages you receive
5. Copies of the relevant configuration files from your router

This manual, accompanying release notes and related documentation are constantly evolving, so please check the Web site periodically for the latest revisions. Your input and suggestions to improve this document are appreciated.

Contact information

World Wide Web:

http://support.imagestream.com/

Electronic Mail: support@imagestream.com
Telephone: (574) 935-8484
Fax: (574) 935-8488

XXVII. Product Return Procedures

This chapter presents general information about equipment returns. Equipment returns to ImageStream fall under the category of Factory Repair or Service Replacement. These categories and guidelines are explained in the following sections.

Factory repair

Customers who return equipment to ImageStream for factory repair should contact ImageStream for return authorization and instructions. When you call ImageStream, you will be given a Return Material Authorization (RMA) control number. Mark this number clearly on the shipping container for ease of identification and service. The RMA control number is simply a shipment-control procedure and does not affect the provisions of a sales or lease agreement. ImageStream will also request that you provide the following information for each piece of equipment you wish to return:

Name of Product and Description
Serial Number
Customer Order Number
Failure Symptoms

You will be provided a shipping address to return any defective equipment or parts.

Re-packing guidelines for equipment return

Equipment or parts that are being returned to ImageStream for any reason must be properly packaged to prevent damage in shipment and handling. If the original packing material and shipping container are available, reuse these items to return equipment. If these items are not available, package the equipment for shipment as follows:

Secure movable and exposed parts before shipping so will not become loose in shipment and cause damage or be damaged. Abrasive or dusty materials should not be used for cushioning. Customers should attempt to ship equipment weighing more than 20 pounds in sturdy or double-wall containers.

When returning more than one item in the same shipping container, wrap each unit individually in air-cell or similar material, prevent possibility of movement of individual units during shipment. Place each printed circuit (PC) card in an individual conductive bag, wrap the card in a double layer air-cell or similar material if possible. Ship in a sturdy container that prevents movement of individually wrapped cards.

Note: Return shipments are your responsibility. You will be responsible for any damages caused by improper packaging.

Specific Packing Guidelines

In returning equipment to ImageStream, the alternative packaging guidelines are listed with the exception of procedures authorized by ImageStream.

Most Desirable

Return the equipment in its original packing material and shipping container.

Acceptable

Wrap the equipment in sufficient air-cell (bubble pack) or similar material providing cushioning, ship in a double-wall container if possible.

XXVIII. Helpful Tools

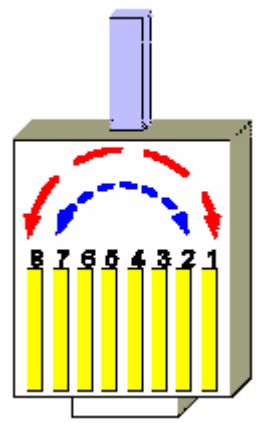
This chapter presents some helpful tools for use in configuring and troubleshooting your ImageStream router.

Netmask conversion table

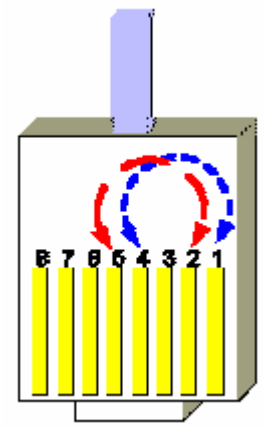
Bitmask (Bits)	Dotted Decimal Netmask	Hexadecimal Netmask	Binary Netmask
/0	0.0.0.0	0x00000000	00000000 00000000 00000000 00000000
/1	128.0.0.0	0x80000000	10000000 00000000 00000000 00000000
/2	192.0.0.0	0xc0000000	11000000 00000000 00000000 00000000
/3	224.0.0.0	0xe0000000	11100000 00000000 00000000 00000000
/4	240.0.0.0	0xf0000000	11110000 00000000 00000000 00000000
/5	248.0.0.0	0xf8000000	11111000 00000000 00000000 00000000
/6	252.0.0.0	0xfc000000	11111100 00000000 00000000 00000000
/7	254.0.0.0	0xfe000000	11111110 00000000 00000000 00000000
/8	255.0.0.0	0xff000000	11111111 00000000 00000000 00000000
/9	255.128.0.0	0xff800000	11111111 10000000 00000000 00000000
/10	255.192.0.0	0xffc00000	11111111 11000000 00000000 00000000
/11	255.224.0.0	0xffe00000	11111111 11100000 00000000 00000000
/12	255.240.0.0	0xfff00000	11111111 11110000 00000000 00000000
/13	255.248.0.0	0xfff80000	11111111 11111000 00000000 00000000
/14	255.252.0.0	0xfffc0000	11111111 11111100 00000000 00000000
/15	255.254.0.0	0xfffe0000	11111111 11111110 00000000 00000000
/16	255.255.0.0	0xffff0000	11111111 11111111 00000000 00000000
/17	255.255.128.0	0xffff8000	11111111 11111111 10000000 00000000
/18	255.255.192.0	0xffffc000	11111111 11111111 11000000 00000000
/19	255.255.224.0	0xffffe000	11111111 11111111 11100000 00000000
/20	255.255.240.0	0xfffff000	11111111 11111111 11110000 00000000
/21	255.255.248.0	0xfffff800	11111111 11111111 11111000 00000000
/22	255.255.252.0	0xfffffc00	11111111 11111111 11111100 00000000
/23	255.255.254.0	0xfffffe00	11111111 11111111 11111110 00000000
/24	255.255.255.0	0xffffff00	11111111 11111111 11111111 00000000
/25	255.255.255.128	0xffffff80	11111111 11111111 11111111 10000000
/26	255.255.255.192	0xffffffc0	11111111 11111111 11111111 11000000
/27	255.255.255.224	0xffffffe0	11111111 11111111 11111111 11100000
/28	255.255.255.240	0xfffffff0	11111111 11111111 11111111 11110000
/29	255.255.255.248	0xfffffff8	11111111 11111111 11111111 11111000
/30	255.255.255.252	0xfffffffc	11111111 11111111 11111111 11111100
/31	255.255.255.254	0xfffffffe	11111111 11111111 11111111 11111110
/32	255.255.255.255	0xffffffff	11111111 11111111 11111111 11111111

RJ48 loopback plug for testing DDS, T1 and E1 CSU/DSUs

The Crossover (Loopback) Cable is a RJ48C to RJ48C cable, optionally supplied. The crossover cable is used to connect two CSU/DSUs together.



DDS (56Kbps) Circuits



T1/Fractional T1 Circuits
E1/Fractional E1 Circuits

Figure C-1, RJ48 Loop Back Plugs

T1 line basics

What Is A T1 Line?

A T1 line is a digital transmission line capable of 1.544 Million bits per second (Mbps). T1 normally carries 24 voice or data channels. Each channel has a sample rate of 8kHz with a resolution of 8 bits of data per sample. Every 192 bits of the transmission a framing bit is added.

24 Voice/Data Channels
8 kHz Sample Rate
8 Bits per Sample
1 Framing Bit per 192 Data bits

24 Channels x 8 Data Bits + 1 Framing Bit = 193 Bits per Frame
193 Bits per Frame x 8,000 Frames per Second = 1,544,000 Total Bits per Second

How Can A T1 Be Used?

T1s can be used to connect two distant PBXs together to form a single functioning PBXs. T1s are also used to form a bridge between two Local Area Networks (LANs). In this way one single Wide Area Network (WAN) is formed. A single T1 line can be used for both PBXs and digital data at the same time by dedicating channels to each task. Other variations of service include fractional T1. Fractional T1 is a reduced number of channels leased from the service provider. The transmission rates vary from 56Kbps to 1.544Mbps.

What is a CSU/DSU?

A Channel Service Unit (CSU)/Data Service Unit (DSU) is a device used to terminate a digital service such as a T1 or E1. The CSU/DSU maintains records on different types of line errors and provides functions for line conditioning, line equalization, and loopback modes. These functions can be accessed from the main office of the service provider to maintain line quality.

What needs to be configured for a CSU to work?

The T1 service provider will inform the customer what settings should be set for their specific service. The service provider will specify the line build out (LBO= 0, -7.5, -15 dB), framing type (D4 or ESF), network line code (B8ZS or AMI), pulse density enforcing (AMI only), and the signaling mode (ATT54016 or ANSI T1.403) used to configure the CSU. For a fractional T1, the service provider must also specify the active channels (DS0s).

AMI versus B8ZS line coding

When using AMI (alternate mark inversion) mode with non-inverted data, a problem arises when a series of zeros is sent across the transmission line. These zeros prevent the receiver, who relies on clock edges for sync, from establishing a proper sync. There are two ways to correct this problem.

1. AMI Mode with Inverted HDLC Data

If the network (external CSU, carrier, etc.) can AMI mode with inverted HDLC data, the N2csu can be placed in INVERT HDLC DATA mode. With data inversion enabled, proper ones density will be maintained on the line.

2. B8ZS Mode (If Available)

B8ZS (bipolar with 8-zero substitution) mode was designed to correct for AMI's pulse density problem. B8ZS inserts BPVs at specific points in the data to allow the receiver to maintain sync. At the receiving end, any B8ZS BPV patterns are recognized and the correct data patterns are re-constructed.