Chapter 1

Planning Your Network

This chapter describes planning steps that will make it easier to configure the physical interfaces, logical interfaces, and routing protocols for the E-series routers in:

- A new network that you are creating and implementing
- An existing network that you are expanding

This chapter contains the following sections:

Platform Considerations

For information about the modules supported on E-series routers:

- See the *ERX Module Guide* for modules supported on ERX-7xx models, ERX-14xx models, and the ERX-310 router.
- See the *E120 and E320 Module Guide* for modules supported on the E120 router and the E320 router.

Interface Specifiers

The configuration task examples in this chapter use the *slot*/*port* format to specify an interface. However, the interface specifier format that you use depends on the router that you are using.

For ERX-7xx models, ERX-14xx models, and ERX-310 routers, use the *slot*/*port* format. For example, the following command specifies an ATM interface on slot 0, port 1 of an ERX-7xx model, ERX-14xx model, or ERX-310 router.

```
host1(config)#interface atm 0/1
```

For E120 and E320 routers, use the *slot*/*adapter*/*port* format, which includes an identifier for the bay in which the I/O adapter (IOA) resides. In the software, adapter 0 identifies the right IOA bay (E120 router) and the upper IOA bay (E320 router); adapter 1 identifies the left IOA bay (E120 router) and the lower IOA bay (E320 router). For example, the following command specifies an ATM interface on slot 5, adapter 0, port 0 of an E320 router.

```
host1(config)#interface atm 5/0/0
```

For more information about supported interface types and specifiers on E-series routers, see *Interface Types and Specifiers* in *JUNOSe Command Reference Guide, About This Guide*.

Edge Applications Overview

The E-series router can be used for a number of edge aggregation applications. Two of the most common are:

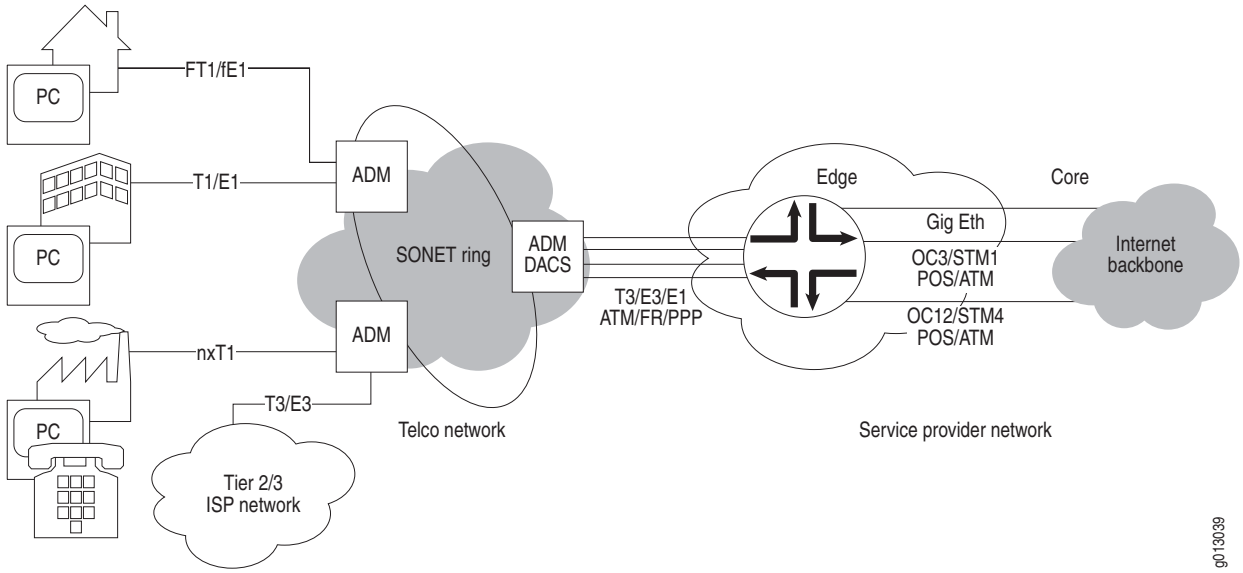
- Private line aggregation
- xDSL session termination

Private Line Aggregation

A major application of the E-series router is for private line aggregation—the consolidation of multiple high-speed access lines into one access point. See Figure 1 on page 3.

In this application, the service provider can use a single router to offer high-speed access (FT1/FE1 through T3/E3) to thousands of subscribers. The individual subscriber lines can be multiplexed into T3 lines by the service provider and fed into the router. (The router can also accept unchannelized T3 or E3 connections from high-speed users and channelized E1 connections directly into the unit.) Once the traffic is received, the router then handles all IP packet processing, including the assignment of QoS and routing policies. The packets are then routed into the backbone network.

Figure 1: Private Line Aggregation with the E-series Router



The router supports a number of access and uplink methods; the most common pairings are listed in Table 4.

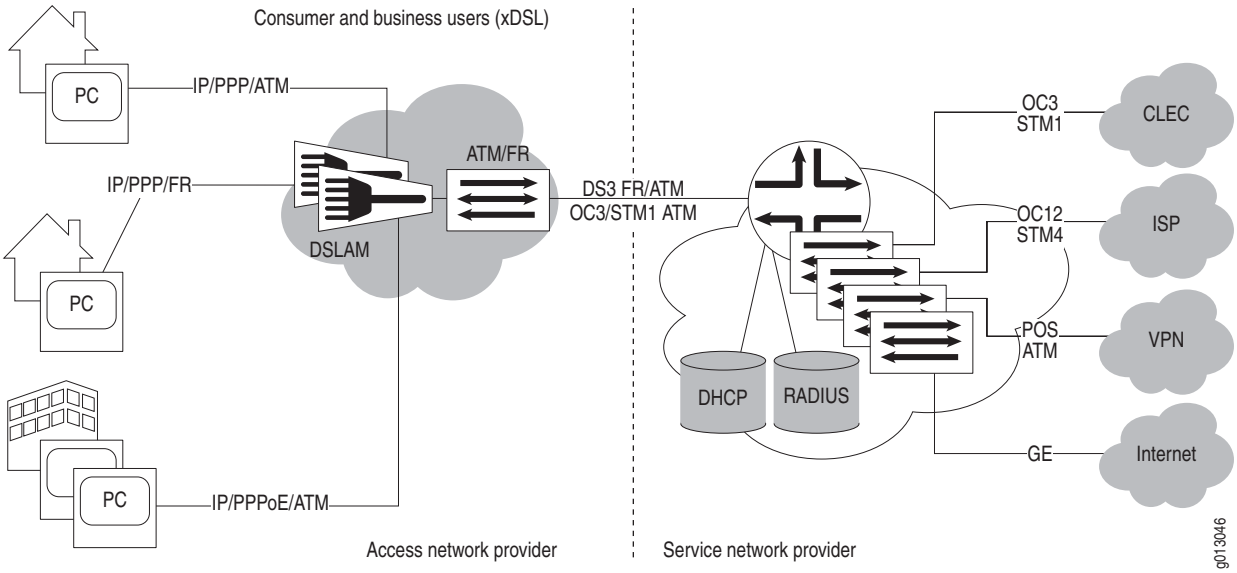
Table 4: Common Access/Uplink Pairings

Access	Uplink
PPP	ATM, Fast Ethernet, Gigabit Ethernet, or POS
Frame Relay	
ATM	

xDSL Session Termination

The router supports Broadband Remote Access Server (B-RAS) applications, as shown in Figure 2 on page 4. In this application, the router handles the aggregated output from the digital subscriber line access multiplexers (DSLAMs). Directly connected to the subscriber premises, the DSLAMs handle the copper termination and aggregate the traffic into a higher-speed uplink. The output from the DSLAM is fed into the router through a DS3 or OC3 link.

Figure 2: B-RAS Application



The router then performs several functions:

- PPP session termination and authentication checking through PAP or CHAP
- Coordination with DHCP servers and local IP pools to assign IP addresses
- Connection to RADIUS servers or use of domain names to associate subscribers with user profile information
- Support for RADIUS accounting to gather detailed billing information
- Application of the user profile to the user traffic flow, which could include QoS, VPN, and routing profiles

The output of the router is typically a high-speed link, such as OC3/STM1 to feed a core backbone router. Virtual routers can also be used to keep the traffic logically separate and to direct packets to different destinations. As shown in Figure 2, the packets can be directed to a CLEC, ISP, corporate VPN, or the Internet.

A large number of xDSL protocols are supported, including:

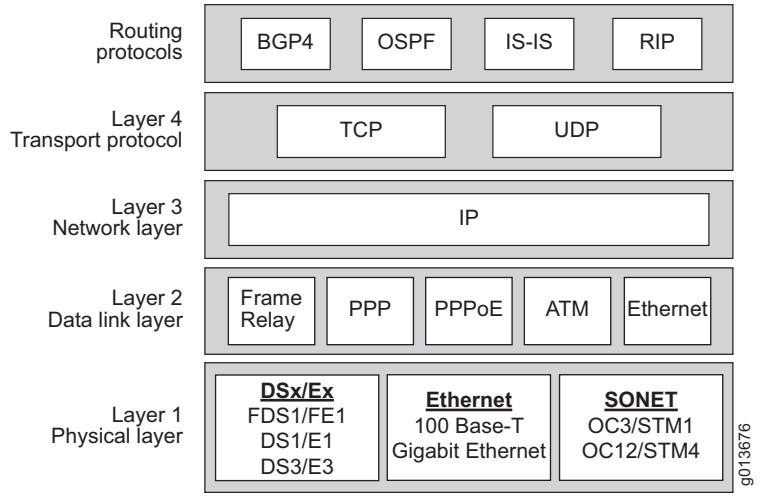
- IP/PPP/ATM
- IP/PPP/Ethernet/ATM
- IP/bridged Ethernet/ATM

See *JUNOSe Broadband Access Configuration Guide, Chapter 1, Configuring Remote Access*, for information about configuring B-RAS.

Layered Approach

The JUNOSe CLI enables you to configure your network based on the hierarchy of the OSI model. Therefore, the JUNOSe configuration guides use a bottom-up approach to describe the configuration process. Figure 3 shows the relationship of layers, protocols, and interfaces to the configuration process. Software functions are layered on top of physical (copper or optical) interfaces. The router supports a number of access protocols (PPP/POS, Frame Relay, ATM) that allow service providers to offer a number of access methods and line speeds to their subscribers. The router is optimized to handle IP connections regardless of the access protocol used. The router also supports a number of protocols that are specific to the B-RAS application. These are shown in Figure 3, and include IP/PPP/ATM and IP/PPP/Ethernet/ATM.

Figure 3: Network Configuration Using a Bottom-Up Approach



Layer 2 (data link) defines how the data is packaged and sent to an IP data connection point in layer 3 (IP interfaces). In layer 3, you define the global attributes for IP services that serve as a platform from which you add routing information.

Line Modules, I/O Modules, and IOAs

A range of line modules, I/O modules, and I/O adapters (IOAs) are available for the router. On the ERX-14xx models, ERX-7xx models, and the ERX-310 router, most line modules pair with a corresponding I/O module. On the E120 router and the E320 router, a single line module pairs with all available IOAs.

I/O modules and IOAs provide the input and output connections from the network to the router. Line modules connect to their corresponding I/O modules or IOAs through a passive midplane. A line module receives packets through its I/O module or IOA and processes those packets. The router then routes the packets out to the network through the designated I/O module or IOA.

Each line module, I/O module, and IOA has a label on its faceplate. In this documentation, these modules are identified by that label. For example, the high-density Gigabit Ethernet line module has two ports, and is called the GE-HDE line module. Its corresponding I/O modules are the GE-HDE I/O module and the GE-2 SFP I/O module.

When we refer to a related set of line modules, I/O modules, or IOAs, the generic information from the module labels is used in this documentation. For example, the term "OCx/STMx line modules" refers to both the OCx/STMx ATM and the OCx/STMx POS line modules. Similarly, the term "GE I/O modules" refers to both the GE Multimode I/O module and the GE Single Mode I/O module.

For a complete list of the line modules and I/O modules available for ERX-14xx models, ERX-7xx models, and the ERX-310 router, see *ERX Module Guide, Table 1, Module Combinations*. For more information about line modules and IOAs available with the E120 and E320 routers, see *E120 and E320 Module Guide, Table 1, Modules and IOAs*.

For more information about managing these modules, see *Chapter 6, Managing Modules*.

Interfaces

The term *interfaces* is used in a very specific way in the JUNOSe CLI and this documentation. Interfaces are both physical and logical channels on the router that define how data is transmitted to and received from lower layers in the protocol stack. Conceptually, you configure an interface as part of the physical layer, layer 1.

For example, you can configure the physical and logical characteristics of T3 and T1 lines coming directly from the customer premises or from a central office switch and OC3 lines going out to the core of your network infrastructure. These physical and logical characteristics define an interface.

Interface layering must always be configured in order from the lowest layer to the highest layer. For example, if you have already configured IP to run over ATM and you want to reconfigure the interface to run IP over PPP over ATM, you must first remove the IP interface, apply PPP, and then reapply IP.

Subinterfaces

A subinterface is a mechanism that allows a single physical interface to support multiple logical interfaces or networks. Several logical interfaces or networks can be associated with a single physical interface. Configuring multiple virtual interfaces, or subinterfaces, on a single physical interface allows greater flexibility and connectivity on the network.

Protocols such as Frame Relay and ATM require that you create one or more virtual circuits over which your data traffic is transmitted to higher layers in the protocol stack. The router requires that you define a subinterface on top of a physical interface as a platform for a virtual circuit, such as a permanent virtual circuit (PVC).

Once you have defined the underlying characteristics of an interface, use the **interface** command to:

1. Assign an *interface type*, such as POS or ATM.
2. Assign the associated *interface specifier* to the interface, such as the *slot/port* or *slot/adapter/port* and *channel/subchannel*.
3. Assign one or more subinterfaces.

interface Command

The **interface** command has the following format:

interface *interfaceType interfaceSpecifier*

Each interface type has an interface specifier associated with it. The interface specifier identifies the physical location of the interface on the router, such as the chassis slot and port number, and logical interface information, such as a T1 channel on a channelized T3 interface.

For detailed information about interface types and specifiers and for specific syntax for the interface command, see the *JUNOSe Command Reference Guide, About This Guide*.

General Configuration Tasks

The configuration process for E-series routers involves the following general tasks:

1. Determine IP-addressing information and information about the physical and logical characteristics of the various interfaces that you want to configure.
2. Determine information about the link-layer protocols.
3. Determine how to organize virtual routers on the router.
4. Determine how IPSec will be used to provide security.
5. Determine routing information that defines all or part of the network.
6. Create the virtual routers.

7. Configure the interfaces and subinterfaces (such as channelized T3, OCx/STMx, and HDLC data channels) over which the higher-layer protocols run.

8. Configure the data link-layer protocols, such as Frame Relay, PPP, and ATM, that run over these physical interfaces.

9. Configure the general IP information from which the other routing protocols will operate.

10. Configure IP tunnels, shared interfaces, and subscriber interfaces.

11. Configure IPSec.

12. Configure the routing protocols that will run on the router, such as IP multicasting protocols, OSPF, IS-IS, RIP, BGP-4, and MPLS.

13. Configure the Virtual Router Redundancy Protocol (VRRP) on IP/Ethernet interfaces.

14. Configure QoS and policy management.

15. Configure the router for remote access.

16. Use the appropriate **show** commands to display network activity on each of the interfaces that you have configured. Do this to verify that they are operating as you expect and to help improve the management of your network.

Configuring Virtual Routers

Multiple distinct virtual routers are supported within a single router, which allows service providers to configure multiple, separate, secure routers within a single chassis. These routers are identified as *virtual routers (VRs).* Applications for this function include the creation of individual routers dedicated to wholesale customers, corporate virtual private network (VPN) users, or a specific traffic type.

The router implements the virtual routers by maintaining a separate instance of each data structure for each virtual router and allowing each protocol to be enabled on a case-by-case basis. Virtual routers provide full support for all supported routing protocols (unicast, multicast, and MPLS).

For information about configuring virtual routers, see *Chapter 13, Configuring Virtual Routers*.

Configuring IPSec

IPSec provides security to IP flows through the use of authentication and encryption.

- Authentication verifies that data is not altered during transmission and ensures that users are communicating with the individual or organization that they believe they are communicating with.
- Encryption makes data confidential by making it unreadable to everyone except the sender and intended recipient.

IPSec comprises two encapsulating protocols:

- Encapsulating Security Payload (ESP) provides confidentiality and authentication functions to every data packet.
- Authentication header (AH) provides authentication to every data packet.

For information about configuring IPSec, see *JUNOSe IP Services Configuration Guide, Chapter 6, Configuring IPSec*.

Configuring Physical Layer Interfaces

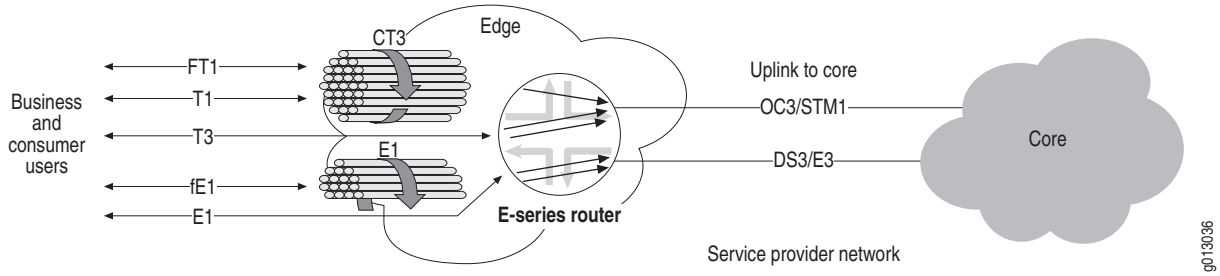
The router supports a number of line rates; some of these are listed per line module below.

- COCX-F3 line module supports unchannelized E3.
- Channelized OCx/STMx (cOCx/STMx) line module supports DS3 channelized to DS1, fractional DS1, or the DS0 level; unchannelized DS3; E1/T1 channelized to fractional DS1; unframed E1.
- CT3 12-F0 line modules support DS3 channelized to DS1, fractional DS1, or the DS0 level. CT3 12-F0 line modules also support unchannelized T3.
- IPSec Service module provides tunnel service for secure tunnels.
- GE/FE line module supports Gigabit Ethernet and Fast Ethernet.
- GE-2 line module and GE-HDE line module support Gigabit Ethernet.
- OCx/STMx ATM line module supports OC3/STM1 ATM, OC12/STM4 ATM, and unchannelized T3.
- OCx/STMx POS line module supports OC3/STM1 POS and OC12/STM4 POS.
- OC48 line module supports OC48/STM16 POS.
- OC3/STM1 GE/FE line module supports OC3/STM1 ATM and Gigabit Ethernet.
- ES2 4G line module (LM) supports OC48/STM16 POS, OC12/STM1 POS, OC3/STM1 ATM, OC12/STM1 ATM, Gigabit Ethernet, 10-Gigabit Ethernet, and tunnel-service interfaces.

- ES2 10G Uplink LM and ES2 10G LM supports 10-Gigabit Ethernet interfaces.
- COCX-F3 line module supports unchannelized T3.
- Service Module (SM) provides tunnel service for IP tunnels and LNS termination.

A variety of protocols are supported over these interfaces, including IP/Frame Relay, IP/ATM, IP/PPP, as well as the protocols to enable B-RAS services. The router's DSx and E1/E3 implementations support termination, statistics gathering, alarm surveillance, and performance monitoring. These links can be used for either network ingress or network egress.

Figure 4: E-series Router Support for Fractional T1/E1 Through T3/E3 Interfaces



As shown in Figure 4, the router can support fractional, full, and channelized interfaces.

NOTE: See *ERX Hardware Guide, Chapter 4, Installing Modules* and *E120 and E320 Hardware Guide, Chapter 4, Installing Modules*, for a discussion of slot groups and modules. See the *ERX Module Guide* and the *E120 and E320 Module Guide,* for a discussion of the combination of line modules allowed in E-series routers.

Line Module Features

The following features are supported by the system line modules:

- Three different clocking options: internal timing, loop timing, and chassis timing
- DS3 framing type—Both M23 framing and C-bit parity
- DS1 framing type—Both D4 framing mode and ESF framing mode
- DS3 loopback—For line, payload, diagnostic, and DS1 loopbacks.
- DS1 loopback—For line, payload, and diagnostic loopbacks
- DS3/DS1 line status/alarm monitoring
- DS1 line coding type—Both AMI line encoding and B8ZS line encoding
- Unique IP interface support—For each PPP or Frame Relay PVC interface

Configurable HDLC Parameters

The following HDLC parameters are configurable:

- Mapping of DS0 timeslots for T1/FT1 DS0 mapping
- Setting the speed of the DS0 to Nx56 or Nx64
- HDLC CRC checking (enable/disable)
- HDLC CRC algorithm (CRC16 or CRC32)
- Channel data inversion (enable/disable)
- Maximum receive unit (MRU)
- Maximum transmit unit (MTU)

Statistics are also gathered per line module.

Configuring Channelized T3 Interfaces

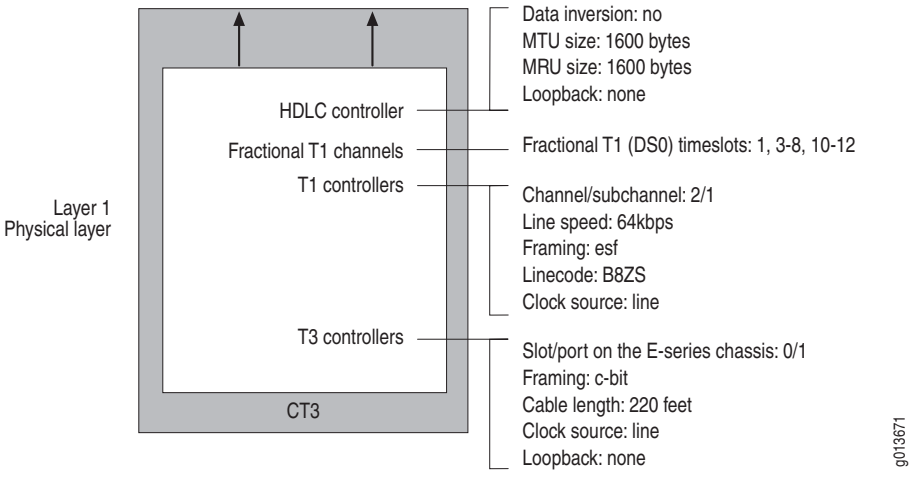
There 12 T3 controllers available on each CT3 12-F0 line module. When you configure these T3 controllers, you are actually configuring T3 (DS3) lines. Each T3 controller has, by definition, 28 T1 controllers representing T1 (DS1) lines.

Use the T3 and T1 commands described in *JUNOSe Physical Layer Configuration Guide, Chapter 1, Configuring Channelized T3 Interfaces*, to:

- Specify the line characteristics, such as framing format and clock source, for T3s and associated T1s.
- Assign full and fractional T1 channels (DS0) to a virtual channel.

Figure 5 shows sample parameters for a channelized T3 interface configuration.

Figure 5: Channelized T3 Interface Configuration Parameters



The following sample command sequence configures a serial interface for a CT3 12-F0 module. See *JUNOSe Physical Layer Configuration Guide, Chapter 1, Configuring Channelized T3 Interfaces*, for details.

```
host1(config)#controller t3 0/1
host1(config-controll)#framing c-bit
host1(config-controll)#clock source line
host1(config-controll)#cablelength 220
host1(config-controll)#t1 2/1
host1(config-controll)#t1 2 framing esf
host1(config-controll)#t1 2 lineCoding b8zs
host1(config-controll)#t1 2/1 timeslots 2/1 1,3-8,10-12
host1(config-controll)#interface serial 0/1:2/1
```

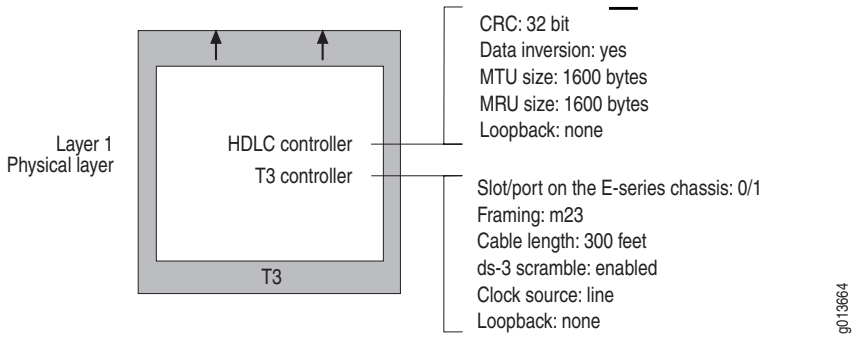
Configuring T3 and E3 Interfaces

The COCX-F3 line module supports the following wide area network (WAN) protocol encapsulations:

- IP over PPP
- IP over ATM
- IP over PPP over ATM
- IP over PPP over PPPoE over ATM
- IP over Frame Relay

Figure 6 shows sample configuration parameters for a T3 interface configuration.

Figure 6: T3 Interface Configuration Parameters



The following sample command sequence configures a serial interface for a T3 module. See *JUNOSe Physical Layer Configuration Guide, Chapter 2, Configuring T3 and E3 Interfaces*, for details.

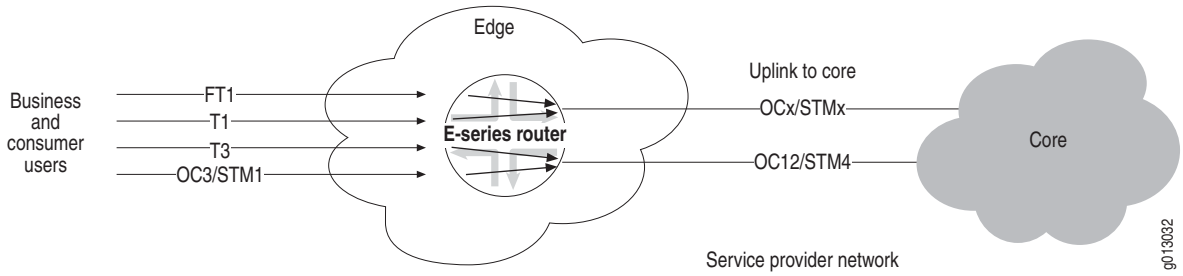
```
host1(config)#controller t3 0/1
host1(config-controll)#framing m23
host1(config-controll)#cablelength 300
host1(config-controll)#ds3-scramble
host1(config-controll)#exit
host1(config)#interface serial 0/1
host1(config-if)#invert data
```

```
host1(config-if)#mtu 1600
host1(config-if)#mru 1600
```

Configuring OCx/STMx and OC48 Interfaces

The router supports IP/ATM, IP/Frame Relay, and IP/PPP over SONET on the OCx/STMx interfaces. OC48 interfaces support IP/Frame Relay and IP/PPP over SONET, but do not support ATM operation. This interface support allows service providers to accept incoming optical connections or connect the router to the backbone network through optical connections. The router's SONET implementation supports termination, statistic gathering, and alarm surveillance at the section, line, and path layers of a SONET interface.

Figure 7: SONET Interfaces



The following sample command sequence configures POS for an OC3 interface. See *JUNOSe Link Layer Configuration Guide, Chapter 6, Configuring Packet over SONET,* for details.

```
host1(config)#interface pos 0/1
host1(config-if)#encapsulation ppp
host1(config-if)#clock source internal module
host1(config-if)#loopback line
host1(config-if)#pos framing sdh
host1(config-if)#mtu 1600
host1(config-if)#mru 1600
host1(config-if)#pos scramble-atm
```

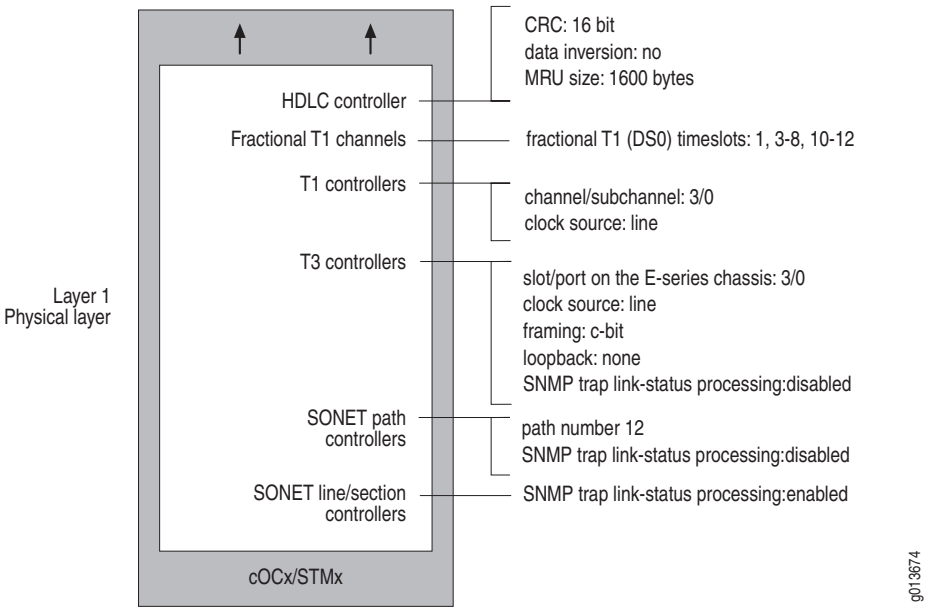
Configuring Channelized OCx/STMx Line Interfaces

The cOCx/STMx modules are generally used for circuit aggregration on the router. These line modules support the following controllers over OC3/STM1 or OC12/STM4, depending on the I/O module used with the line module:

- Fractional T1/E1 over SONET/SDH virtual tributaries or T3
- Unframed E1
- Unchannelized DS3

Figure 8 shows the configuration parameters for a sample T1 over DS3 interface configuration.

Figure 8: Parameters for T1 over DS3 Interface Configuration



The following sample command sequence configures T1 over DS3 on a channelized SONET interface as described in Figure 8. See *JUNOSe Physical Layer Configuration Guide, Chapter 4, Configuring Channelized OCx/STMx Interfaces,* for details.

```
host1(config)#controller sonet 3/0
host1(config-controller)#path 12 oc1 4/1
host1(config-controller)#path 12 ds3 1 channelized
host1(config-controller)#path 12 ds3 1 t1 4
host1(config-controller)#path 12 ds3 1 t1 4/2 timeslots 1, 3-8, 10-12
host1(config)#interface serial 3/0:12/1/4/2
```

Configuring Ethernet Interfaces

Ethernet interfaces support IP, PPPoE, multinetting (multiple IP addresses), and VLANs (subinterfaces). Ethernet modules use the Address Resolution Protocol (ARP) to obtain MAC addresses for outgoing Ethernet frames and support quality of service (QoS) classification. See *JUNOSe Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*, for a description of limitations of individual modules.

Use the Fast Ethernet, Gigabit Ethernet, and 10-Gigabit Ethernet commands described in *JUNOSe Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces* to:

- Configure with IP only, with PPPoE only, with both IP and PPPoE, and with or without VLANs.
- Specify the line speed and duplex mode.
- Specify the MTU.

The following sample command sequence configures an IP interface on a VLAN on an Ethernet interface:

```
host1(config)#interface fastEthernet 2/0
host1(config-if)#encapsulation vlan
host1(config-if)#interface fastEthernet 2/0.1
host1(config-if)#vlan id 201
host1(config-if)#ip address 192.168.129.5 255.255.255.0
```

The following sample command sequence adds an IP interface over PPPoE to the same VLAN:

```
host1(config)#interface fastEthernet 2/0.1.2
host1(config-if)#encapsulation pppoe
host1(config-if)#interface fastEthernet 2/0.1.2.1
host1(config-if)#encapsulation ppp
host1(config-if)#ip address 192.2.2.1 255.255.255.0
```

Configuring IPSec-Service Interfaces

IPSec Service modules support interfaces associated with secure IP tunnels. You configure and delete these interfaces statically; however, the router assigns tunnels to the interfaces dynamically. This mechanism means that you must manage the interfaces for tunnels manually; however, the router will add and remove tunnels when required.

For information about configuring secure IP interfaces, see *JUNOSe IP Services Configuration Guide, Chapter 6, Configuring IPSec*. For information about managing IPSec service interfaces, see *JUNOSe Physical Layer Configuration Guide, Chapter 6, Managing Tunnel-Service and IPSec-Service Interfaces*.

Configuring Tunnel Service Interfaces

You can configure both dynamic tunnels associated with L2TP and static IP tunnels on your E-series router; however, you must first install a Service Module (SM). Dynamic tunnels, which are not associated with a particular interface, are described in *JUNOSe Broadband Access Configuration Guide, Chapter 13, Configuring an L2TP LNS*. Static tunnels, in which the tunnel is assigned to a particular interface and specified in slot/port format, are described in *JUNOSe IP Services Configuration Guide, Chapter 10, Configuring IP Tunnels*.

For information about managing these types of tunnels on the router, see *JUNOSe Physical Layer Configuration Guide, Chapter 6, Managing Tunnel-Service and IPSec-Service Interfaces*.

Configuring Data Link-Layer Interfaces

You can configure the following data link-layer interfaces:

- IP/Frame Relay or multilink Frame Relay
- IP/ATM
- IP/PPP or multilink PPP

- IP/Cisco HDLC
- IP/Ethernet

Configuring IP/Frame Relay

The router supports IP over Frame Relay PVCs on the CT3 12-F0 and OCx/STMx POS modules. The interface presented to the incoming traffic is an IP/Frame Relay router. In addition, IP/PPP/Frame Relay is supported on the T3 and E3 modules. With this interface, the service provider can:

- Receive traffic from subscribers that have CPE equipment, such as routers with Frame Relay interfaces
- Take in traffic from other network devices that use Frame Relay, such as DSLAMs and Frame Relay switches
- Use Frame Relay as an uplink technology on an unchannelized T3 or E3 link

Figure 9 shows the structure of the Frame Relay interface. Each Frame Relay major interface sits on top of an HDLC interface. The Frame Relay implementation is divided into two levels: a major interface and one or more subinterfaces. This division allows a single physical interface to support multiple logical interfaces. Multiple IP interfaces can also be assigned to each Frame Relay major interface through the subinterfaces.

Figure 9: Frame Relay Interface Design

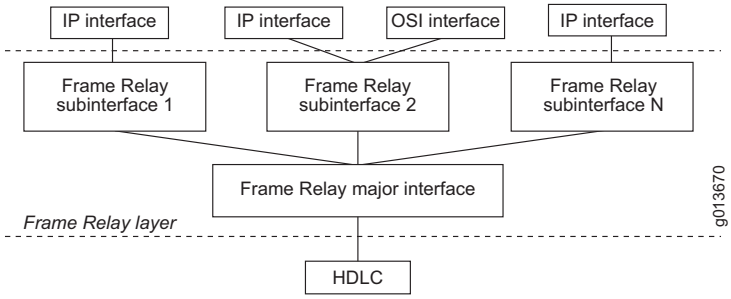
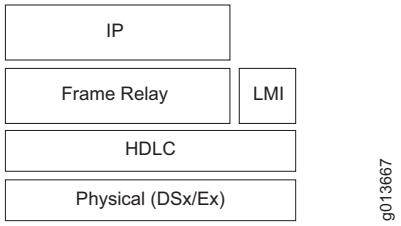


Figure 10 shows the structure of the Frame Relay protocols with the physical layer as the foundation. For Frame Relay, the physical layer can be channelized E1, E3, channelized T1, T3, or a fractional service, as supported by the different line module ports. The HDLC layer is on top of the physical layer and can support flexible assignment of physical resources.

For example, an HDLC channel can support one DS0, a fractional T1, or an entire T1. The major Frame Relay interface sits on top of the HDLC resource, and the subinterfaces sit on top of the major interface. The Frame Relay subinterfaces connect to the IP interface layer.

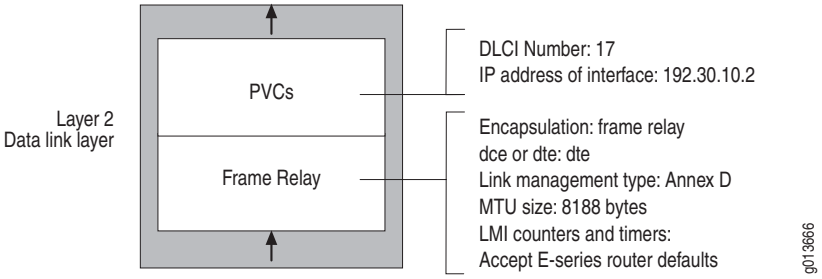
Figure 10: Structure of Frame Relay Protocols



The router supports Frame Relay LMI (local management interface) to provide the operator with configuration and status information relating to the Frame Relay VCs in operation. LMI specifies a polling mechanism to receive incremental and full-status updates from the network. The router can represent either side of the User-to-Network Interface (UNI) and supports unidirectional LMI. Bidirectional support for the Network-to-Network Interface (NNI) is also supported.

Figure 11 shows sample configuration parameters for Frame Relay on a serial interface.

Figure 11: Serial Interface Configuration Parameters for a Frame Relay Connection



The following sample command sequence configures a serial interface for Frame Relay. See *JUNOSe Link Layer Configuration Guide, Chapter 2, Configuring Frame Relay*, for information.

```
host1(config)#interface serial 0/1:1/5
host1(config-if)#encapsulation frame-relay ietf
host1(config-if)#frame-relay intf-type dte
host1(config-if)#frame-relay lmi-type ansi
host1(config-if)#interface serial 0/1:1/5.1
host1(config-subif)#frame-relay interface-dlci 17 ietf
host1(config-subif)#ip address 192.32.10.2 255.255.255.0
```

Configuring IP/ATM

The router supports IP over ATM PVCs on ATM line modules. This support allows service providers to receive traffic from subscribers who have CPE equipment, such as routers with ATM interfaces, to take in traffic from other network devices that use ATM, such as DSLAMs, and to connect to service providers with ATM backbone structures.

Figure 12 shows an IP/ATM access connection.

Figure 12: E-series Router IP/ATM Access Connection

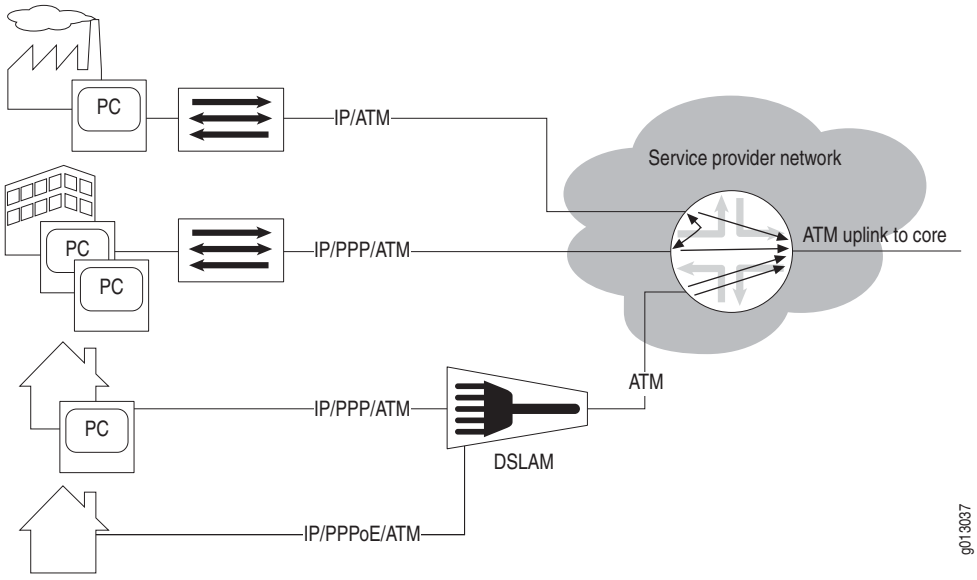


Figure 13 shows the structure of the ATM interface. For ATM, this can be SONET, DS3, or E3 as supported by the different line modules. The major ATM interface sits on top of the SONET/DS3/E3 resource, and the subinterfaces sit on top of the major interface. The ATM subinterfaces connect to the IP interface layer.

Figure 13: Structure of the ATM Interface Design

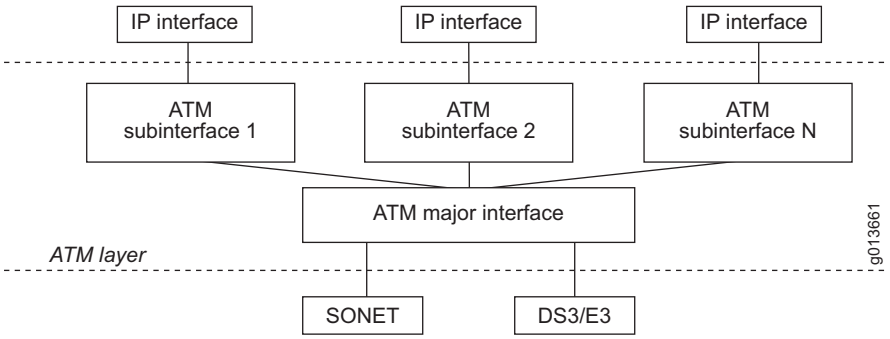


Figure 14 shows the structure of the ATM protocols. The physical layer (SONET and/or DSx/Ex) is the foundation and provider of layer 1 framing service. The ATM layer is on top and provides cell, circuit, and OAM services. The AAL5 layer provides a frame-oriented interface to the ATM layer. The integrated local management interface (ILMI) provides local management across the UNI.

Figure 14: Structure of ATM Protocol

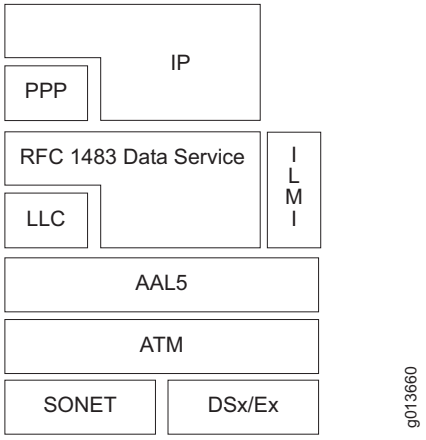
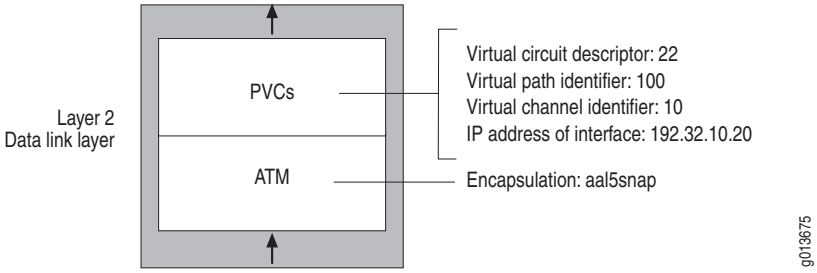


Figure 15 shows sample configuration parameters for a typical ATM interface configuration.

Figure 15: ATM Interface Configuration Parameters



The following sample command sequence configures an ATM interface on port 0 of the line module in slot 1. See *JUNOSe Link Layer Configuration Guide, Chapter 1, Configuring ATM*, for information about how to configure an ATM interface.

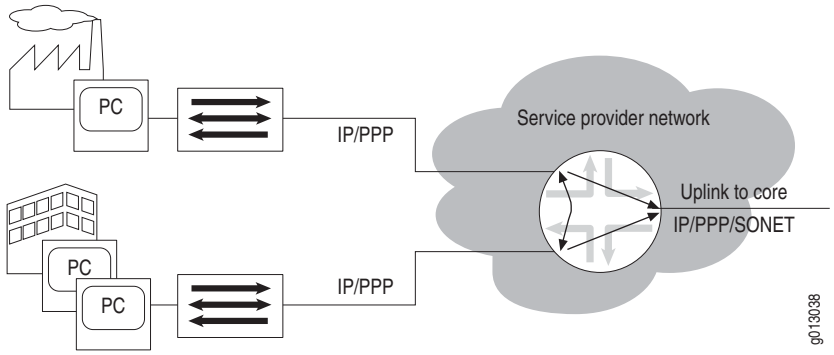
```
host1(config)#interface atm 0/1
host1(config-if)#interface atm 0/1.22
host1(config-if)#atm pvc 22 100 10 aal5snap
host1(config-subif)#ip address 192.32.10.20 255.255.255.0
```

Configuring IP/PPP

The router supports IP/PPP on the channelized T3, E1, and T3/E3 interfaces and IP/PPP/SONET on the OC3/STM1 and OC12/STM4 interfaces. This support allows service providers to accept traffic from subscribers who have CPE equipment, such as routers with PPP interfaces, and to transmit traffic in PPP format to other network devices.

Figure 16 shows that the router supports the incoming IP/PPP traffic from the CPE. This traffic can then be routed to the uplink(s) attached to the router or to other CPEs that are attached to the router.

Figure 16: IP/PPP Connections from the CPE on an E-series Router



As shown in Figure 17, the PPP protocol can exist directly on top of the HDLC layer or on top of a layer 2 Frame Relay or ATM interface. In either case, IP rides on top of PPP, providing support for IP/PPP/ATM, IP/PPP/HDLC, and IP/PPP/Frame Relay. Both SONET and DSx/Ex interfaces are supported at the physical layer.

Figure 17: Structure of PPP

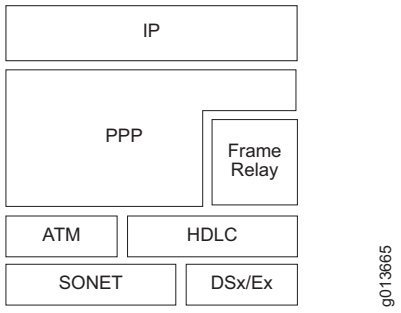
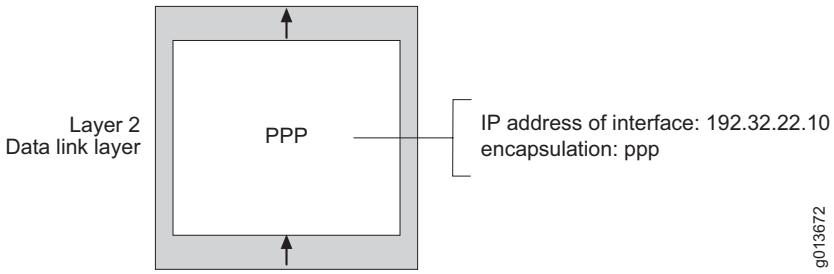


Figure 18 shows sample configuration parameters for PPP on a serial interface.

Figure 18: PPP Interface Configuration Parameters



The following sample command sequence configures PPP on a serial interface. See *JUNOSe Link Layer Configuration Guide, Chapter 4, Configuring Point-to-Point Protocol*, for details.

```
host1(config)#interface serial 3/0:2/5
host1(config-if)#encapsulation ppp
host1(config-if)#ip address 192.32.22.10 255.255.255.0
```

Configuring IP/HDLC

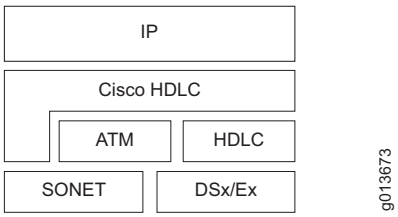
The E-series router supports IP over Cisco HDLC on many types of serial interfaces. Cisco HDLC monitors line status on a serial interface by exchanging keepalive request messages with peer network devices. It also allows routers to discover IP addresses of neighbors by exchanging Serial Link Address Resolution Protocol (SLARP) address request and address response messages with peer network devices.

The E-series router Cisco HDLC is compatible with the Cisco Systems Cisco-HDLC protocol, the default protocol for all Cisco serial interfaces.

The router supports the following framing features:

- HDLC for data-link framing
- 18,000-byte information field size

Figure 19: Structure of Cisco HDLC Protocol



As shown in Figure 19, the Cisco HDLC protocol can exist directly on top of the HDLC layer or ATM or SONET interface. Both SONET and DSx/Ex interfaces are supported at the physical layer.

The following example configures HDLC on a serial interface. See *JUNOSe Link Layer Configuration Guide, Chapter 11, Configuring Cisco HDLC,* for details.

```
host1(config)#interface serial 3/1:2/1
host1(config-if)#encapsulation hdlc
host1(config-if)#ip address 192.32.10.2 255.255.255.0
```

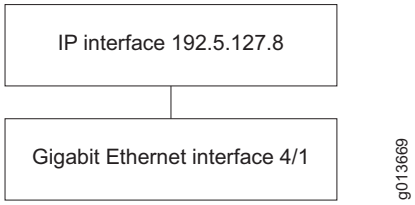
Configuring IP/Ethernet

The E-series router supports IP/Ethernet. When you select an Ethernet interface, you can assign an IP address to it, as the following example shows:

```
host1(config)#interface fastethernet 4/1
host1(config-if)#ip address 192.5.127.8 255.255.255.0
```

Figure 20 shows an IP/Ethernet interface stack.

Figure 20: Example of IP over Ethernet Stacking Configuration Steps



Configuring IP Tunnels, Shared IP Interfaces, and Subscriber Interfaces

The E-series router supports IP tunnels, shared IP interfaces, and subscriber interfaces.

Configuring IP Tunnels

IP tunnels provide a way of transporting datagrams between routers separated by networks that do not support all the protocols that those routers support. To configure an IP tunnel, you must first configure a tunnel-service interface. (See *Configuring Tunnel Service Interfaces* on page 15.)

When you have configured a tunnel-service interface, treat it in the same way as any IP interface on the router. For example, you can configure static IP routes or enable routing protocols on the tunnel interface. The IP configurations that you apply to the tunnels control how traffic travels through the network.

Configuring Shared Interfaces and Subscriber Interfaces

A shared IP interface is one of a group of IP interfaces that use the same layer 2 interface. Shared IP interfaces are unidirectional—they can transmit but not receive traffic. A subscriber interface is an extension of a shared IP interface. Subscriber interfaces are bidirectional—they can both receive and transmit traffic.

You can create multiple shared IP interfaces over the same layer 2 logical interface—for example, atm 5/3.101—enabling more than one IP interface to share the same logical resources. This capability is useful, for example, when data received in one VRF needs to be forwarded out an interface in another VRF, such as for BGP/MPLS VPNs (see *JUNOSe BGP and MPLS Configuration Guide, Chapter 3, Configuring BGP-MPLS Applications*, for more information). You can configure one or more shared IP interfaces. Data sent over shared interfaces uses the same layer 2 interface. You can configure shared interfaces as you would other IP interfaces. Each shared interface has its own statistics.

The E-series router supports subscriber interfaces on a particular type of layer 2 interface, Ethernet. In the absence of VLANS, Ethernet does not have a demultiplexing layer. A subscriber interface adds a demultiplexing layer for an Ethernet interface that is configured without VLANs. Using subscriber interfaces, the router can demultiplex or separate the traffic associated with different subscribers. You can use subscriber interfaces to separate traffic for cable modem subscribers with different levels of service and to separate traffic for VPNs.

For information about configuring shared interfaces and subscriber interfaces, see *JUNOSe IP, IPv6, and IGP Configuration Guide, Chapter 1, Configuring IP*.

Configuring Routing Protocols

After you have set up the interfaces on which IP traffic flows, you can configure the following routing protocols:

- IP multicast protocols—IP multicasting allows a device to send packets to a group of hosts, rather than to a list of individual hosts. Routers use multicast routing algorithms to determine the best route and transmit datagrams throughout the network. See *JUNOSe Multicast Routing Configuration Guide, Chapter 1, Configuring IPv4 Multicast*, for information about how to configure IP multicast.

- Open Shortest Path First (OSPF)—This interior gateway protocol (IGP) advertises the states of network links within an autonomous system. An autonomous system is a set of routers having a single routing policy running under a single technical administration. See *JUNOSe IP, IPv6, and IGP Configuration Guide, Chapter 5, Configuring OSPF,* for information about how to configure OSPF.

- Integrated Intermediate System–to–Intermediate System (integrated IS-IS)—The integrated IS-IS protocol provides routing for IP networks and is an extension of the original IS-IS protocol, which provides routing for pure Open Systems Interconnection (OSI) environments. This link-state protocol builds a complete and consistent picture of a network's topology by sharing link-state information across network devices in a routing domain. A routing domain is a collection of contiguous networks that provide full connectivity to all end systems located within them. See *JUNOSe IP, IPv6, and IGP Configuration Guide, Chapter 6, Configuring IS-IS,* for information about how to configure IS-IS.

- Border Gateway Protocol (BGP)—BGP, an external gateway protocol (EGP), provides loop-free interdomain routing between autonomous systems. See *JUNOSe BGP and MPLS Configuration Guide, Chapter 1, Configuring BGP Routing,* for information about how to configure BGP.

- Routing Information Protocol (RIP)—RIP is an IGP created for use in small, homogeneous networks. RIP uses distance-vector routing to route information through IP networks. See *JUNOSe IP, IPv6, and IGP Configuration Guide, Chapter 4, Configuring RIP,* for information about how to configure RIP.

- Multiprotocol Label Switching (MPLS)—MPLS is a hybrid protocol that integrates network layer routing with label switching to provide a layer 3 network with traffic management capability. Traffic engineering enables more effective use of network resources while maintaining high bandwidth and stability. MPLS enables service providers to offer their customers the best service available given the provider's resources. There are two fundamental aspects to MPLS:

  - Label distribution—The set of actions MPLS performs to establish and maintain a label-switched path (LSP), also known as an MPLS tunnel.

  - Data mapping—The process of getting data packets onto an established LSP.

  See *JUNOSe BGP and MPLS Configuration Guide, Chapter 2, Configuring MPLS,* for information about configuring MPLS.

In addition, if you want to make configuration adjustments to IP, see *JUNOSe IP, IPv6, and IGP Configuration Guide, Chapter 1, Configuring IP*, for details.

Configuring VRRP

The Virtual Router Redundancy Protocol (VRRP) can prevent loss of network connectivity to end hosts if the static default IP gateway fails. By implementing VRRP, you can designate a number of routers as "backup" routers in case the default "master" router fails. You can configure VRRP on IP/Ethernet interfaces.

For information about configuring VRRP, see *JUNOSe IP Services Configuration Guide, Chapter 14, Configuring VRRP*.

Configuring Routing Policy

The router supports a number of features that allow the service provider to control the exchange of routing information between virtual routers in the router, between routers in the network, and between protocols within a router:

- Access lists—Provide filters that can be applied to route maps or distribution lists. They allow policies to be created, such as a policy to prevent forwarding of specified routes between the BGP-4 and IS-IS routing tables.

- Route maps—Modify the characteristics of a route (generally to set its metric or to specify additional attributes) as it is transmitted or accepted by a router. Route maps can use access lists to identify the set of routes to modify.

- Distribution lists—Control the routing information that is accepted or transmitted to peer routers. Distribution lists always use access lists to identify routes for distribution. For example, distribution lists could use access lists to specify routes to advertise.

- Redistribute routes—Allow routes to be shared between routing protocols and routing domains. For example, a subset of BGP-4 routes could be leaked into the IS-IS routing tables.

See *JUNOSe IP Services Configuration Guide, Chapter 1, Configuring Routing Policy,* for details.

Configuring QoS

QoS is a suite of features that configure queuing and scheduling on the forwarding path of your E-series router. QoS provides a level of predictability and control beyond the best-effort service that is the E-series router's default data delivery service. Packets not assigned to a specific traffic class are carried in the best-effort traffic class. Best-effort service provides packet transmission with no guarantee of results.

The major QoS features that the E-series router provides are:

- Multiple traffic classes

- Configurable scheduling

- Configurable buffer management

For information about configuring QoS, see *JUNOSe Quality of Service Configuration Guide, Chapter 16, Configuring and Attaching QoS Profiles to an Interface*.

Configuring Policy Management

Policy management allows network service providers to implement packet forwarding and routing specifically tailored to their customer's requirements. Using policy management, customers can implement policies that selectively cause packets to take different paths. Policy management provides several types of services:

- Policy routing—Predefines packet flow to a destination port or IP address

- QoS classification and marking—Marks packets of a packet flow.

- Packet forwarding—Allows forwarding of a packet flow.

- Packet filtering—Drops packets of a packet flow.

- Packet logging—Logs packets of a packet flow.

- Rate limiting—Enforces line rates below the physical line rate of the port and sets limits on packet flows.
- RADIUS policy support—Allows you to attached a preconfigured policy to an interface through RADIUS.

See *JUNOSe Policy Management Configuration Guide, Chapter 1, Managing Policies on the E-series Router,* for details about configuring policy management.

Configuring Remote Access

The E-series router supports the following remote access functionality:

- Broadband Remote Access Server (B-RAS)—This application runs on the router and is responsible for:
  - Aggregating the output from DSLAMs
  - Providing user PPP sessions and PPP session termination
  - Enforcing QoS policies
  - Routing traffic into an ISP's backbone network

  See *JUNOSe Broadband Access Configuration Guide, Chapter 1, Configuring Remote Access*.
- Layer 2 Tunneling Protocol (L2TP)—A method of encapsulating layer 2 packets, such as PPP, for transmission across a network. In an L2TP relationship, an L2TP access concentrator (LAC) forms a client-server relationship with a destination, known as an L2TP network server (LNS), on a remote network.

  You can configure the router to act as an LAC in PPP pass-through mode. The router creates tunnels dynamically by using AAA authentication parameters and transmits L2TP packets to the LNS through IP/UDP. See *JUNOSe Broadband Access Configuration Guide, Chapter 12, Configuring an L2TP LAC*.
- Non-PPP equal access—A method of allowing remote access in which the router provides IP addresses to subscribers' computers through Dynamic Host Configuration Protocol (DHCP). This method is particularly convenient for broadband (cable and DSL) environments or environments that use bridged Ethernet over ATM, because network operators can support one central system rather than an individual PPPoE client on each subscriber's computer. See *JUNOSe Broadband Access Configuration Guide, Chapter 17, DHCP Overview*.